TACOMA HARBOR, WA
FEASIBILITY STUDY
PIERCE COUNTY, WASHINGTON

APPENDIX D – Compliance Documents

March 2022
UPDATED June 2022

US Army Corps of Engineers
Seattle District

Port of Tacoma

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DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Planning, Environmental and Cultural Resources Branch

OCT 30 2013

Allyson Brooks, Ph.D.
Washington State Historic Preservation Officer
Department of Archaeology and Historic Preservation
P. O. Box 48343
Olympia, WA 98504

SUBJECT: Tacoma Harbor General Investigation, Tacoma, Washington, Determination of APE

Dear Dr. Brooks:

The United States Army Corps of Engineers (Corps) is conducting a General Investigation for navigation improvements to the Sitcum and Blair Waterways of Tacoma Harbor. The Port of Tacoma has requested that the Corps conduct a feasibility study of a potential deepening project in order to meet the draft requirements of the current and anticipated container ship fleet and to improve cost efficiencies at the Port of Tacoma. The Corps has determined and documented the area of potential effects (APE) for the undertaking and is consulting with your office under Section 106 as provided for at 36 CFR § 800.4(a). This letter also summarizes efforts that the Corps has taken to date to identify historic properties that may be affected by the undertaking.

a. **Project Location:** The project area consists of the federally authorized navigation channel of Blair Waterway, the full extent of Sitcum Waterway, the training wall located east of the mouth of the Puyallup River and extending outward into Commencement Bay; and the Saltchuk beneficial use zone, a potential disposal site for dredged materials. The two waterways, training wall, and possible disposal site are located within Sections 22, 27, 28, 33, 34, 35, and 36 Township 21 Range 3 East and Sections 1 and 2 Township 20 Range 3 East, Pierce County, Washington (Figures 1 and 2). The Corps has determined the Area of Potential Effects (APE) to include the full width and length of the federally authorized navigation channel within Blair Waterway, the full length and width of the Sitcum Waterway, the full length and width of the training wall by the Puyallup River mouth, and the entirety of the Saltchuk beneficial use zone. The total surface area of the APE is approximately 770 acres (Figure 3). The Corps believes that the APE is sufficient to identify and consider both direct and indirect effects of the project.

b. **Project Description:** The Corps will identify and evaluate a full range of alternatives in the Blair and Sitcum Waterways. Currently, six alternatives are under consideration:

- No action
- Deepening the federally authorized navigation channel and turning basin in Blair Waterway to 58 feet below mean lower low water (MLLW) with two feet of over dredge

- Deepening Sitcum Waterway to 58 feet below MLLW with two feet of over dredge, removing the northeast dock
- Deepening Sitcum Waterway up to 58 feet below MLLW with two feet of over dredge without removing the northeast dock
- Deepening Blair Waterway as described above and deepening Sitcum Waterway to 58 feet below MLLW with two feet of over dredge, removing the northeast dock
- Deepening Blair Waterway as described above and deepening Sitcum Waterway up to 58 feet below MLLW with two feet of over dredge without removing the northeast dock

The depths of the waterways as of April 2018 are as follows:

- Blair Waterway: Controlling depths for Blair waterway in feet at MLLW range from 48 to 51, while depths outside of the federally authorized navigation channel but within the Blair Waterway range from 26 to 53 feet at MLLW (National Oceanic and Atmospheric Administration 2013, corrected through 2018).
- Sitcum Waterway: Soundings for Sitcum Waterway range from 39 to 53 feet at MLLW (National Oceanic and Atmospheric Administration 2013, corrected through 2018).

Any dredged materials removed from the waterways during the process of deepening would be disposed of in one of three locations: an existing open water disposal site, an existing upland disposal site, or the Saltchuk beneficial use zone.

c. **Cultural Resources:** We would like to summarize efforts taken to date to identify cultural resources within the APE. The Corps staff archaeologist has completed a records and literature search in the Washington Information System for Architectural & Archaeological Records Data (WISAARD) and within the Corps' Seattle District library of cultural resource reports. In addition, aerial photographs, General Land Office plat maps, nautical charts, 19th century maps of the area, and National Oceanic and Atmospheric Administration (NOAA) bathymetric sounding reports were reviewed.

One archaeological site has been located within the APE. Site 45PI47 (Wapato Creek Fish Weir) is located roughly two miles southeast of the Blair Waterway entrance near Berths A and B, and sat roughly 0.5 miles from the location where Wapato Creek previously emptied into Commencement Bay. The site was found during dredging in October 1970, and was excavated hydraulically (Munsell n. d.). Later, the site was dated to CE 1420-1640 through radiometric analysis (Cooper 2008). Dating and placement suggest that the weir would have been located in the Wapato Creek marsh zone when in use (Berger, Medville, and Chambers 2008). A comparison of nautical charts from 1970 and 2013 indicates that in the vicinity of the site, the depth of Blair Waterway has increased from a maximum of 43 feet to a maximum of 51 feet below MLLW (Coast and Geodetic Survey 1970, National Oceanic and Atmospheric Administration 2013).

Research established that an additional three recorded archaeological sites exist within one mile of the project area. These sites include PI00706, a historic refuse scatter dated to a 1945-1950 squatter occupation and a circa 1910 dairy farm (Kent 2004); PI00975 (Cooper 2009), identified as abandoned pilings and historic debris dating to the late 19th to mid-20th century waterfront; and PI00974, a shell midden 2.14 meters below the modern surface and located below the water table, fill, floodplain, wetland, and a layer of peat (Shantry 2009).

Beginning with the establishment of the Port in 1918, much of the Port area has been heavily modified as fill from construction of the waterways was placed atop the Tacoma tideflats resulting in five to 10 feet of fill deposit upon which the port has been built, indicating that any pre-contact archaeological sites likely exist at a minimum depth of five feet (Berger and Chambers 2006; Port of Tacoma 2018). Geotechnical borings taken immediately west of Blair Waterway indicated peat layers at approximately 35 feet below modern surface, potentially indicative of the past existence of a stable surface within the Tacoma tideflats (Dively and Martin 2010).

The Saltchuk beneficial use zone, a possible location for dredged material disposal, sits immediately southeast of Tyee Marina near the shoreline of southeast Commencement Bay. A 1948 nautical chart produced by the U. S. Coast and Geodetic Survey indicates that the area was used as booming grounds, and ranged in depth from 3 to 47 feet (Coast and Geodetic Survey 1948). A similar chart corrected through 2018 depicts the area in use for the same purpose (National Oceanic and Atmospheric Association 2013). Between 2007 and 2009 multi-beam hydrography and side scan sonar data was collected by NOAA in the majority of the Port of Tacoma, to include Blair and Sitcum Waterways, in order to validate the existing Electronic Nautical Chart. No shipwrecks were noted in Blair or Sitcum. The log booming area in southeast Commencement Bay where Saltchuk is located and the mouth of the Puyallup River were not surveyed. However, the results indicate that the "area near Tyee Marina [...] is littered with debris and sunken wrecks" (Simmons 2009). It is unknown how much dredged material could be placed at the Saltchuk beneficial use area or if it will be selected for the purpose of benefical use as the project moves forward.

c. **Next Steps:** As this study develops, the Corps will be conducting sediment sampling within Blair and Sitcum waterways. An archaeologist will monitor the sediment sampling to determine if cultural resources are present. The Corps will be conducting further research of the project area as the project progresses.

The Corps is also notifying the Confederated Tribes and Bands of the Yakama Nation Puyallup Tribe of Indians, Muckleshoot Indian Tribe, Nisqually Indian Tribe, the Snoqualmie Tribe, and the Squaxin Island Tribe about the study to identify properties to which they may attach religious or cultural significance and to address other concerns about historic properties that may be affected.

The Corps requests your review and agreement with our determination of the APE. If you have any questions or desire additional information, please contact the project archaeologists, Kara Kanaby at kara.m.kanaby@usace.army.mil or (206) 764-6857 and Alaina Harmon at alaina.harmon@usace.army.mil or (206) 764-3630. I may be contacted at laura.a.boerner@usace.army.mil or (206) 764-6761.

Sincerely,

LAURA A. BOERNER

Chief, Planning, Environmental and
Cultural Resources Branch
Seattle District, U. S. Army Corps of Engineers

References Cited:

Berger, Margaret and Jennifer Chambers.

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1970. Tacoma Harbor. Chart retrieved from NOAA's Office of Coast Survey Historical Map & Chart Collection. https://historicalcharts.noaa.gov.

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N. d. The Wapato Creek Fish Weir Site 45 PI 47 Tacoma, Washington. U. S. Army Corps of Engineers, Seattle District, Seattle, WA.

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Port of Tacoma

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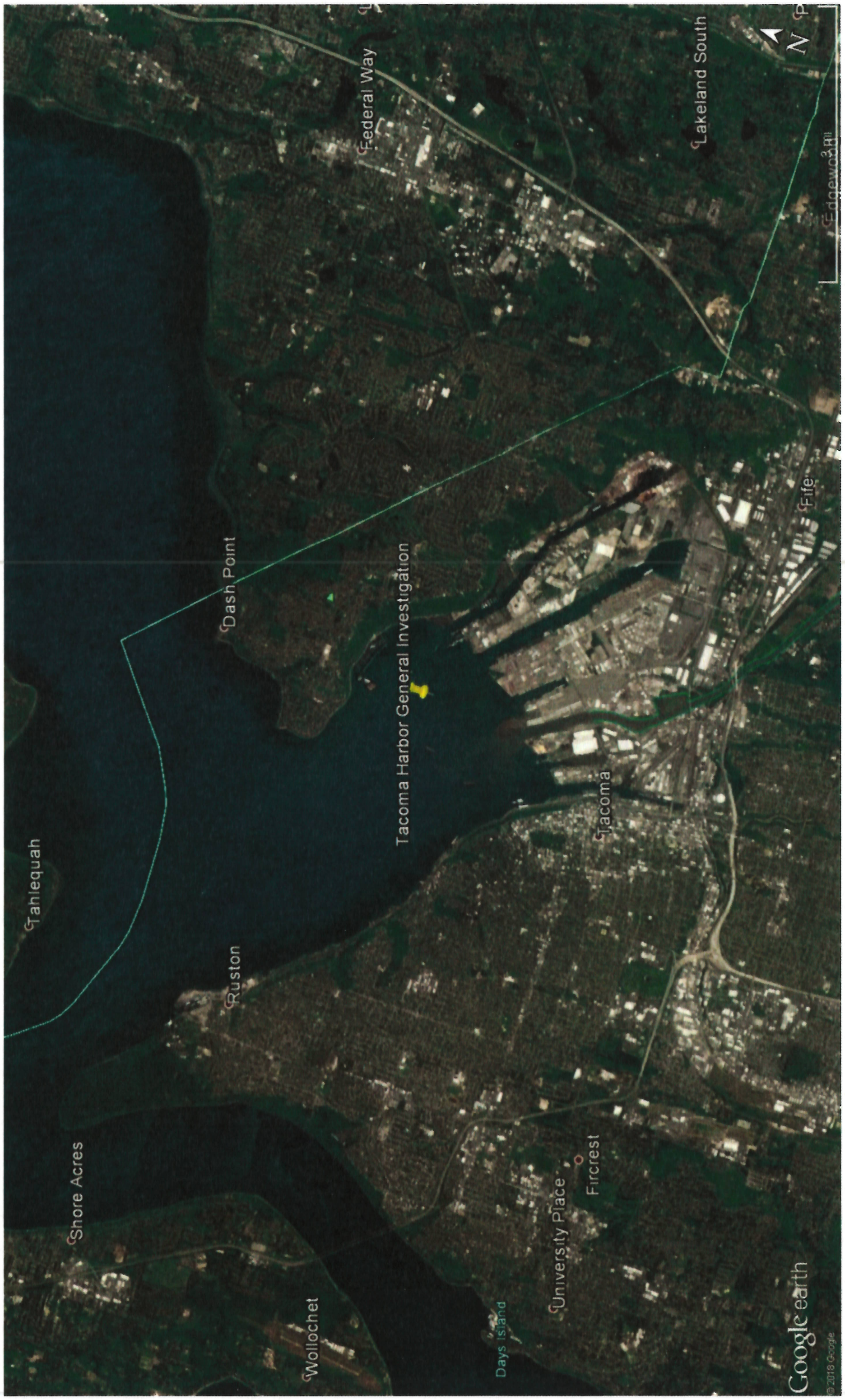


Figure 1: Study location

Figure 2: Overview of study area.

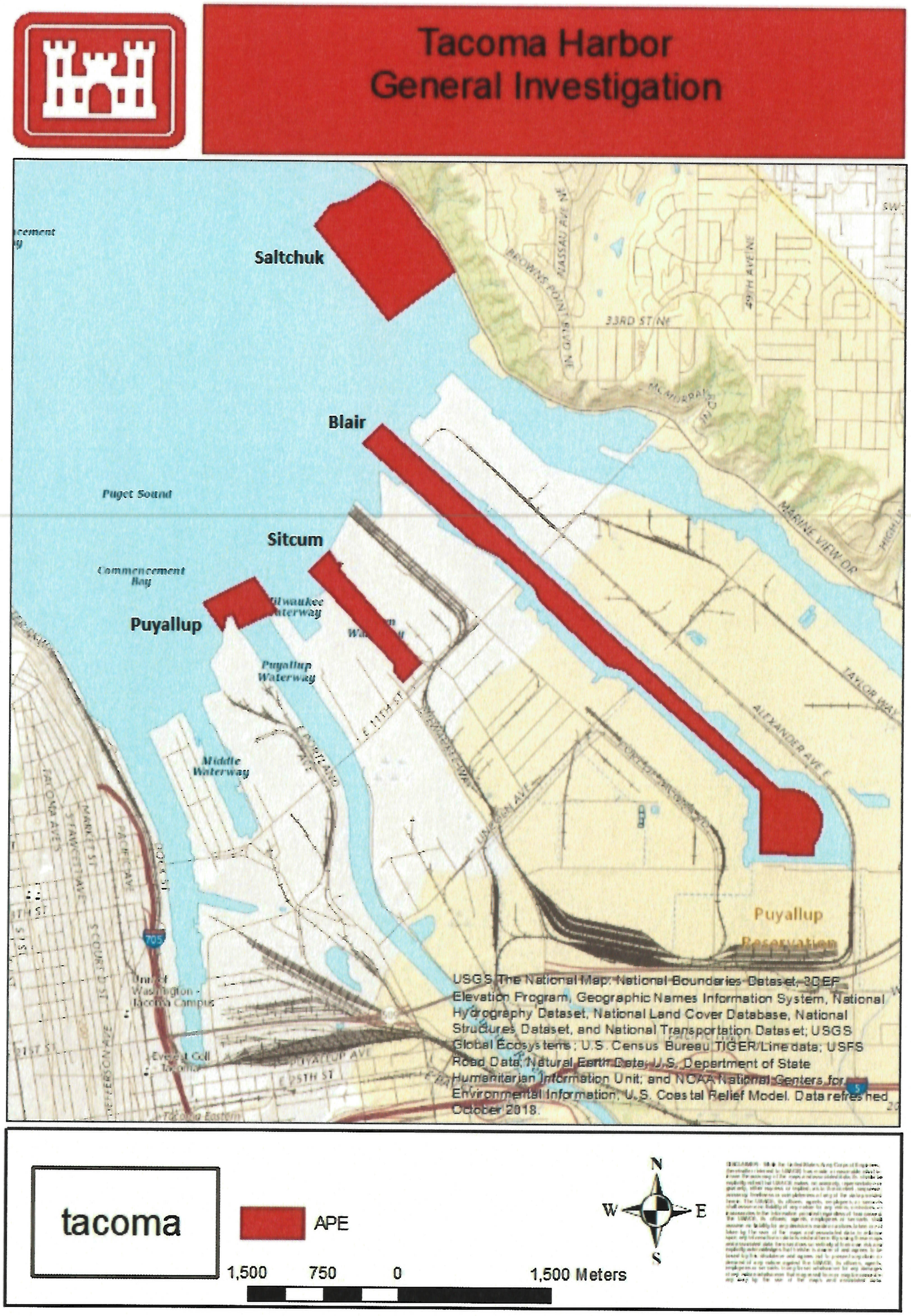


Figure 3: Study APE.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Planning, Environmental and Cultural Resources Branch

MAR 26 2019

Allyson Brooks, Ph.D.
Washington State Historic Preservation Officer
Department of Archaeology and Historic Preservation
P. O. Box 48343
Olympia, WA 98504

SUBJECT: Tacoma Harbor Investigation, Tacoma, Washington, Revision of APE, DAHP Project 2018-10-08487

Dear Dr. Brooks:

The United States Army Corps of Engineers (Corps) is continuing consultation on the Tacoma Harbor Investigation project, DAHP Project 2018-10-08487. In our letter of 30 October 2018, the Corps documented the area of potential effect (APE) with which your office agreed on 30 October 2018. This letter documents the revised APE, and provides an update to the project description. As mentioned in our 30 October 2018 letter, the Port of Tacoma has requested that the Corps conduct a feasibility study of a potential deepening project in order to meet the draft requirements of the current and anticipated container ship fleet and to improve cost efficiencies at the Port of Tacoma. Currently, large vessels upwards of 14,000 twenty-foot equivalent units are already calling on the Blair Waterway and the Port of Tacoma.

The following changes have occurred to the project: the training wall by the Puyallup River mouth and the Sitcum Waterway have been removed from the project. The Port of Tacoma has determined that deepening of Sitcum Waterway would require a significant investment, and is not projected to be feasible within the next 10 years. The training wall in the project was connected to the inclusion of Sitcum Waterway to address the possibility that there could be faster accumulation of sediment from the Puyallup River into Sitcum Waterway resulting in an increase of maintenance dredging.

In addition, the footprint for the Blair Waterway has been expanded to account for the widening and lengthening of the navigation channel and widening of the turning basin. Currently, the Blair Waterway is approximately 2.75 miles long including the turning basin. The authorized dimensions are 520 feet wide from the mouth to 11th Street, 345 feet wide through the 11th Street reach, 520 feet wide from 11th street to Lincoln Avenue, and 330 feet wide from Lincoln Avenue to the turning basin. The turning basin is 1300 feet wide and the dredge depth is -51 feet mean lower low water (MLLW) for the Waterway and turning basin. For this project the following is proposed:

- the authorized width of 520 feet from the mouth to 11th Street would be maintained;

- the authorized width of the 11th Street reach would increase from 345 feet wide to 520 feet wide;
- the authorized width of the 11th Street to Lincoln Avenue would be maintained at 520 feet wide;
- the authorized width of the Lincoln Avenue to the turning basin would increase from 330 feet wide to 520 feet;
- the turning basin would increase from 1300 feet to 1600 feet;
- the depth of dredging would be –58 feet MLLW plus two feet of over dredge for the Waterway and turning basin

The project area consists of the federally authorized navigation channel of Blair Waterway; and the Saltchuk beneficial use zone, a potential disposal site for dredged materials. The Blair Waterway and possible disposal site are located within Sections 22, 27, 28, 34, 35, and 36 Township 21 Range 3 East and Sections 1 and 2 Township 20 Range 3 East, Pierce County, Washington (Enclosures 1 and 2). The Corps has determined the revised APE to include the full width from pier head to pier head, length and depth of the Blair Waterway necessary for deepening the Waterway, and the entirety of the Saltchuk beneficial use zone.

The total surface area of the revised APE is approximately 872 acres. The Corps believes that the revised APE is sufficient to identify and consider both direct and indirect effects of the project.

The Corps previously notified the Confederated Tribes and Bands of the Yakama Nation Puyallup Tribe of Indians, Muckleshoot Indian Tribe, Nisqually Indian Tribe, the Snoqualmie Tribe, and the Squaxin Island Tribe by letter on 30 October 2018 about the study in order to identify properties to which they may attach religious or cultural significance and to address other concerns about historic properties that may be affected. The Corps will notify the aforementioned Tribes of the revised APE and changes to the projects description in a separate letter.

The Corps requests your review and agreement with our determination of the revised APE. If you have any questions or desire additional information, please contact the project archaeologist, Kara Kanaby at kara.m.kanaby@usace.army.mil or (206) 764-6857. I may be contacted at laura.a.boerner@usace.army.mil or (206) 764-6761.

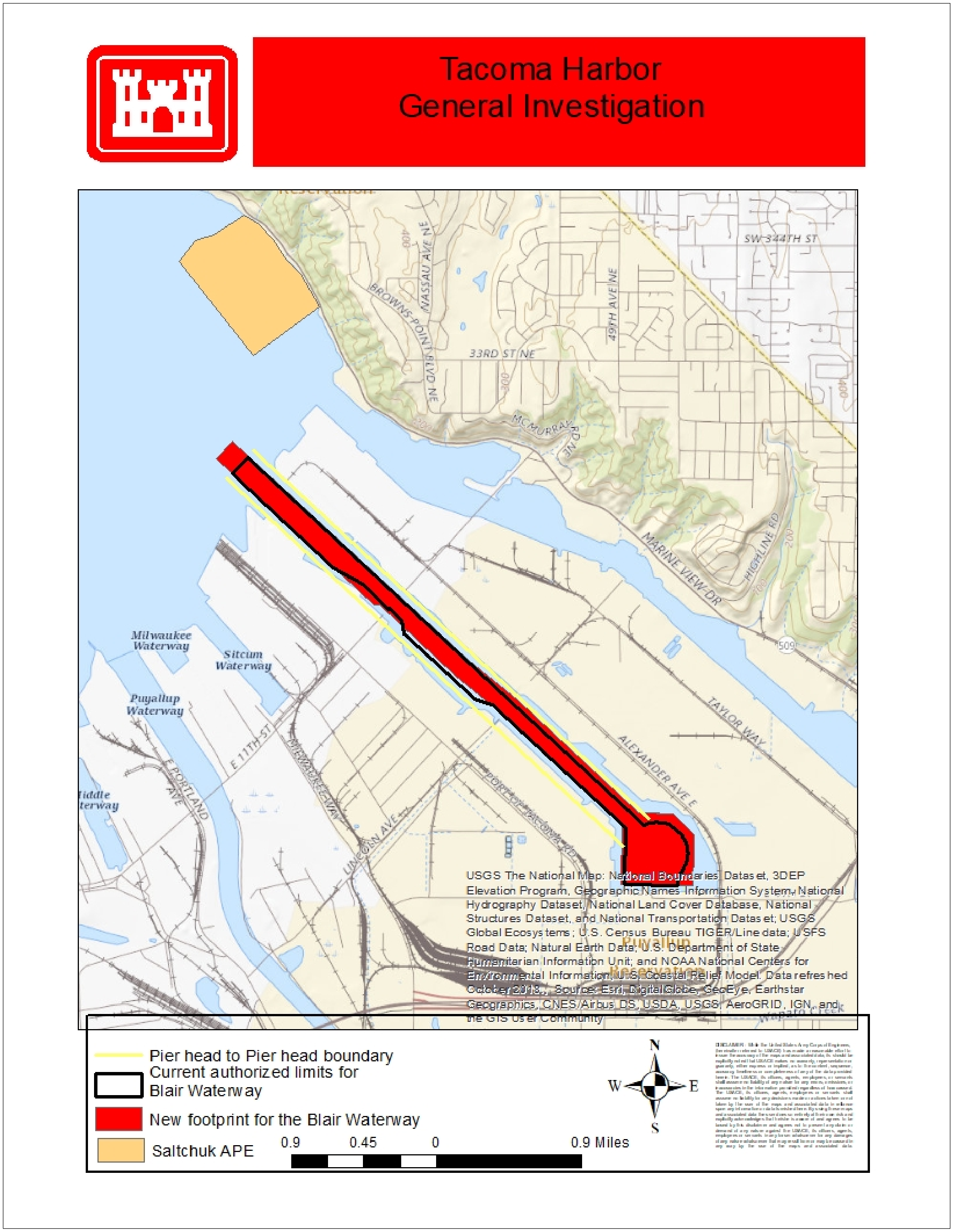
2 Encl

Sincerely,

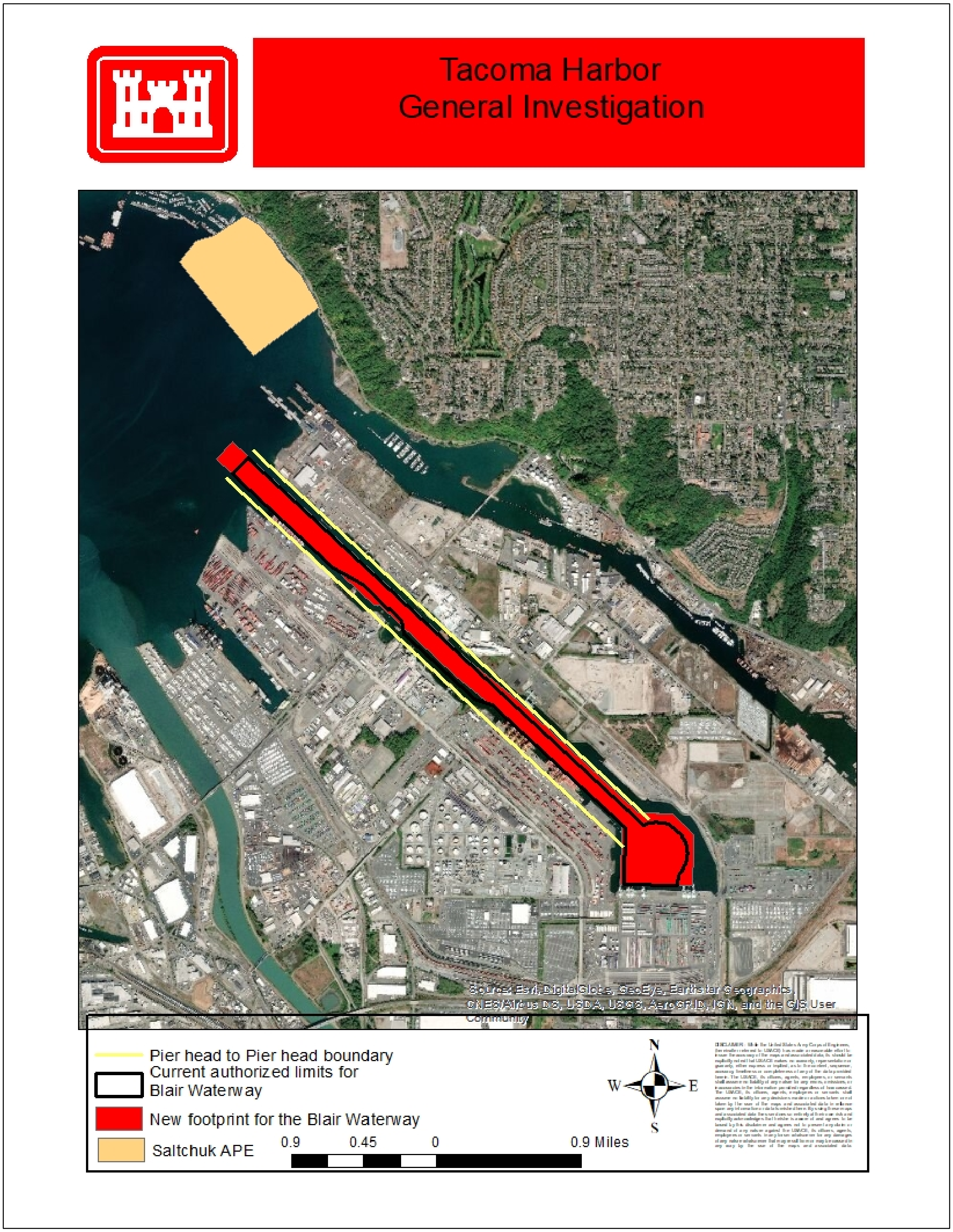
for

LAURA A. BOERNER

Chief, Planning, Environmental and
Cultural Resources Branch
Seattle District, U. S. Army Corps of
Engineers



Enclosure 1: Revised APE



Enclosure 2: Aerial map of revised APE.

dahp
protect the past, shape the future

Allyson Brooks Ph.D., Director
State Historic Preservation Officer

October 30, 2018

Ms. Laura A. Boerner
Environmental Resources Section
Corps of Engineers – Seattle District
PO Box 3755
Seattle, Washington 98124-3755

Re: Tacoma Harbor General Investigation Project
Log No.: 2018-10-08487-COE-S

Dear Ms. Boerner:

Thank you for contacting our department. We have reviewed the materials you provided for the Area of Potential Effect (APE) for the proposed Tacoma Harbor General Investigation Project to the Sitcum and Blair Waterways, Tacoma, Pierce County, Washington

We concur with your determination of the Area of Potential Effect (APE) as described and presented in your figures and text.

We look forward to further consultations as you consult with the concerned tribal governments, provide the results of the professional cultural resources review, and render your determination of effect.

We would also appreciate receiving any correspondence or comments from concerned tribes or other parties that you receive as you consult under the requirements of 36CFR800.4(a)(4).

These comments are based on the information available at the time of this review and on behalf of the State Historic Preservation Officer in compliance with the Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations 36CFR800.4. Should additional information become available, our assessment may be revised. Thank you for the opportunity to comment.

Sincerely,

Robert G. Whitlam, Ph.D.
State Archaeologist
(360) 890-2615
email: *rob.whitlam@dahp.wa.gov*

April 8, 2019

Ms. Laura A. Boerner
Environmental Resources Section
Corps of Engineers – Seattle District
PO Box 3755
Seattle, Washington 98124-3755

Re: Tacoma Harbor Investigations Project
Log No.: 2018-10-08487-COE-S

Dear Ms. Boerner:

Thank you for contacting our department. We have reviewed the revised materials you provided for the Area of Potential Effect (APE) for the proposed Tacoma Harbor Investigations Project, Pierce County, Washington

We concur with your determination of the Area of Potential Effect (APE) as described and presented in your figures and text.

We look forward to further consultations as you consult with the concerned tribal governments, provide the results of the professional cultural resources review, and render your determination of effect.

We would also appreciate receiving any correspondence or comments from concerned tribes or other parties that you receive as you consult under the requirements of 36CFR800.4(a)(4).

These comments are based on the information available at the time of this review and on behalf of the State Historic Preservation Officer in compliance with the Section 106 of the National Historic Preservation Act, as amended, and its implementing regulations 36CFR800.4. Should additional information become available, our assessment may be revised. Thank you for the opportunity to comment.

Sincerely,

Robert G. Whitlam, Ph.D.
State Archaeologist
(360) 890-2615
email: *rob.whitlam@dahp.wa.gov*

Laroy, Tobie M CIV USARMY CENWS (USA)

From: Castronuevo, Agnes F CIV USARMY CENWS (USA)
Sent: Tuesday, April 27, 2021 11:23 AM
To: Whitlock, Kaitlin E CIV USARMY CENWS (US); Laroy, Tobie M CIV USARMY CENWS (USA); Ceragioli, Kristine S CIV USARMY CENWS (USA); Kramer, Donald J CIV USARMY CENWS (USA)
Subject: FW: [Non-DoD Source] RE: USACE - Tacoma Harbor GI Project DAHP Log.: 2018-10-08487-COE-S

Hi All,

Please find an email confirmation from SHPO of the Corps' determination of No Adverse Effect to Historic Properties.

Sincerely,
Agnes

Agnes F Castronuevo
Archaeologist
U.S. Army Corps of Engineers - Seattle District
Office: 206-316-3096
Agnes.F.Castronuevo@usace.army.mil

From: Whitlam, Rob (DAHP) <Rob.Whitlam@DAHP.WA.GOV>
Sent: Tuesday, April 27, 2021 10:21 AM
To: Castronuevo, Agnes F CIV USARMY CENWS (USA) <Agnes.F.Castronuevo@usace.army.mil>
Cc: Punke, Matthew M CIV USARMY CENWS (USA) <Matthew.M.Punke@usace.army.mil>
Subject: [Non-DoD Source] RE: USACE - Tacoma Harbor GI Project DAHP Log.: 2018-10-08487-COE-S

Agnes;

Thank you for this email and follow on.. Yes, we concur with the determination of No Adverse Effect…

Regards,

Rob

From: Castronuevo, Agnes F CIV USARMY CENWS (USA) <Agnes.F.Castronuevo@usace.army.mil>
Sent: Tuesday, April 27, 2021 9:22 AM
To: Whitlam, Rob (DAHP) <Rob.Whitlam@DAHP.WA.GOV>
Cc: Punke, Matthew M CIV USARMY CENWS (USA) <Matthew.M.Punke@usace.army.mil>
Subject: USACE - Tacoma Harbor GI Project DAHP Log.: 2018-10-08487-COE-S

External Email

Hi Rob,

In November 2019, the Corps submitted a Determination of No Adverse Effect to Historic Properties to SHPO. We received a SHPO letter indicating its concurrence with No Effect to Historic Properties.

Based on your recent conversation with Matt Punke, Corps Cultural Resources Branch Chief, regarding the Corps' Determination of Effect of No Adverse Effect to Historic Properties, do you concur with the Corps' determination? Please advise.

Sincerely,
Agnes

Agnes F Castronuevo
Archaeologist
U.S. Army Corps of Engineers - Seattle District
Office: 206-316-3096
Agnes.F.Castronuevo@usace.army.mil

Tribal Coordination Letters

Introductory tribal coordination letters were sent to the following local tribes on October 3, 2018:

- Muckleshoot Indian Tribe
- Puyallup Tribe of Indians
- Nisqually Indian Tribe
- Snoqualmie Indian Tribe
- Squaxin Island Tribe
- The Confederated Tribes and Bands of the Yakama Nation

An example letter with identifying information removed follows this sheet. The letters were sent to the tribal chair and the tribal natural resources director to solicit comments and hear about specific resources of concern.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

October 3, 2018

Planning, Environmental, and Cultural Resources Branch

[redacted]

OCT 0 3 2018

Dear [redacted]

The U.S. Army Corps of Engineers, Seattle District (Corps) has initiated a feasibility study at Tacoma Harbor, Washington. The purpose of the study is to investigate modification of the Tacoma Harbor deep draft navigation project in the interest of navigation improvements for efficiency. The focus of the feasibility study is on navigation improvements specifically in the Blair and Sitcum Waterways, where the Corps will evaluate the feasibility of deepening and widening the waterways up to -58 feet Mean Lower Low Water (Figures 1 and 2). The Corps has identified the [redacted] (Tribe) as having interest in this study because of the location and possible effects on water resources located in your traditional lands and potentially usual and accustomed fishing areas. The Port of Tacoma is the non-Federal sponsor for the Corps study.

We would like to introduce our staff who will be working on the project:

Project Manager: Kristine Ceragioli	(206) 764-6745
Plan Formulator: Donald Kramer	(206) 764-6967
Lead Environmental Coordinator: Nancy Gleason	(206) 764-6577
Environmental Coordinator: Kaitlin Whitlock	(206) 764-3576
Cultural Resources: Kara Kanaby	(206) 764-6857

The Corps has initiated scoping for development of an integrated Draft Feasibility Report/National Environmental Policy Act document. During the scoping process, we would like to afford the Tribe the opportunity to provide input to what is studied and regarding tribal resources considerations. We wish to maintain assurance of your interests and be apprised of any objections, requests, or requirements you may have. The Corps welcomes the opportunity to work with your Tribe on the technical issues of this study as well. Should you decide to engage any of your technical staff on this study, please provide the name(s) and contact information of any person(s) with whom you wish us to work directly on technical matters of concern to your Tribe.

To facilitate communication regarding environmental and cultural considerations in this study, the Corps will host a special session to discuss the Tacoma Harbor feasibility study during the next Semi-Annual Agency and Tribal Dredging Coordination meeting on October 25, 2018 at 1:30 p.m. at the Seattle District office. An email will come to your staff requesting participation and to provide meeting details. The Corps is also formally consulting with the Puyallup Tribe of Indians, Nisqually Indian Tribe, Snoqualmie Indian Tribe, Squaxin Island Tribe, and the Yakama Nation. They will be invited to the upcoming meeting.

A copy of this letter has been sent to the following Tribal staff member, [redacted] Natural Resources Director. You will be receiving additional correspondence from the Corps by separate letter regarding the Corps' Section 106 consultation responsibilities under the National Historic Preservation Act.

For additional information regarding the Tacoma Harbor feasibility study, please contact Ms. Kristine Ceragioli, Project Manager, at (206) 764-6745 or Kristine.S.Ceragioli@usace.army.mil. For assistance regarding tribal coordination, please contact Ms. Lori Morris, Tribal Liaison, at (206) 764-3625 or frances.morris@usace.army.mil.

Sincerely,

[redacted]

Laura A. Boerner
Chief, Planning, Environmental & Cultural
Resources Branch

Enclosures

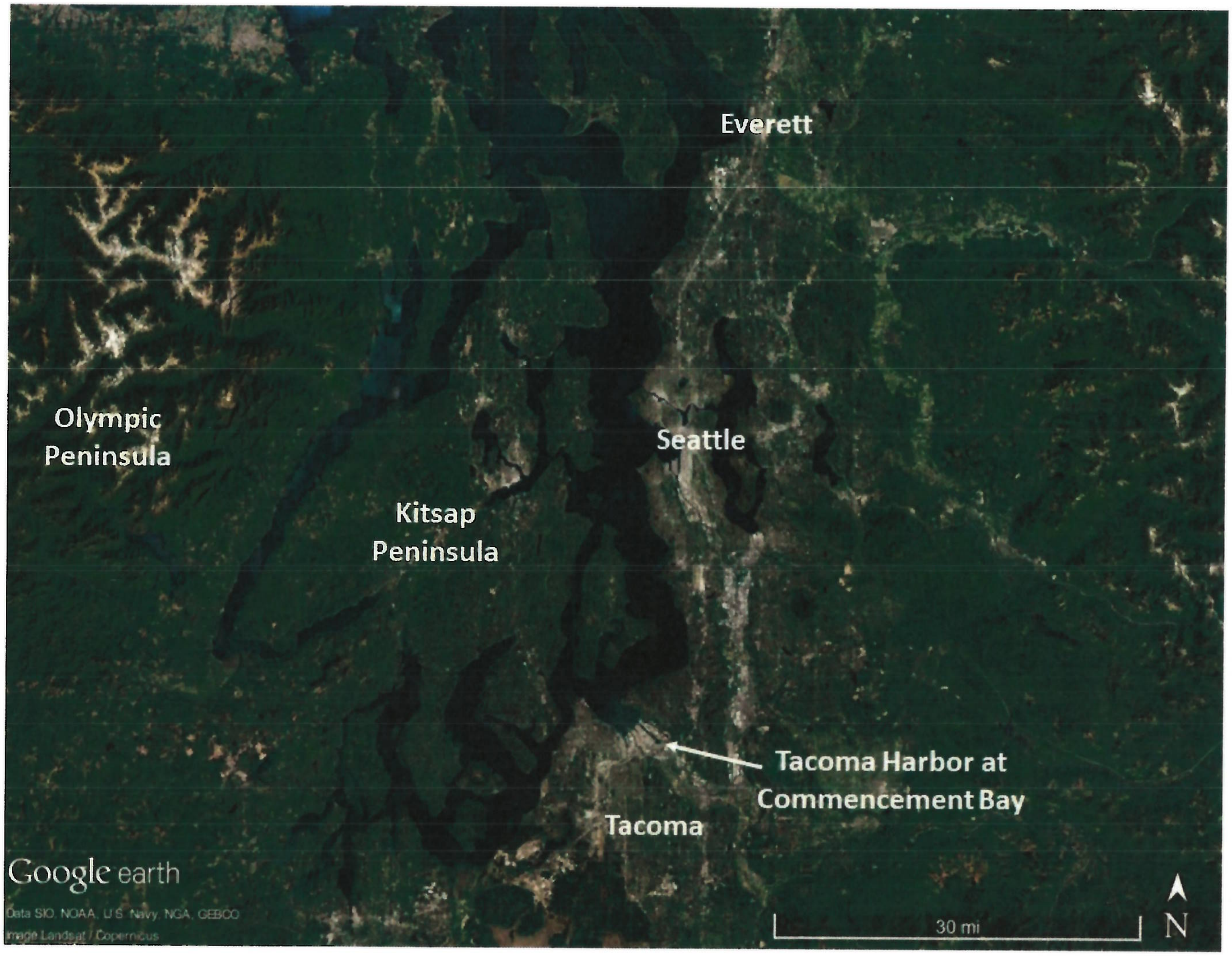


Figure 1. Vicinity of the project location, Tacoma Harbor at Commencement Bay, within Puget Sound.

Figure 2. Location of the proposed feasibility study area in the Blair and Sitcum Waterways within Commencement Bay and adjacent to the Puyallup River.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Planning, Environmental and Cultural Resources Branch

OCT 30 2018

The Honorable Virginia Cross
Chair, Muckleshoot Indian Tribe
39105 172th Avenue Southeast
Auburn, WA 98092

SUBJECT: Section 106 Review for the Tacoma Harbor General Investigation, Tacoma, Washington

Dear Madam Chair:

The United States Army Corps of Engineers (Corps) is conducting a General Investigation for navigation improvements to the Sitcum and Blair Waterways of Tacoma Harbor. The Port of Tacoma has requested that the Corps conduct a feasibility study of a potential deepening project in order to meet the draft requirements of the current and anticipated container ship fleet and to improve cost efficiencies at the Port of Tacoma. To assist in our review of the proposed project under Section 106 of the National Historic Preservation Act (NHPA), we are notifying the Muckleshoot Indian Tribe (Tribe) about the project, requesting your assistance in identifying any issues or concerns the Tribe may have, and seeking information to identify properties that may be affected by the project which may be of religious or cultural significance to the Tribe (see 36 CFR 800.4(a)(4)).

a. **Project Location:** The project area consists of the federally authorized navigation channel of Blair Waterway, the full extent of Sitcum Waterway, the training wall located east of the mouth of the Puyallup River and extending outward into Commencement Bay; and the Saltchuk beneficial use zone, a potential disposal site for dredged materials. The two waterways, training wall, and possible disposal site are located within Sections 22, 27, 28, 33, 34, 35, and 36 Township 21 Range 3 East and Sections 1 and 2 Township 20 Range 3 East, Pierce County, Washington (Figures 1 and 2). The Corps has determined the Area of Potential Effects (APE) to include the full width and length of the federally authorized navigation channel within Blair Waterway, the full length and width of the Sitcum Waterway, the full length and width of the training wall by the Puyallup River mouth, and the entirety of the Saltchuk beneficial use zone. The total surface area of the APE is approximately 770 acres (Figure 3). The Corps believes that the APE is sufficient to identify and consider both direct and indirect effects of the project.

b. **Project Description:** The Corps will identify and evaluate a full range of alternatives in the Blair and Sitcum Waterways. Currently, six alternatives are under consideration:

- No action

- Deepening the federally authorized navigation channel and turning basin in Blair Waterway to 58 feet below mean lower low water (MLLW) with two feet of over dredge
- Deepening Sitcum Waterway to 58 feet below MLLW with two feet of over dredge, removing the northeast dock
- Deepening Sitcum Waterway up to 58 feet below MLLW with two feet of over dredge without removing the northeast dock
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The depths of the waterways as of April 2018 are as follows:

- Blair Waterway: Controlling depths for Blair waterway in feet at MLLW range from 48 to 51, while depths outside of the federally authorized navigation channel but within the Blair Waterway range from 26 to 53 feet at MLLW (National Oceanic and Atmospheric Administration 2013, corrected through 2018).
- Sitcum Waterway: Soundings for Sitcum Waterway range from 39 to 53 feet at MLLW (National Oceanic and Atmospheric Administration 2013, corrected through 2018).

Any dredged materials removed from the waterways during the process of deepening would be disposed of in one of three locations: an existing open water disposal site, an existing upland disposal site, or the Saltchuk beneficial use zone.

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Research established that an additional three recorded archaeological sites exist within one mile of the project area. These sites include PI00706, a historic refuse scatter dated to a 1945-1950 squatter occupation and a circa 1910 dairy farm (Kent 2004); PI00975 (Cooper 2009), identified as abandoned pilings and historic debris dating to the late 19th to mid-20th

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The Saltchuk beneficial use zone, a possible location for dredged material disposal, sits immediately southeast of Tyee Marina near the shoreline of southeast Commencement Bay. A 1948 nautical chart produced by the U. S. Coast and Geodetic Survey indicates that the area was used as booming grounds, and ranged in depth from 3 to 47 feet (Coast and Geodetic Survey 1948). A similar chart corrected through 2018 depicts the area in use for the same purpose (National Oceanic and Atmospheric Association 2013). Between 2007 and 2009 multi-beam hydrography and side scan sonar data was collected by NOAA in the majority of the Port of Tacoma, to include Blair and Sitcum Waterways, in order to validate the existing Electronic Nautical Chart. No shipwrecks were noted in Blair or Sitcum. The log booming area in southeast Commencement Bay where Saltchuk is located and the mouth of the Puyallup River were not surveyed. However, the results indicate that the "area near Tyee Marina [...] is littered with debris and sunken wrecks" (Simmons 2009). It is unknown how much dredged material could be placed at the Saltchuk beneficial use area or if it will be selected for the purpose of benefical use as the project moves forward.

c. **Next Steps:** As this study develops, the Corps will be conducting sediment sampling within Blair and Sitcum waterways. An archaeologist will monitor the sediment sampling to determine if cultural resources are present. The Corps will be conducting further research of the project area as the project progresses.

If the Muckleshoot Indian Tribe has concerns with the proposed project or has information or concerns regarding properties which may be of religious or cultural significance that you believe may be affected by this project, please contact us as soon as possible so that we may consult with you and ensure consideration of your views and comments in a timely manner. A copy of this letter with enclosures will be sent to Laura Murphy, Archaeologist, Muckleshoot Indian Tribe, 39105 172th Avenue Southeast, Auburn, WA 98092.

For more information about this project, clarification about this request, or to request a formal government-to-government meeting for Section 106 or other concerns with this project please contact the project archaeologists, Kara Kanaby at kara.m.kanaby@usace.army.mil or (206) 764-6857 and Alaina Harmon at alaina.harmon@usace.army.mil or (206) 764-3630. You may also contact Ms. Lori Morris, Tribal Liaison, at (206) 764-3625 or by email at frances.morris@usace.army.mil. I may be contacted at laura.a.boerner@usace.army.mil or (206) 764-6761.

Sincerely,

LAURA A. BOERNER

Chief, Planning, Environmental and
Cultural Resources Branch
Seattle District, U. S. Army Corps of Engineers

References Cited:

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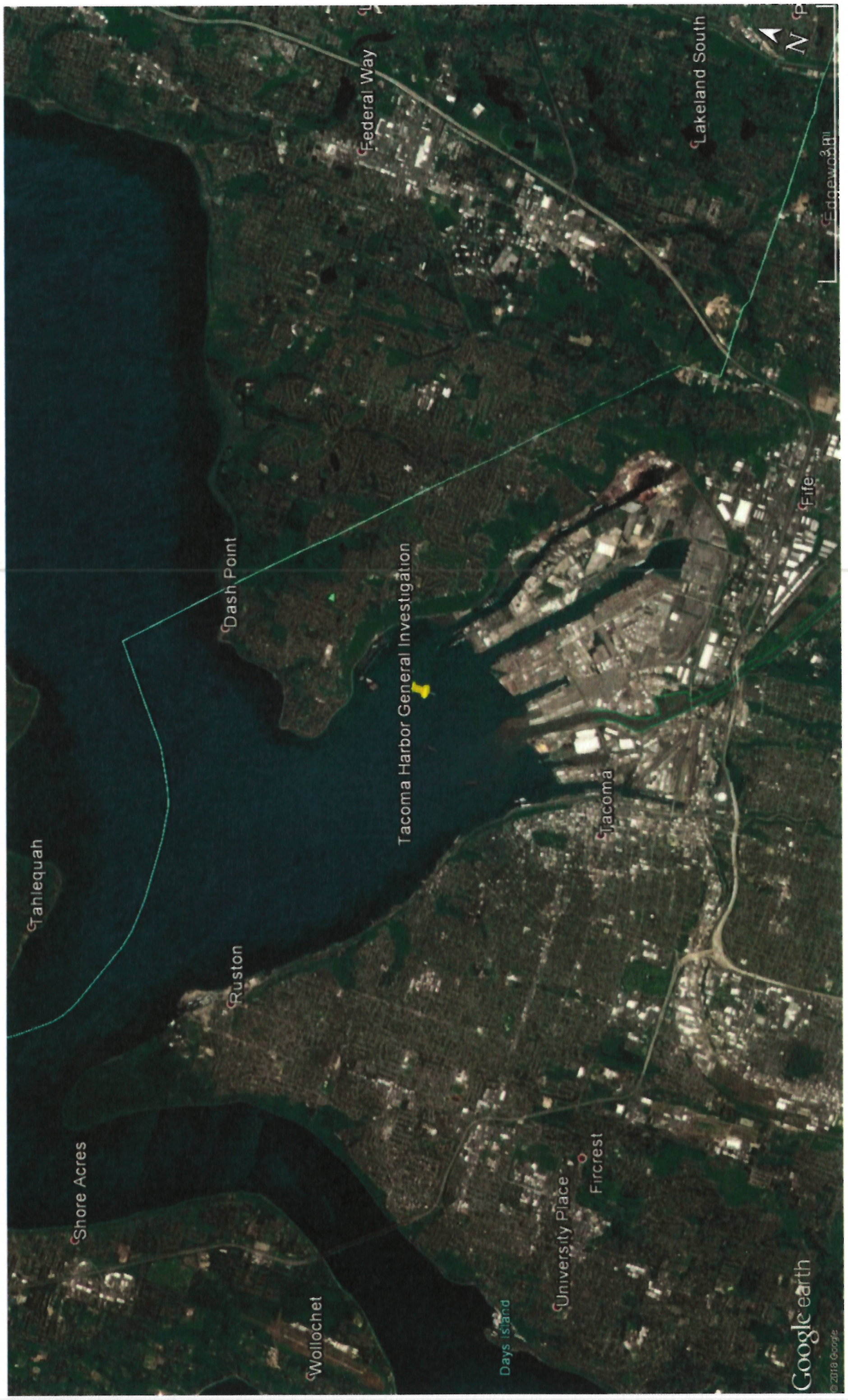

Figure 1: Study location

Figure 2: Overview of study area.

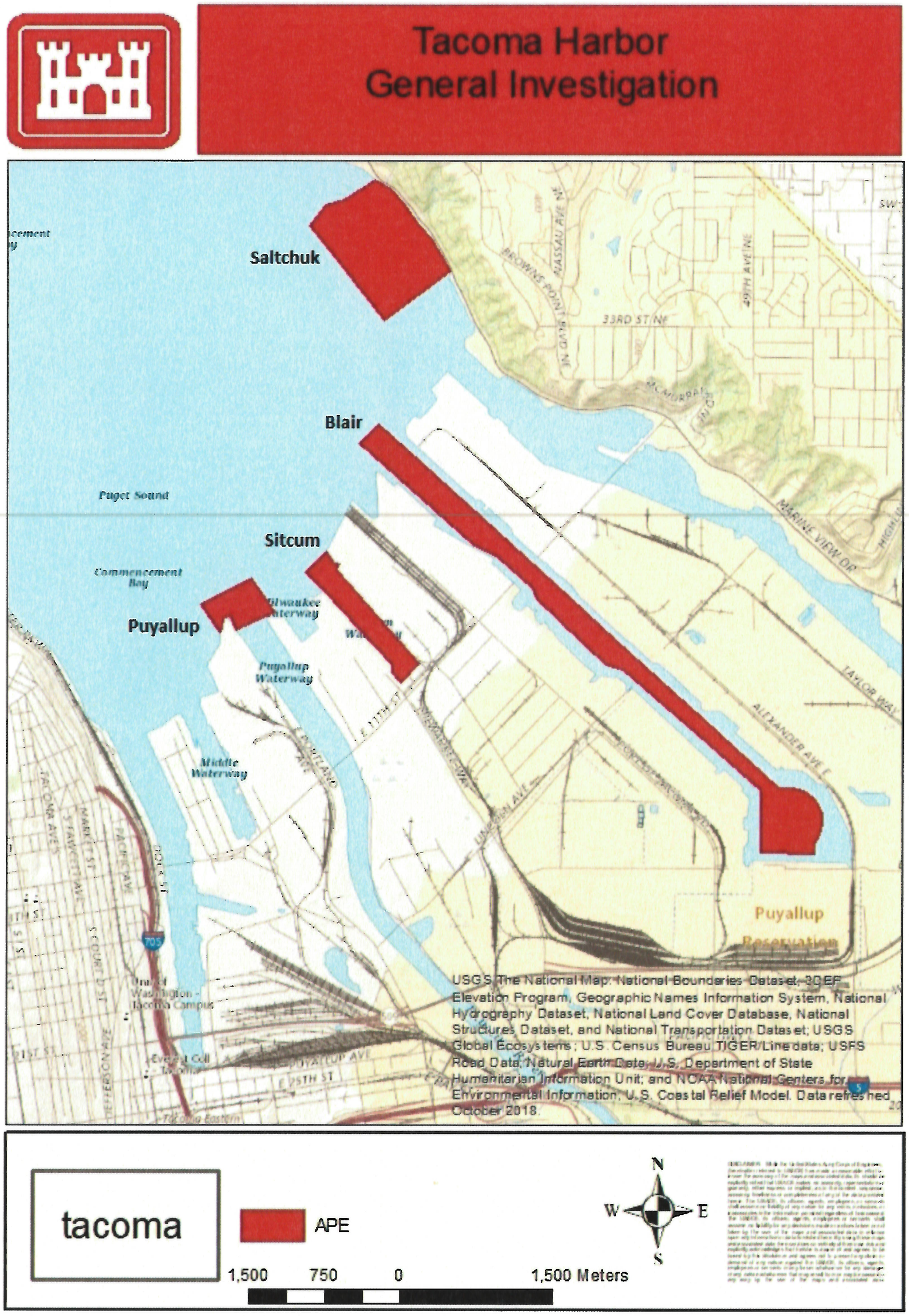

Figure 3: Study APE.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Planning, Environmental and Cultural Resources Branch

OCT 30 2018

The Honorable Ken Choke
Chair, Nisqually Indian Tribe
4820 She-Nah-Num Drive SE
Olympia, WA 98513

SUBJECT: Section 106 Review for the Tacoma Harbor General Investigation, Tacoma, Washington

Dear Chairman Choke:

The United States Army Corps of Engineers (Corps) is conducting a General Investigation for navigation improvements to the Sitcum and Blair Waterways of Tacoma Harbor. The Port of Tacoma has requested that the Corps conduct a feasibility study of a potential deepening project in order to meet the draft requirements of the current and anticipated container ship fleet and to improve cost efficiencies at the Port of Tacoma. To assist in our review of the proposed project under Section 106 of the National Historic Preservation Act (NHPA), we are notifying the Nisqually Indian Tribe (Tribe) about the project, requesting your assistance in identifying any issues or concerns the Tribe may have, and seeking information to identify properties that may be affected by the project which may be of religious or cultural significance to the Tribe (see 36 CFR 800.4(a)(4)).

a. **Project Location:** The project area consists of the federally authorized navigation channel of Blair Waterway, the full extent of Sitcum Waterway, the training wall located east of the mouth of the Puyallup River and extending outward into Commencement Bay; and the Saltchuk beneficial use zone, a potential disposal site for dredged materials. The two waterways, training wall, and possible disposal site are located within Sections 22, 27, 28, 33, 34, 35, and 36 Township 21 Range 3 East and Sections 1 and 2 Township 20 Range 3 East, Pierce County, Washington (Figures 1 and 2). The Corps has determined the Area of Potential Effects (APE) to include the full width and length of the federally authorized navigation channel within Blair Waterway, the full length and width of the Sitcum Waterway, the full length and width of the training wall by the Puyallup River mouth, and the entirety of the Saltchuk beneficial use zone. The total surface area of the APE is approximately 770 acres (Figure 3). The Corps believes that the APE is sufficient to identify and consider both direct and indirect effects of the project.

b. **Project Description:** The Corps will identify and evaluate a full range of alternatives in the Blair and Sitcum Waterways. Currently, six alternatives are under consideration:

- No action
- Deepening the federally authorized navigation channel and turning basin in Blair Waterway to 58 feet below mean lower low water (MLLW) with two feet of over dredge
- Deepening Sitcum Waterway to 58 feet below MLLW with two feet of over dredge, removing the northeast dock
- Deepening Sitcum Waterway up to 58 feet below MLLW with two feet of over dredge without removing the northeast dock
- Deepening Blair Waterway as described above and deepening Sitcum Waterway to 58 feet below MLLW with two feet of over dredge, removing the northeast dock
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The depths of the waterways as of April 2018 are as follows:

- Blair Waterway: Controlling depths for Blair waterway in feet at MLLW range from 48 to 51, while depths outside of the federally authorized navigation channel but within the Blair Waterway range from 26 to 53 feet at MLLW (National Oceanic and Atmospheric Administration 2013, corrected through 2018).
- Sitcum Waterway: Soundings for Sitcum Waterway range from 39 to 53 feet at MLLW (National Oceanic and Atmospheric Administration 2013, corrected through 2018).

Any dredged materials removed from the waterways during the process of deepening would be disposed of in one of three locations: an existing open water disposal site, an existing upland disposal site, or the Saltchuk beneficial use zone.

c. **Cultural Resources:** We would like to summarize efforts taken to date to identify cultural resources within the APE. The Corps staff archaeologist has completed a records and literature search in the Washington Information System for Architectural & Archaeological Records Data (WISAARD) and within the Corps' Seattle District library of cultural resource reports. In addition, aerial photographs, General Land Office plat maps, nautical charts, 19th century maps of the area, and National Oceanic and Atmospheric Administration (NOAA) bathymetric sounding reports were reviewed.

One archaeological site has been located within the APE. Site 45PI47 (Wapato Creek Fish Weir) is located roughly two miles southeast of the Blair Waterway entrance near Berths A and B, and sat roughly 0.5 miles from the location where Wapato Creek previously emptied into Commencement Bay. The site was found during dredging in October 1970, and was excavated hydraulically (Munsell n. d.). Later, the site was dated to CE 1420-1640 through radiometric analysis (Cooper 2008). Dating and placement suggest that the weir would have been located in the Wapato Creek marsh zone when in use (Berger, Medville, and Chambers 2008). A comparison of nautical charts from 1970 and 2013 indicates that in the vicinity of the site, the depth of Blair Waterway has increased from a maximum of 43 feet to a maximum of 51 feet below MLLW (Coast and Geodetic Survey 1970, National Oceanic and Atmospheric Administration 2013).

Research established that an additional three recorded archaeological sites exist within one mile of the project area. These sites include PI00706, a historic refuse scatter dated to a 1945-1950 squatter occupation and a circa 1910 dairy farm (Kent 2004); PI00975 (Cooper

2009), identified as abandoned pilings and historic debris dating to the late 19th to mid-20th century waterfront; and PI00974, a shell midden 2.14 meters below the modern surface and located below the water table, fill, floodplain, wetland, and a layer of peat (Shantry 2009). Beginning with the establishment of the Port in 1918, much of the Port area has been heavily modified as fill from construction of the waterways was placed atop the Tacoma tideflats resulting in five to 10 feet of fill deposit upon which the port has been built, indicating that any pre-contact archaeological sites likely exist at a minimum depth of five feet (Berger and Chambers 2006; Port of Tacoma 2018). Geotechnical borings taken immediately west of Blair Waterway indicated peat layers at approximately 35 feet below modern surface, potentially indicative of the past existence of a stable surface within the Tacoma tideflats (Dively and Martin 2010).

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c. **Next Steps:** As this study develops, the Corps will be conducting sediment sampling within Blair and Sitcum waterways. An archaeologist will monitor the sediment sampling to determine if cultural resources are present. The Corps will be conducting further research of the project area as the project progresses.

If the Nisqually Indian Tribe has concerns with the proposed project or has information or concerns regarding properties which may be of religious or cultural significance that you believe may be affected by this project, please contact us as soon as possible so that we may consult with you and ensure consideration of your views and comments in a timely manner. A copy of this letter with enclosures will be sent to Annette Bullchild, Tribal Historic Preservation Office, Nisqually Indian Tribe, 4820 She-Nah-Num Drive SE, Olympia, WA 98513.

For more information about this project, clarification about this request, or to request a formal government-to-government meeting for Section 106 or other concerns with this project please contact the project archaeologists, Kara Kanaby at kara.m.kanaby@usace.army.mil or (206) 764-6857 and Alaina Harmon at alaina.harmon@usace.army.mil or (206) 764-3630. You may also contact Ms. Lori Morris, Tribal Liaison, at (206) 764-3625 or by email at frances.morris@usace.army.mil. I may be contacted at laura.a.boerner@usace.army.mil or (206) 764-6761.

Sincerely,

Lm Ben

LAURA A. BOERNER

Chief, Planning, Environmental and
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Seattle District, U. S. Army Corps of Engineers

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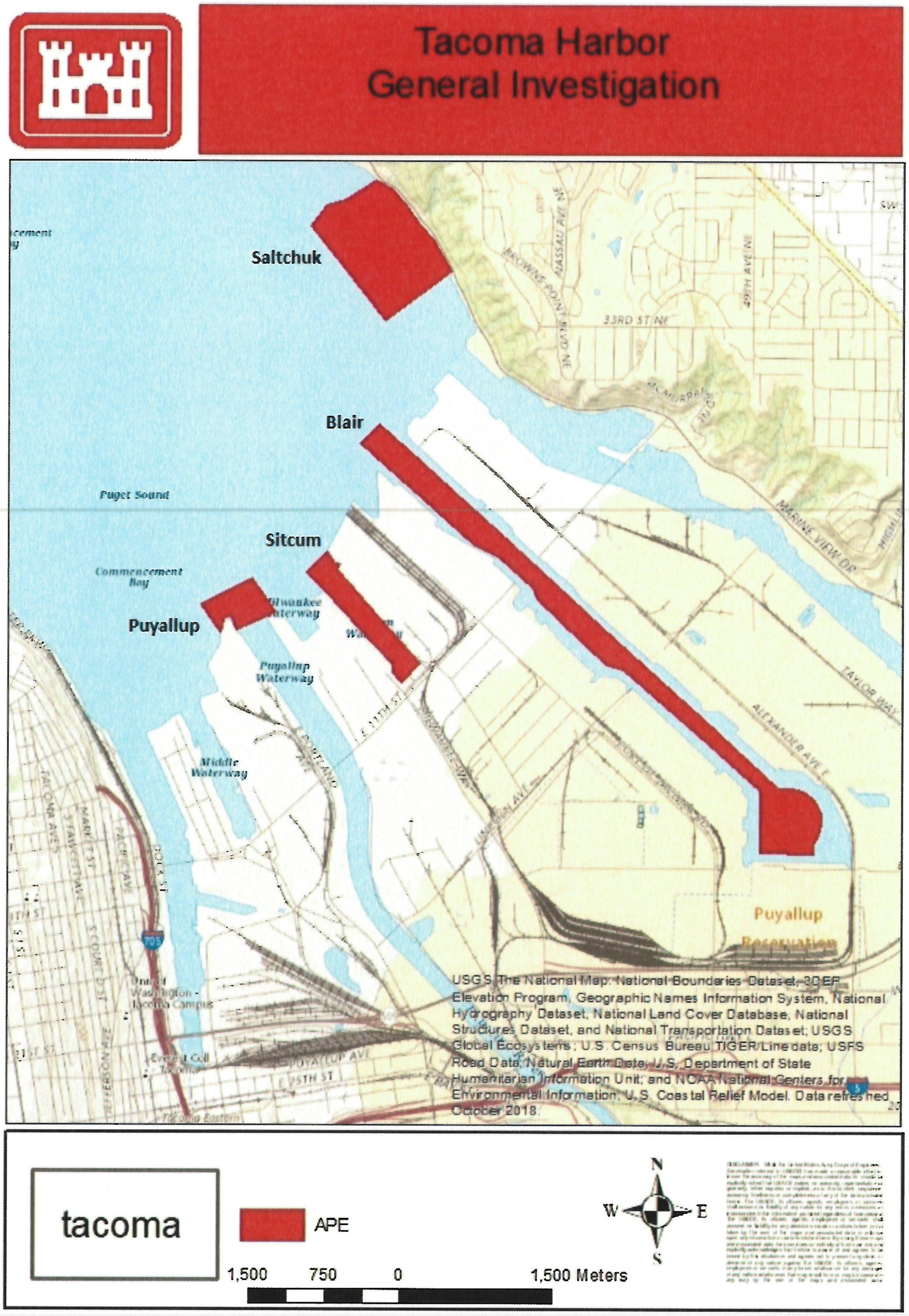

Figure 3: Study APE.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Planning, Environmental and Cultural Resources Branch

OCT 30 2018

The Honorable Bill Sterud
Chair, Puyallup Tribe of Indians
2009 East Portland Ave.
Tacoma, WA 98404

SUBJECT: Section 106 Review for the Tacoma Harbor General Investigation, Tacoma, Washington

Dear Chairman Sterud:

The United States Army Corps of Engineers (Corps) is conducting a General Investigation for navigation improvements to the Sitcum and Blair Waterways of Tacoma Harbor. The Port of Tacoma has requested that the Corps conduct a feasibility study of a potential deepening project in order to meet the draft requirements of the current and anticipated container ship fleet and to improve cost efficiencies at the Port of Tacoma. To assist in our review of the proposed project under Section 106 of the National Historic Preservation Act (NHPA), we are notifying the Puyallup Tribe of Indians (Tribe) about the project, requesting your assistance in identifying any issues or concerns the Tribe may have, and seeking information to identify properties that may be affected by the project which may be of religious or cultural significance to the Tribe (see 36 CFR 800.4(a)(4)).

a. **Project Location:** The project area consists of the federally authorized navigation channel of Blair Waterway, the full extent of Sitcum Waterway, the training wall located east of the mouth of the Puyallup River and extending outward into Commencement Bay; and the Saltchuk beneficial use zone, a potential disposal site for dredged materials. The two waterways, training wall, and possible disposal site are located within Sections 22, 27, 28, 33, 34, 35, and 36 Township 21 Range 3 East and Sections 1 and 2 Township 20 Range 3 East, Pierce County, Washington (Figures 1 and 2). The Corps has determined the Area of Potential Effects (APE) to include the full width and length of the federally authorized navigation channel within Blair Waterway, the full length and width of the Sitcum Waterway, the full length and width of the training wall by the Puyallup River mouth, and the entirety of the Saltchuk beneficial use zone. The total surface area of the APE is approximately 770 acres (Figure 3). The Corps believes that the APE is sufficient to identify and consider both direct and indirect effects of the project.

b. **Project Description:** The Corps will identify and evaluate a full range of alternatives in the Blair and Sitcum Waterways. Currently, six alternatives are under consideration:

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If the Puyallup Tribe of Indians has concerns with the proposed project or has information or concerns regarding properties which may be of religious or cultural significance that you believe may be affected by this project, please contact us as soon as possible so that we may consult with you and ensure consideration of your views and comments in a timely manner. A copy of this letter with enclosures will be sent to Brandon Reynon, Cultural Regulatory Specialist/Tribal Archaeologist, Puyallup Tribe of Indians, 2009 East Portland Avenue, Tacoma, WA 98404.

For more information about this project, clarification about this request, or to request a formal government-to-government meeting for Section 106 or other concerns with this project please contact the project archaeologists, Kara Kanaby at kara.m.kanaby@usace.army.mil or (206) 764-6857 and Alaina Harmon at alaina.harmon@usace.army.mil or (206) 764-3630. You may also contact Ms. Lori Morris, Tribal Liaison, at (206) 764-3625 or by email at frances.morris@usace.army.mil. I may be contacted at laura.a.boerner@usace.army.mil or (206) 764-6761.

Sincerely,

LAURA A. BOERNER

Chief, Planning, Environmental and
Cultural Resources Branch
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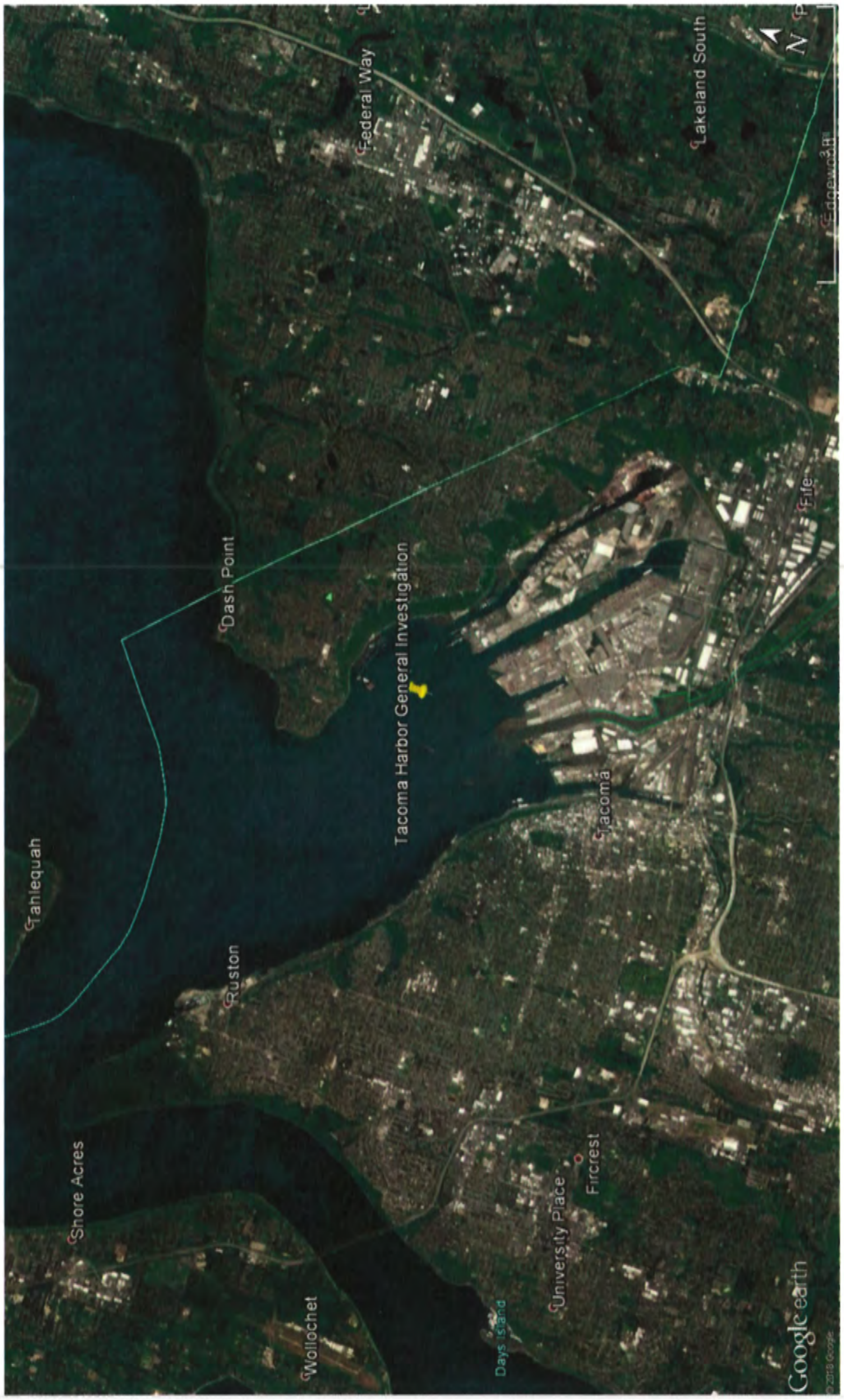

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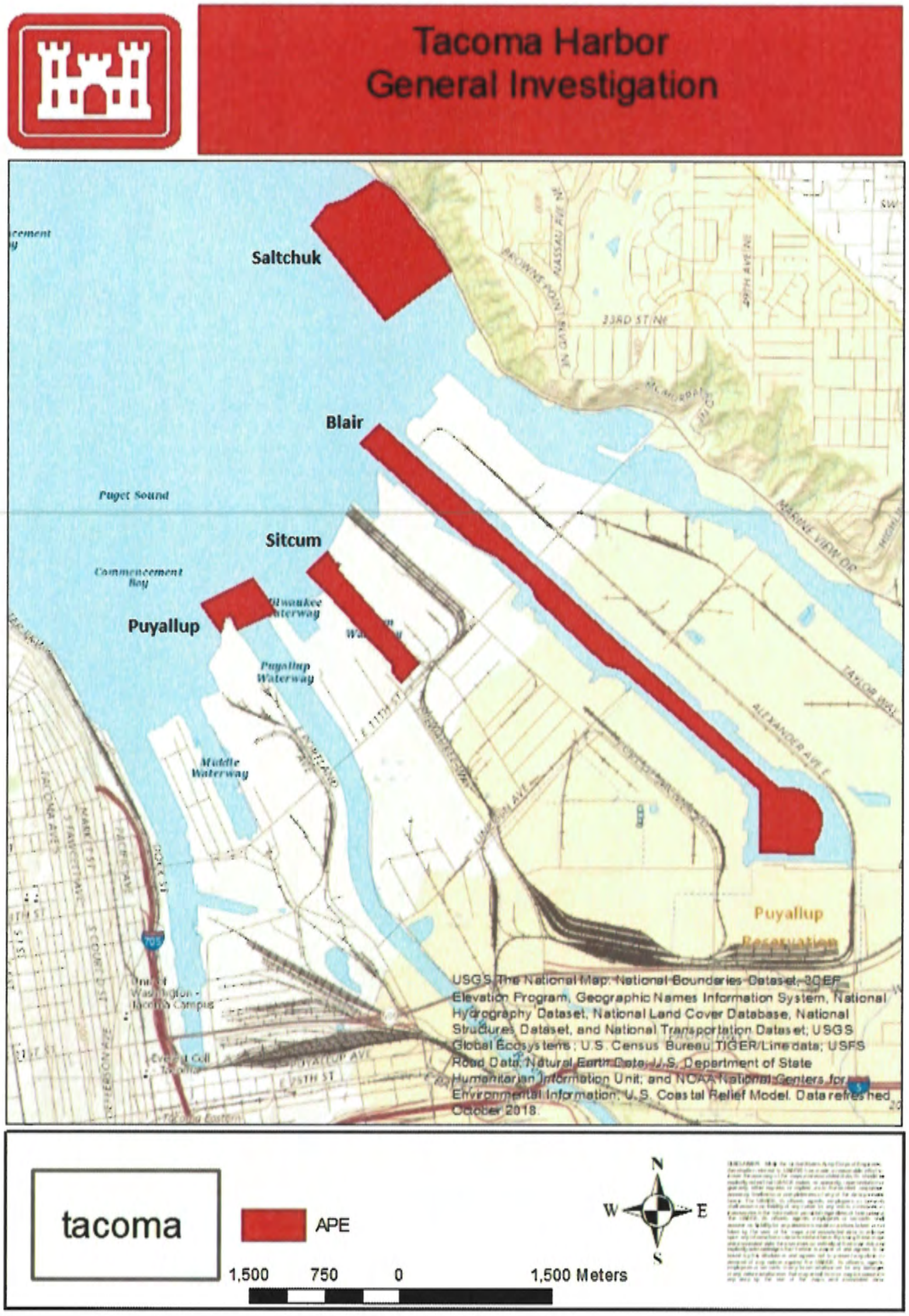

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DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Planning, Environmental and Cultural Resources Branch

OCT 30 2018

The Honorable Robert de los Angeles
Chair, Snoqualmie Tribe
P. O. Box 969
Snoqualmie, WA 98065

SUBJECT: Section 106 Review for the Tacoma Harbor General Investigation, Tacoma, Washington

Dear Chairman de los Angeles:

The United States Army Corps of Engineers (Corps) is conducting a General Investigation for navigation improvements to the Sitcum and Blair Waterways of Tacoma Harbor. The Port of Tacoma has requested that the Corps conduct a feasibility study of a potential deepening project in order to meet the draft requirements of the current and anticipated container ship fleet and to improve cost efficiencies at the Port of Tacoma. To assist in our review of the proposed project under Section 106 of the National Historic Preservation Act (NHPA), we are notifying the Snoqualmie Tribe (Tribe) about the project, requesting your assistance in identifying any issues or concerns the Tribe may have, and seeking information to identify properties that may be affected by the project which may be of religious or cultural significance to the Tribe (see 36 CFR 800.4(a)(4)).

a. **Project Location:** The project area consists of the federally authorized navigation channel of Blair Waterway, the full extent of Sitcum Waterway, the training wall located east of the mouth of the Puyallup River and extending outward into Commencement Bay; and the Saltchuk beneficial use zone, a potential disposal site for dredged materials. The two waterways, training wall, and possible disposal site are located within Sections 22, 27, 28, 33, 34, 35, and 36 Township 21 Range 3 East and Sections 1 and 2 Township 20 Range 3 East, Pierce County, Washington (Figures 1 and 2). The Corps has determined the Area of Potential Effects (APE) to include the full width and length of the federally authorized navigation channel within Blair Waterway, the full length and width of the Sitcum Waterway, the full length and width of the training wall by the Puyallup River mouth, and the entirety of the Saltchuk beneficial use zone. The total surface area of the APE is approximately 770 acres (Figure 3). The Corps believes that the APE is sufficient to identify and consider both direct and indirect effects of the project.

b. **Project Description:** The Corps will identify and evaluate a full range of alternatives in the Blair and Sitcum Waterways. Currently, six alternatives are under consideration:

- No action
- Deepening the federally authorized navigation channel and turning basin in Blair Waterway to 58 feet below mean lower low water (MLLW) with two feet of over dredge
- Deepening Sitcum Waterway to 58 feet below MLLW with two feet of over dredge, removing the northeast dock
- Deepening Sitcum Waterway up to 58 feet below MLLW with two feet of over dredge without removing the northeast dock
- Deepening Blair Waterway as described above and deepening Sitcum Waterway to 58 feet below MLLW with two feet of over dredge, removing the northeast dock
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The depths of the waterways as of April 2018 are as follows:

- Blair Waterway: Controlling depths for Blair waterway in feet at MLLW range from 48 to 51, while depths outside of the federally authorized navigation channel but within the Blair Waterway range from 26 to 53 feet at MLLW (National Oceanic and Atmospheric Administration 2013, corrected through 2018).
- Sitcum Waterway: Soundings for Sitcum Waterway range from 39 to 53 feet at MLLW (National Oceanic and Atmospheric Administration 2013, corrected through 2018).

Any dredged materials removed from the waterways during the process of deepening would be disposed of in one of three locations: an existing open water disposal site, an existing upland disposal site, or the Saltchuk beneficial use zone.

c. **Cultural Resources:** We would like to summarize efforts taken to date to identify cultural resources within the APE. The Corps staff archaeologist has completed a records and literature search in the Washington Information System for Architectural & Archaeological Records Data (WISAARD) and within the Corps' Seattle District library of cultural resource reports. In addition, aerial photographs, General Land Office plat maps, nautical charts, 19th century maps of the area, and National Oceanic and Atmospheric Administration (NOAA) bathymetric sounding reports were reviewed.

One archaeological site has been located within the APE. Site 45PI47 (Wapato Creek Fish Weir) is located roughly two miles southeast of the Blair Waterway entrance near Berths A and B, and sat roughly 0.5 miles from the location where Wapato Creek previously emptied into Commencement Bay. The site was found during dredging in October 1970, and was excavated hydraulically (Munsell n. d.). Later, the site was dated to CE 1420-1640 through radiometric analysis (Cooper 2008). Dating and placement suggest that the weir would have been located in the Wapato Creek marsh zone when in use (Berger, Medville, and Chambers 2008). A comparison of nautical charts from 1970 and 2013 indicates that in the vicinity of the site, the depth of Blair Waterway has increased from a maximum of 43 feet to a maximum of 51 feet below MLLW (Coast and Geodetic Survey 1970, National Oceanic and Atmospheric Administration 2013).

Research established that an additional three recorded archaeological sites exist within one mile of the project area. These sites include PI00706, a historic refuse scatter dated to a 1945-1950 squatter occupation and a circa 1910 dairy farm (Kent 2004); PI00975 (Cooper

2009), identified as abandoned pilings and historic debris dating to the late 19th to mid-20th century waterfront; and PI00974, a shell midden 2.14 meters below the modern surface and located below the water table, fill, floodplain, wetland, and a layer of peat (Shantry 2009). Beginning with the establishment of the Port in 1918, much of the Port area has been heavily modified as fill from construction of the waterways was placed atop the Tacoma tideflats resulting in five to 10 feet of fill deposit upon which the port has been built, indicating that any pre-contact archaeological sites likely exist at a minimum depth of five feet (Berger and Chambers 2006; Port of Tacoma 2018). Geotechnical borings taken immediately west of Blair Waterway indicated peat layers at approximately 35 feet below modern surface, potentially indicative of the past existence of a stable surface within the Tacoma tideflats (Dively and Martin 2010).

The Saltchuk beneficial use zone, a possible location for dredged material disposal, sits immediately southeast of Tyee Marina near the shoreline of southeast Commencement Bay. A 1948 nautical chart produced by the U. S. Coast and Geodetic Survey indicates that the area was used as booming grounds, and ranged in depth from 3 to 47 feet (Coast and Geodetic Survey 1948). A similar chart corrected through 2018 depicts the area in use for the same purpose (National Oceanic and Atmospheric Association 2013). Between 2007 and 2009 multi-beam hydrography and side scan sonar data was collected by NOAA in the majority of the Port of Tacoma, to include Blair and Sitcum Waterways, in order to validate the existing Electronic Nautical Chart. No shipwrecks were noted in Blair or Sitcum. The log booming area in southeast Commencement Bay where Saltchuk is located and the mouth of the Puyallup River were not surveyed. However, the results indicate that the "area near Tyee Marina [...] is littered with debris and sunken wrecks" (Simmons 2009). It is unknown how much dredged material could be placed at the Saltchuk beneficial use area or if it will be selected for the purpose of benefical use as the project moves forward.

c. **Next Steps:** As this study develops, the Corps will be conducting sediment sampling within Blair and Sitcum waterways. An archaeologist will monitor the sediment sampling to determine if cultural resources are present. The Corps will be conducting further research of the project area as the project progresses.

If the Snoqualmie Tribe has concerns with the proposed project or has information or concerns regarding properties which may be of religious or cultural significance that you believe may be affected by this project, please contact us as soon as possible so that we may consult with you and ensure consideration of your views and comments in a timely manner. A copy of this letter with enclosures will be sent to Steven Mullen Moses, Director, Archeology and Historic Preservation, Snoqualmie Tribe, P. O. Box 969, Snoqualmie, WA 98065.

For more information about this project, clarification about this request, or to request a formal government-to-government meeting for Section 106 or other concerns with this project please contact the project archaeologists, Kara Kanaby at kara.m.kanaby@usace.army.mil or (206) 764-6857 and Alaina Harmon at alaina.harmon@usace.army.mil or (206) 764-3630. You may also contact Ms. Lori Morris, Tribal Liaison, at (206) 764-3625 or by email at frances.morris@usace.army.mil. I may be contacted at laura.a.boerner@usace.army.mil or (206) 764-6761.

Sincerely,

LAURA A. BOERNER

Chief, Planning, Environmental and
Cultural Resources Branch
Seattle District, U. S. Army Corps of Engineers

References Cited:

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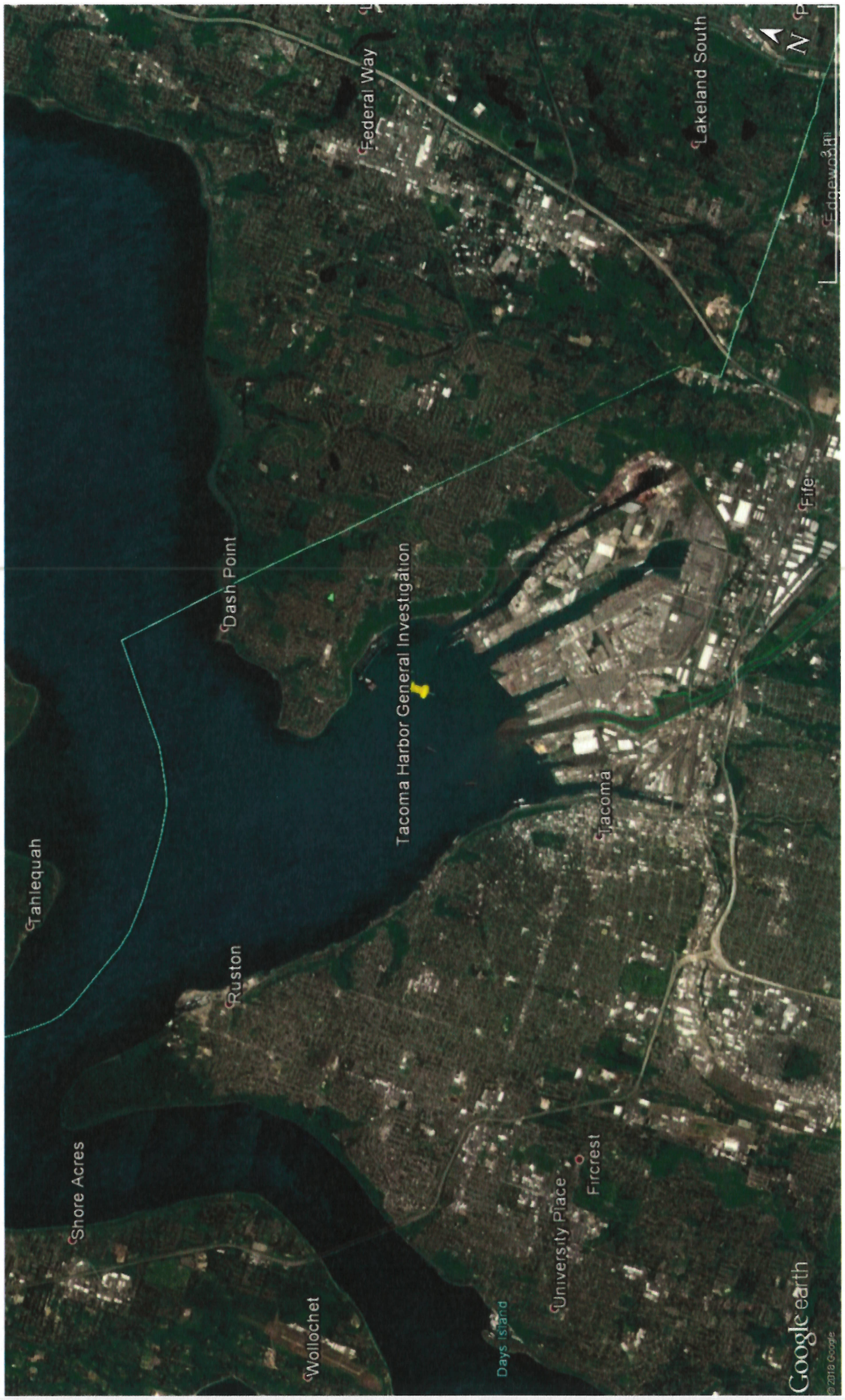

Figure 1: Study location

Figure 2: Overview of study area.

Figure 3: Study APE.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Planning, Environmental and Cultural Resources Branch

OCT 30 2018

The Honorable Arnold Cooper
Chair, Squaxin Island Tribe
10 SE Squaxin Lane
Shelton, WA 98584

SUBJECT: Section 106 Review for the Tacoma Harbor General Investigation, Tacoma, Washington

Dear Chairman Cooper:

The United States Army Corps of Engineers (Corps) is conducting a General Investigation for navigation improvements to the Sitcum and Blair Waterways of Tacoma Harbor. The Port of Tacoma has requested that the Corps conduct a feasibility study of a potential deepening project in order to meet the draft requirements of the current and anticipated container ship fleet and to improve cost efficiencies at the Port of Tacoma. To assist in our review of the proposed project under Section 106 of the National Historic Preservation Act (NHPA), we are notifying the Squaxin Island Tribe (Tribe) about the project, requesting your assistance in identifying any issues or concerns the Tribe may have, and seeking information to identify properties that may be affected by the project which may be of religious or cultural significance to the Tribe (see 36 CFR 800.4(a)(4)).

a. **Project Location:** The project area consists of the federally authorized navigation channel of Blair Waterway, the full extent of Sitcum Waterway, the training wall located east of the mouth of the Puyallup River and extending outward into Commencement Bay; and the Saltchuk beneficial use zone, a potential disposal site for dredged materials. The two waterways, training wall, and possible disposal site are located within Sections 22, 27, 28, 33, 34, 35, and 36 Township 21 Range 3 East and Sections 1 and 2 Township 20 Range 3 East, Pierce County, Washington (Figures 1 and 2). The Corps has determined the Area of Potential Effects (APE) to include the full width and length of the federally authorized navigation channel within Blair Waterway, the full length and width of the Sitcum Waterway, the full length and width of the training wall by the Puyallup River mouth, and the entirety of the Saltchuk beneficial use zone. The total surface area of the APE is approximately 770 acres (Figure 3). The Corps believes that the APE is sufficient to identify and consider both direct and indirect effects of the project.

b. **Project Description:** The Corps will identify and evaluate a full range of alternatives in the Blair and Sitcum Waterways. Currently, six alternatives are under consideration:

- No action
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Any dredged materials removed from the waterways during the process of deepening would be disposed of in one of three locations: an existing open water disposal site, an existing upland disposal site, or the Saltchuk beneficial use zone.

c. **Cultural Resources:** We would like to summarize efforts taken to date to identify cultural resources within the APE. The Corps staff archaeologist has completed a records and literature search in the Washington Information System for Architectural & Archaeological Records Data (WISAARD) and within the Corps' Seattle District library of cultural resource reports. In addition, aerial photographs, General Land Office plat maps, nautical charts, 19th century maps of the area, and National Oceanic and Atmospheric Administration (NOAA) bathymetric sounding reports were reviewed.

One archaeological site has been located within the APE. Site 45PI47 (Wapato Creek Fish Weir) is located roughly two miles southeast of the Blair Waterway entrance near Berths A and B, and sat roughly 0.5 miles from the location where Wapato Creek previously emptied into Commencement Bay. The site was found during dredging in October 1970, and was excavated hydraulically (Munsell n. d.). Later, the site was dated to CE 1420-1640 through radiometric analysis (Cooper 2008). Dating and placement suggest that the weir would have been located in the Wapato Creek marsh zone when in use (Berger, Medville, and Chambers 2008). A comparison of nautical charts from 1970 and 2013 indicates that in the vicinity of the site, the depth of Blair Waterway has increased from a maximum of 43 feet to a maximum of 51 feet below MLLW (Coast and Geodetic Survey 1970, National Oceanic and Atmospheric Administration 2013).

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c. **Next Steps:** As this study develops, the Corps will be conducting sediment sampling within Blair and Sitcum waterways. An archaeologist will monitor the sediment sampling to determine if cultural resources are present. The Corps will be conducting further research of the project area as the project progresses.

If the Squaxin Island Tribe has concerns with the proposed project or has information or concerns regarding properties which may be of religious or cultural significance that you believe may be affected by this project, please contact us as soon as possible so that we may consult with you and ensure consideration of your views and comments in a timely manner. A copy of this letter with enclosures will be sent to Rhonda Foster, Tribal Historic Preservation Officer, Squaxin Island Tribe, 10 Squaxin Lane, Shelton WA 98584.

For more information about this project, clarification about this request, or to request a formal government-to-government meeting for Section 106 or other concerns with this project please contact the project archaeologists, Kara Kanaby at kara.m.kanaby@usace.army.mil or (206) 764-6857 and Alaina Harmon at alaina.harmon@usace.army.mil or (206) 764-3630. You may also contact Ms. Lori Morris, Tribal Liaison, at (206) 764-3625 or by email at frances.morris@usace.army.mil. I may be contacted at laura.a.boerner@usace.army.mil or (206) 764-6761.

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Seattle District, U. S. Army Corps of Engineers

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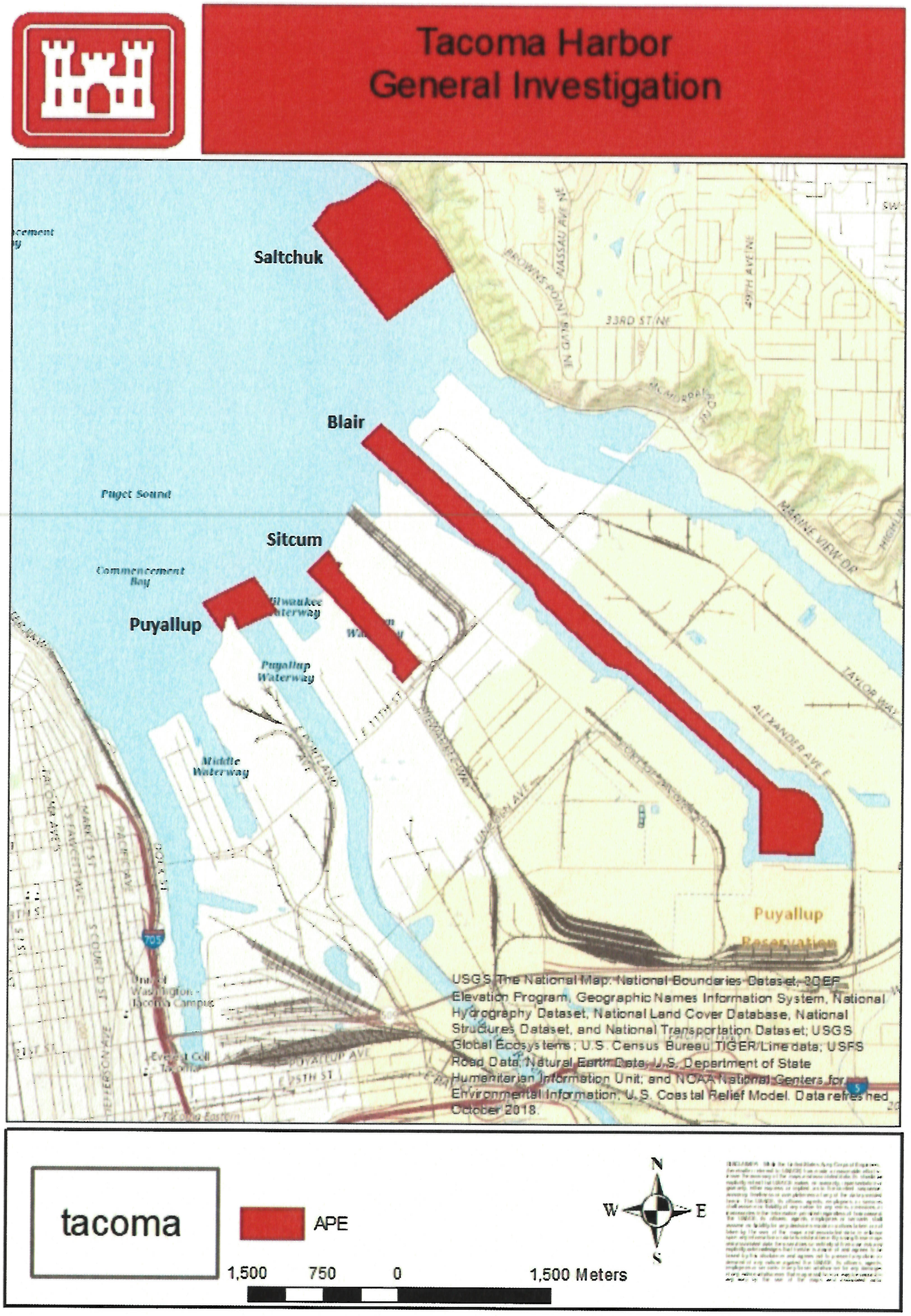

Figure 3: Study APE.

CC (without enclosures): 19 October 2018

SUBJECT: Request for Information or Concerns from the Confederated Tribes and Bands of the Yakama Nation in Regard to the Tacoma Harbor General Investigation, Tacoma, Washington (Harmon).

	INITIALS	DATE
HARMON, PMP-C	ACH	24 Oct. 2018
KANABY, PMP-C	KMK	10/25/18
CERAGIOLI, PMC	LSC	10/26/18
MORRIS, TL	FJM	10/26/18
OGDEN, PMP-E	LAO	10/26/18
BOERNER, PMP/s	SMB	10/26/18

Return to Alaina Harmon, PMP-C

PMP files _____ _______

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Planning, Environmental and Cultural Resources Branch

OCT 30 2018

The Honorable JoDe Goudy
Chair, The Confederated Tribes and Bands of the Yakama Nation
P. O. Box 151
Toppenish, WA 98948

SUBJECT: Section 106 Review for the Tacoma Harbor General Investigation, Tacoma, Washington

Dear Chairman Goudy:

The United States Army Corps of Engineers (Corps) is conducting a General Investigation for navigation improvements to the Sitcum and Blair Waterways of Tacoma Harbor. The Port of Tacoma has requested that the Corps conduct a feasibility study of a potential deepening project in order to meet the draft requirements of the current and anticipated container ship fleet and to improve cost efficiencies at the Port of Tacoma. To assist in our review of the proposed project under Section 106 of the National Historic Preservation Act (NHPA), we are notifying the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation) about the project, requesting your assistance in identifying any issues or concerns the Yakama Nation may have, and seeking information to identify properties that may be affected by the project which may be of religious or cultural significance to the Yakama Nation (see 36 CFR 800.4(a)(4)).

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Sincerely,

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LAURA A. BOERNER

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Berger, Margaret and Jennifer Chambers.

2006. Cultural Resources Assessment for the Tacoma Grinding Plant Project, 1220 Alexander Avenue, Tacoma, Pierce County, Washington. Technical Report no. 284. Western Shore Heritage Services, Inc., Bainbridge Island, WA.

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Figure 1: Study location

Figure 2: Overview of study area.

Figure 3: Study APE.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Planning, Environmental and Cultural Resources Branch

MAR 26 2019

The Honorable Virginia Cross
Chair, Muckleshoot Indian Tribe
39105 172th Avenue Southeast
Auburn, WA 98092

SUBJECT: Tacoma Harbor Investigation, Tacoma, Washington, Revision of APE, DAHP Project 2018-10-08487

Dear Madam Chair:

The United States Army Corps of Engineers (Corps) is continuing consultation on the Tacoma Harbor Investigation project, DAHP Project 2018-10-08487. In our letter of 30 October 2018, the Corps documented the area of potential effect (APE) with which your office agreed on 30 October 2018. This letter documents the revised APE, and provides an update to the project description. As mentioned in our 30 October 2018 letter, the Port of Tacoma has requested that the Corps conduct a feasibility study of a potential deepening project in order to meet the draft requirements of the current and anticipated container ship fleet and to improve cost efficiencies at the Port of Tacoma. Currently, large vessels upwards of 14,000 twenty-foot equivalent units are already calling on the Blair Waterway and the Port of Tacoma.

The following changes have occurred to the project: the training wall by the Puyallup River mouth and the Sitcum Waterway have been removed from the project. The Port of Tacoma has determined that deepening of Sitcum Waterway would require a significant investment, and is not projected to be feasible within the next 10 years. The training wall in the project was connected to the inclusion of Sitcum Waterway to address the possibility that there could be faster accumulation of sediment from the Puyallup River into Sitcum Waterway resulting in an increase of maintenance dredging.

In addition, the footprint for the Blair Waterway has been expanded to account for the widening and lengthening of the navigation channel and widening of the turning basin. Currently, the Blair Waterway is approximately 2.75 miles long including the turning basin. The authorized dimensions are 520 feet wide from the mouth to 11th Street, 345 feet wide through the 11th Street reach, 520 feet wide from 11th street to Lincoln Avenue, and 330 feet wide from Lincoln Avenue to the turning basin. The turning basin is 1300 feet wide and the dredge depth is -51 feet mean lower low water (MLLW) for the Waterway and turning basin. For this project the following is proposed:

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- the authorized width of the Lincoln Avenue to the turning basin would increase from 330 feet wide to 520 feet;
- the turning basin would increase from 1300 feet to 1600 feet;
- the depth of dredging would be –58 feet MLLW plus two feet of over dredge for the Waterway and turning basin

The project area consists of the federally authorized navigation channel of Blair Waterway; and the Saltchuk beneficial use zone, a potential disposal site for dredged materials. The Blair Waterway and possible disposal site are located within Sections 22, 27, 28, 34, 35, and 36 Township 21 Range 3 East and Sections 1 and 2 Township 20 Range 3 East, Pierce County, Washington (Enclosures 1 and 2). The Corps has determined the revised APE to include the full width from pier head to pier head, length and depth of the Blair Waterway necessary for deepening the Waterway, and the entirety of the Saltchuk beneficial use zone.

The total surface area of the revised APE is approximately 872 acres. The Corps believes that the revised APE is sufficient to identify and consider both direct and indirect effects of the project.

A copy of this letter with enclosures will be sent to Laura Murphy, Archaeologist, Muckleshoot Indian Tribe, 39105 172th Avenue Southeast, Auburn, WA 98092.

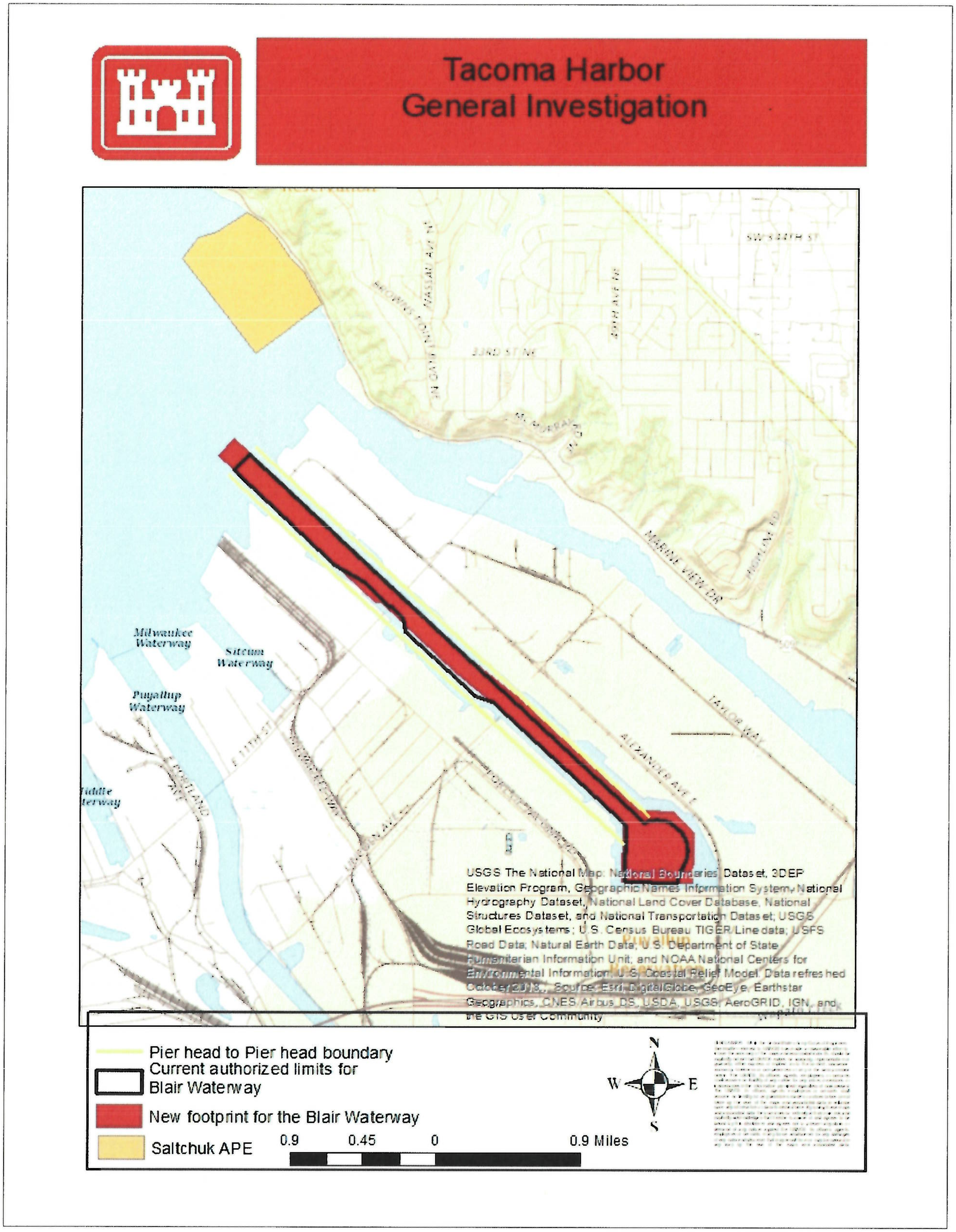
If you have any questions or desire additional information, please contact the project archaeologist, Kara Kanaby at kara.m.kanaby@usace.army.mil or (206) 764-6857. I may be contacted at laura.a.boerner@usace.army.mil or (206) 764-6761.

2 Encl

Sincerely,

LAURA A. BOERNER

Chief, Planning, Environmental and Cultural Resources Branch
Seattle District, U. S. Army Corps of Engineers



Enclosure 1: Revised APE

Enclosure 2: Aerial map of revised APE.

SUBJECT: Tacoma Harbor General Investigation, Tacoma, Washington, Letter documenting the revised of APE, DAHP Project 2018-10-08487 (Kanaby)

	INITIALS	DATE
KANABY, PMP-C	KMK	3/18/19
CERAGIOLI, PMC		
MORRIS, TL		
PUNKE, PMP-E	MP	18-Mar-19
BOERNER, PMP/s	AB	18MAR19

Return to Kara Kanaby, PMP-C

PMP files		

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Planning, Environmental and Cultural Resources Branch

MAR 26 2019

The Honorable Ken Choke
Chair, Nisqually Indian Tribe
4820 She-Nah-Num Drive SE
Olympia, WA 98513

SUBJECT: Tacoma Harbor Investigation, Tacoma, Washington, Revision of APE, DAHP Project 2018-10-08487

Dear Chairman Choke:

The United States Army Corps of Engineers (Corps) is continuing consultation on the Tacoma Harbor Investigation project, DAHP Project 2018-10-08487. In our letter of 30 October 2018, the Corps documented the area of potential effect (APE) with which your office agreed on 30 October 2018. This letter documents the revised APE, and provides an update to the project description. As mentioned in our 30 October 2018 letter, the Port of Tacoma has requested that the Corps conduct a feasibility study of a potential deepening project in order to meet the draft requirements of the current and anticipated container ship fleet and to improve cost efficiencies at the Port of Tacoma. Currently, large vessels upwards of 14,000 twenty-foot equivalent units are already calling on the Blair Waterway and the Port of Tacoma.

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In addition, the footprint for the Blair Waterway has been expanded to account for the widening and lengthening of the navigation channel and widening of the turning basin. Currently, the Blair Waterway is approximately 2.75 miles long including the turning basin. The authorized dimensions are 520 feet wide from the mouth to 11th Street, 345 feet wide through the 11th Street reach, 520 feet wide from 11th street to Lincoln Avenue, and 330 feet wide from Lincoln Avenue to the turning basin. The turning basin is 1300 feet wide and the dredge depth is -51 feet mean lower low water (MLLW) for the Waterway and turning basin. For this project the following is proposed:

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The total surface area of the revised APE is approximately 872 acres. The Corps believes that the revised APE is sufficient to identify and consider both direct and indirect effects of the project.

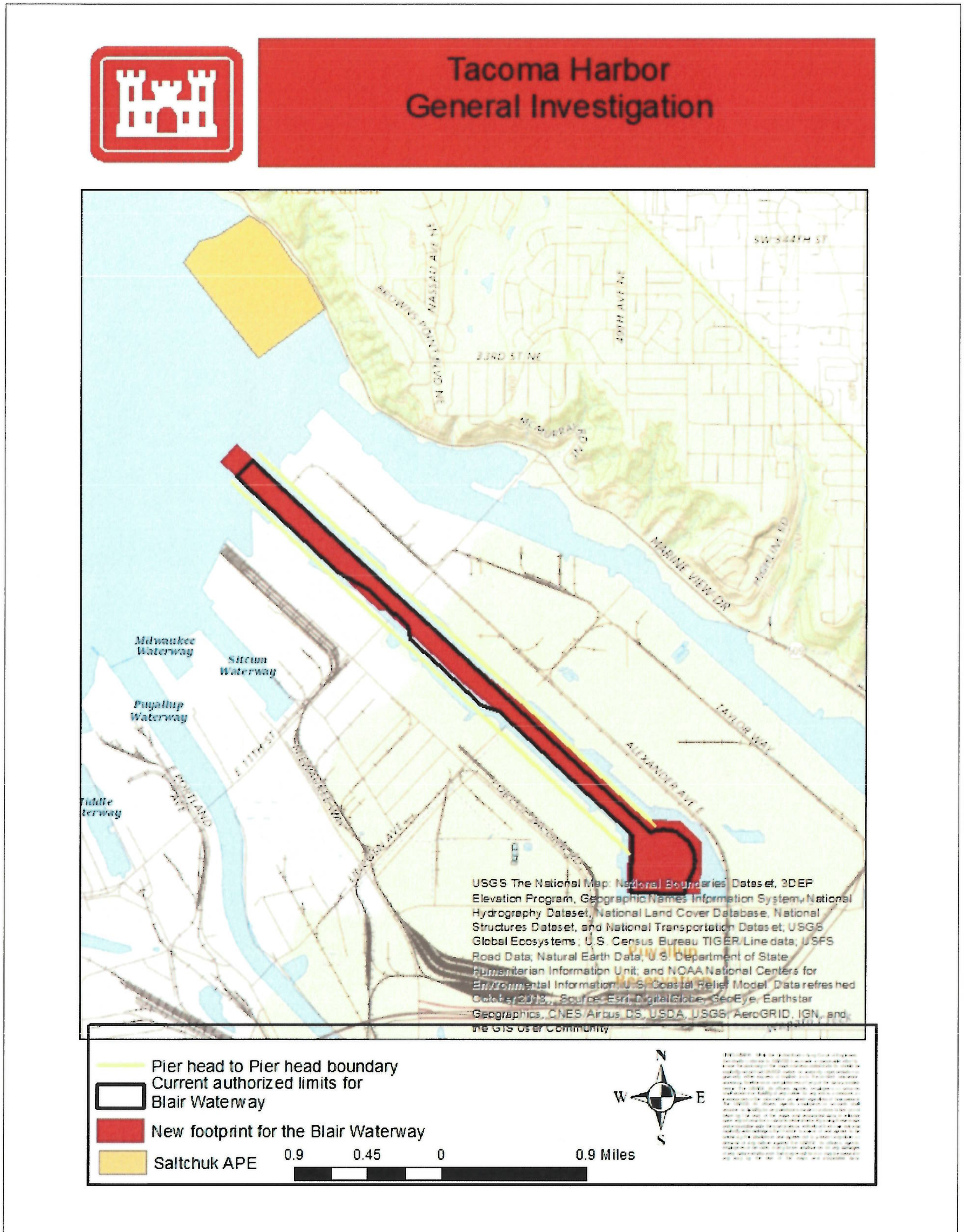
A copy of this letter with enclosures will be sent to Annette Bullchild, Cultural Resources, Nisqually Indian Tribe, 4820 She-Nah-Num Drive SE, Olympia, WA 98513.

If you have any questions or desire additional information, please contact the project archaeologist, Kara Kanaby at kara.m.kanaby@usace.army.mil or (206) 764-6857. I may be contacted at laura.a.boerner@usace.army.mil or (206) 764-6761

Sincerely,

LAURA A. BOERNER

Chief, Planning, Environmental and
Cultural Resources Branch
Seattle District, U. S. Army Corps of
Engineers


Tacoma Harbor
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33RD ST NE
MARINE VIEW DR
TAYLOR WAY
ALEXANDER AVE E
Milwaukee Waterway
Sitcum Waterway
Puyallup Waterway
USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed October, 2018. ; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Pier head to Pier head boundary
Current authorized limits for Blair Waterway
New footprint for the Blair Waterway
Saltchuk APE
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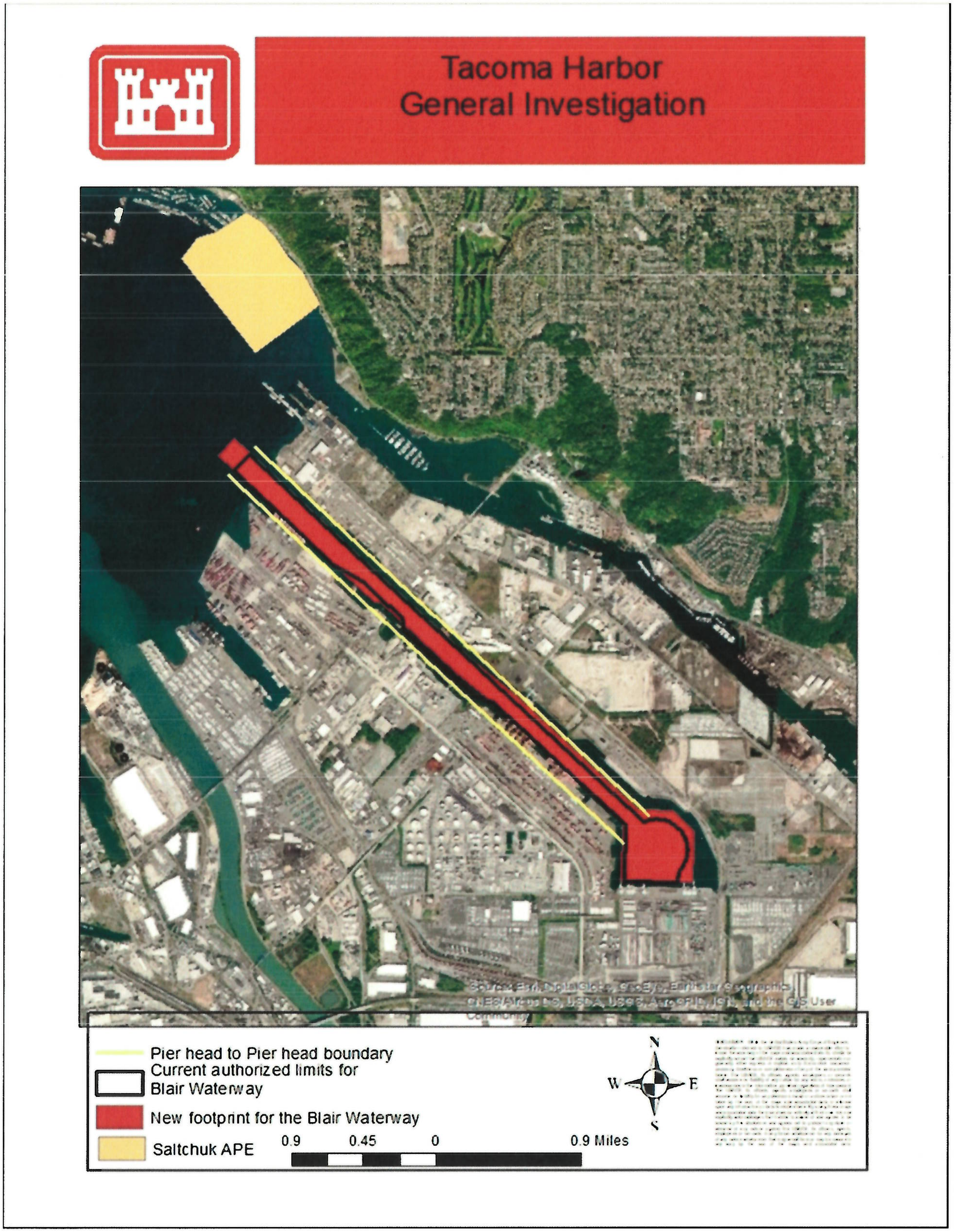
Enclosure 1: Revised APE



DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Planning, Environmental and Cultural Resources Branch

The Honorable Bill Sterud
Chair, Puyallup Tribe of Indians
2009 East Portland Ave.
Tacoma, WA 98404

MAR 26 2019

SUBJECT: Tacoma Harbor Investigation, Tacoma, Washington, Revision of APE, DAHP Project 2018-10-08487

Dear Chairman Sterud:

The United States Army Corps of Engineers (Corps) is continuing consultation on the Tacoma Harbor Investigation project, DAHP Project 2018-10-08487. In our letter of 30 October 2018, the Corps documented the area of potential effect (APE) with which your office agreed on 30 October 2018. This letter documents the revised APE, and provides an update to the project description. As mentioned in our 30 October 2018 letter, the Port of Tacoma has requested that the Corps conduct a feasibility study of a potential deepening project in order to meet the draft requirements of the current and anticipated container ship fleet and to improve cost efficiencies at the Port of Tacoma. Currently, large vessels upwards of 14,000 twenty-foot equivalent units are already calling on the Blair Waterway and the Port of Tacoma.

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The total surface area of the revised APE is approximately 872 acres. The Corps believes that the revised APE is sufficient to identify and consider both direct and indirect effects of the project.

A copy of this letter with enclosures will be sent to Brandon Reynon, Cultural Regulatory Specialist/Tribal Archaeologist, Puyallup Tribe of Indians, 2009 East Portland Avenue, Tacoma, WA 98404.

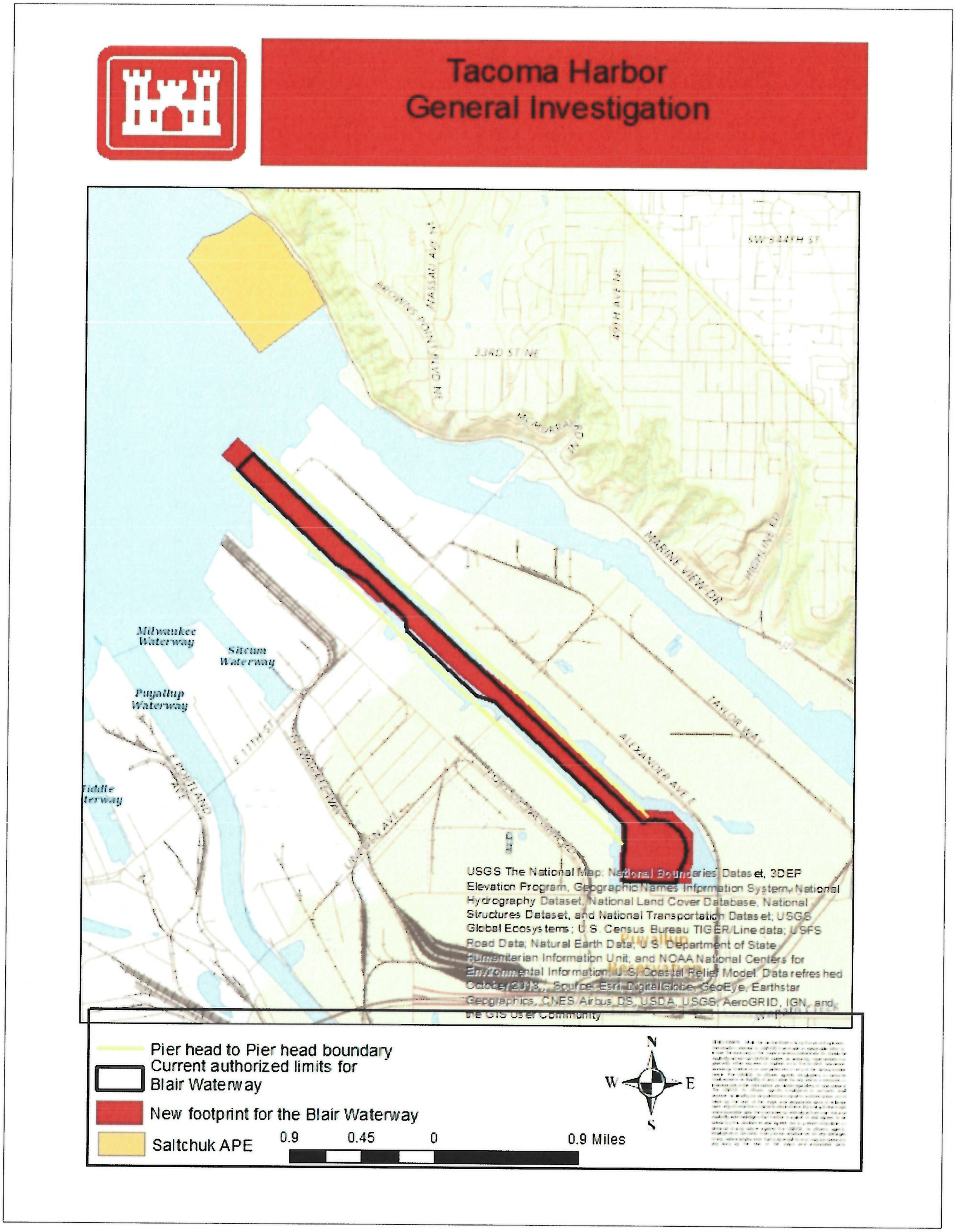
If you have any questions or desire additional information, please contact the project archaeologist, Kara Kanaby at kara.m.kanaby@usace.army.mil or (206) 764-6857. I may be contacted at laura.a.boerner@usace.army.mil or (206) 764-6761.

2 Encl

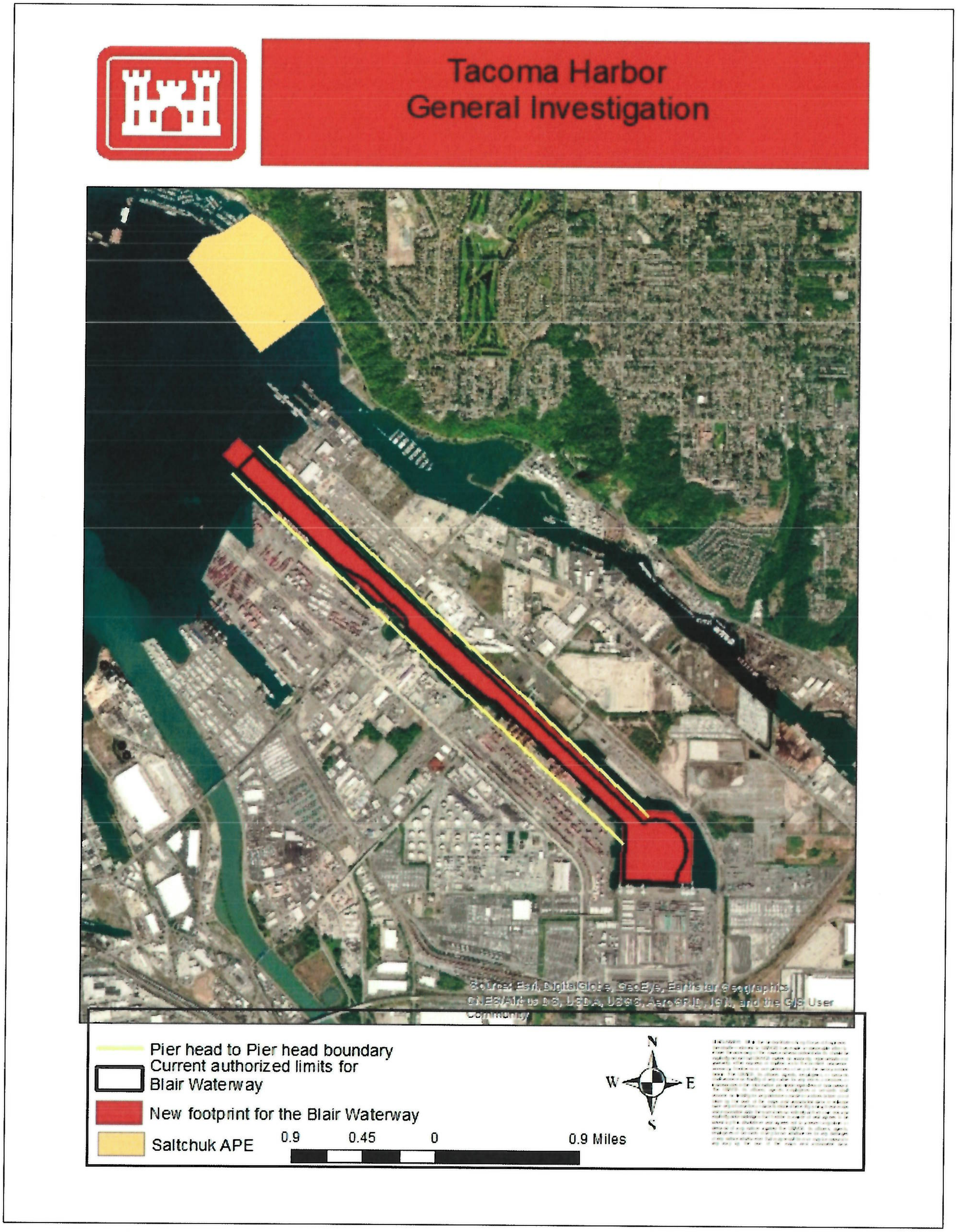
Sincerely,

LAURA A. BOERNER

Chief, Planning, Environmental and Cultural Resources Branch
Seattle District, U. S. Army Corps of Engineers



Enclosure 1: Revised APE



Enclosure 2: Aerial map of revised APE.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Planning, Environmental and Cultural Resources Branch

MAR 26 2019

The Honorable Robert de los Angeles
Chair, Snoqualmie Tribe
P. O. Box 969
Snoqualmie, WA 98065

SUBJECT: Tacoma Harbor Investigation, Tacoma, Washington, Revision of APE, DAHP Project 2018-10-08487

Dear Chairman de los Angeles:

The United States Army Corps of Engineers (Corps) is continuing consultation on the Tacoma Harbor Investigation project, DAHP Project 2018-10-08487. In our letter of 30 October 2018, the Corps documented the area of potential effect (APE) with which your office agreed on 30 October 2018. This letter documents the revised APE, and provides an update to the project description. As mentioned in our 30 October 2018 letter, the Port of Tacoma has requested that the Corps conduct a feasibility study of a potential deepening project in order to meet the draft requirements of the current and anticipated container ship fleet and to improve cost efficiencies at the Port of Tacoma. Currently, large vessels upwards of 14,000 twenty-foot equivalent units are already calling on the Blair Waterway and the Port of Tacoma.

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The total surface area of the revised APE is approximately 872 acres. The Corps believes that the revised APE is sufficient to identify and consider both direct and indirect effects of the project.

A copy of this letter with enclosures will be sent to Steven Mullen Moses, Director, Archeology and Historic Preservation, Snoqualmie Tribe, P. O. Box 969, Snoqualmie, WA 98065.

If you have any questions or desire additional information, please contact the project archaeologist, Kara Kanaby at kara.m.kanaby@usace.army.mil or (206) 764-6857. I may be contacted at laura.a.boerner@usace.army.mil or (206) 764-6761.

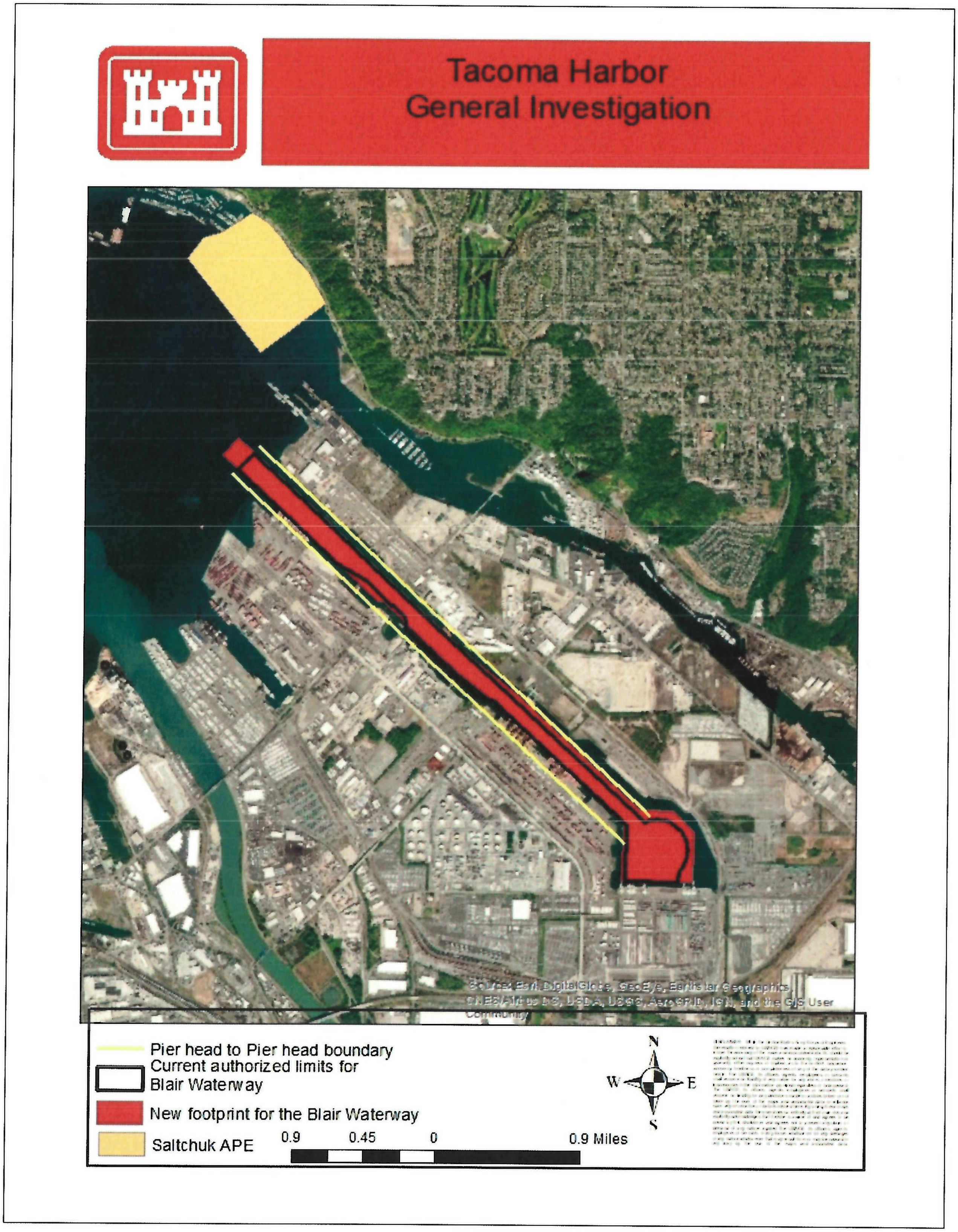
2 Encl

Sincerely,

LAURA A. BOERNER

Chief, Planning, Environmental and
Cultural Resources Branch
Seattle District, U. S. Army Corps of
Engineers

Enclosure 1: Revised APE



Enclosure 2: Aerial map of revised APE.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Planning, Environmental and Cultural Resources Branch

MAR 26 2019

The Honorable Arnold Cooper
Chair, Squaxin Island Tribe
10 SE Squaxin Lane
Shelton, WA 98584

SUBJECT: Tacoma Harbor Investigation, Tacoma, Washington, Revision of APE, DAHP Project 2018-10-08487

Dear Chairman Cooper:

The United States Army Corps of Engineers (Corps) is continuing consultation on the Tacoma Harbor Investigation project, DAHP Project 2018-10-08487. In our letter of 30 October 2018, the Corps documented the area of potential effect (APE) with which your office agreed on 30 October 2018. This letter documents the revised APE, and provides an update to the project description. As mentioned in our 30 October 2018 letter, the Port of Tacoma has requested that the Corps conduct a feasibility study of a potential deepening project in order to meet the draft requirements of the current and anticipated container ship fleet and to improve cost efficiencies at the Port of Tacoma. Currently, large vessels upwards of 14,000 twenty-foot equivalent units are already calling on the Blair Waterway and the Port of Tacoma.

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A copy of this letter with enclosures will be sent to Rhonda Foster, Tribal Historic Preservation Officer, Squaxin Island Tribe, 10 Squaxin Lane, Shelton WA 98584.

If you have any questions or desire additional information, please contact the project archaeologist, Kara Kanaby at kara.m.kanaby@usace.army.mil or (206) 764-6857. I may be contacted at laura.a.boerner@usace.army.mil or (206) 764-6761.

2 Encl

Sincerely,

LAURA A. BOERNER

Chief, Planning, Environmental and
Cultural Resources Branch
Seattle District, U. S. Army Corps of
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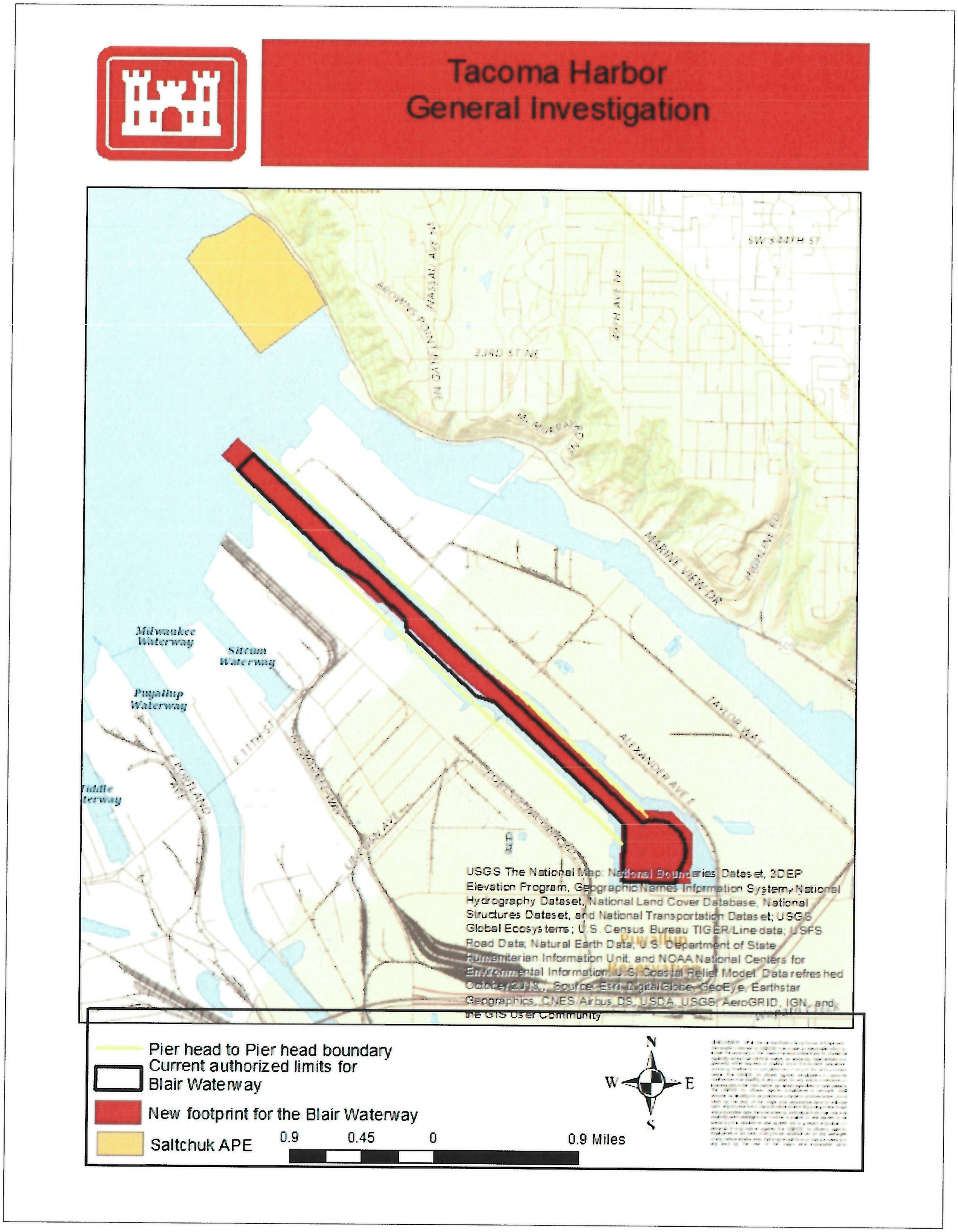
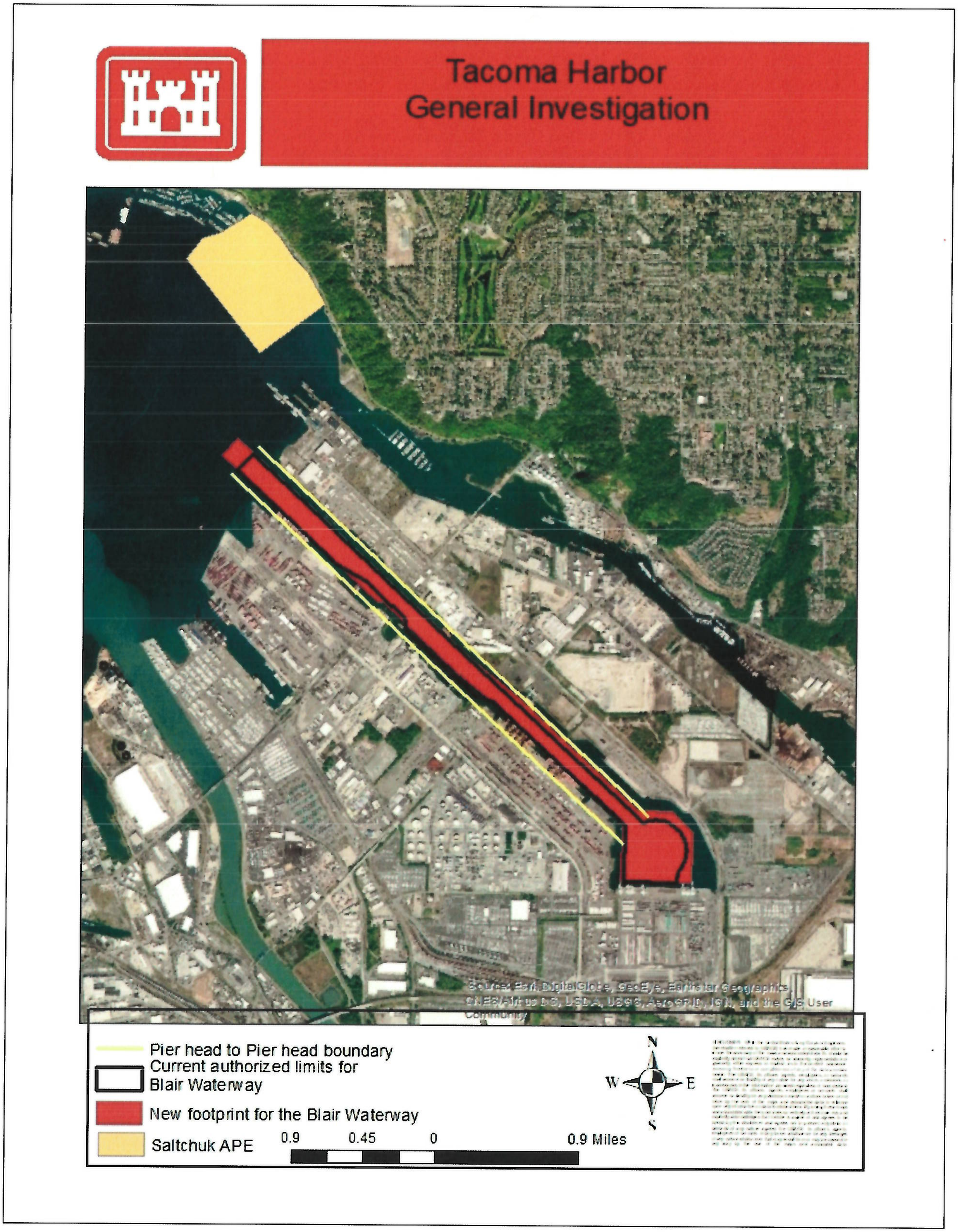


Enclosure 1: Revised APE



Enclosure 2: Aerial map of revised APE.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Planning, Environmental and Cultural Resources Branch

MAR 26 2019

The Honorable JoDe Goudy
Chair, The Confederated Tribes and Bands of the Yakama Nation
P. O. Box 151
Toppenish, WA 98948

SUBJECT: Tacoma Harbor Investigation, Tacoma, Washington, Revision of APE, DAHP Project 2018-10-08487

Dear Chairman Goudy:

The United States Army Corps of Engineers (Corps) is continuing consultation on the Tacoma Harbor Investigation project, DAHP Project 2018-10-08487. In our letter of 30 October 2018, the Corps documented the area of potential effect (APE) with which your office agreed on 30 October 2018. This letter documents the revised APE, and provides an update to the project description. As mentioned in our 30 October 2018 letter, the Port of Tacoma has requested that the Corps conduct a feasibility study of a potential deepening project in order to meet the draft requirements of the current and anticipated container ship fleet and to improve cost efficiencies at the Port of Tacoma. Currently, large vessels upwards of 14,000 twenty-foot equivalent units are already calling on the Blair Waterway and the Port of Tacoma.

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The total surface area of the revised APE is approximately 872 acres. The Corps believes that the revised APE is sufficient to identify and consider both direct and indirect effects of the project.

A copy of this letter with enclosures will be sent to V. Kate Valdez, Tribal Historic Preservation Officer, Confederated Tribes and Bands of the Yakama Nation, P. O. Box 151, Toppenish, WA 98948.

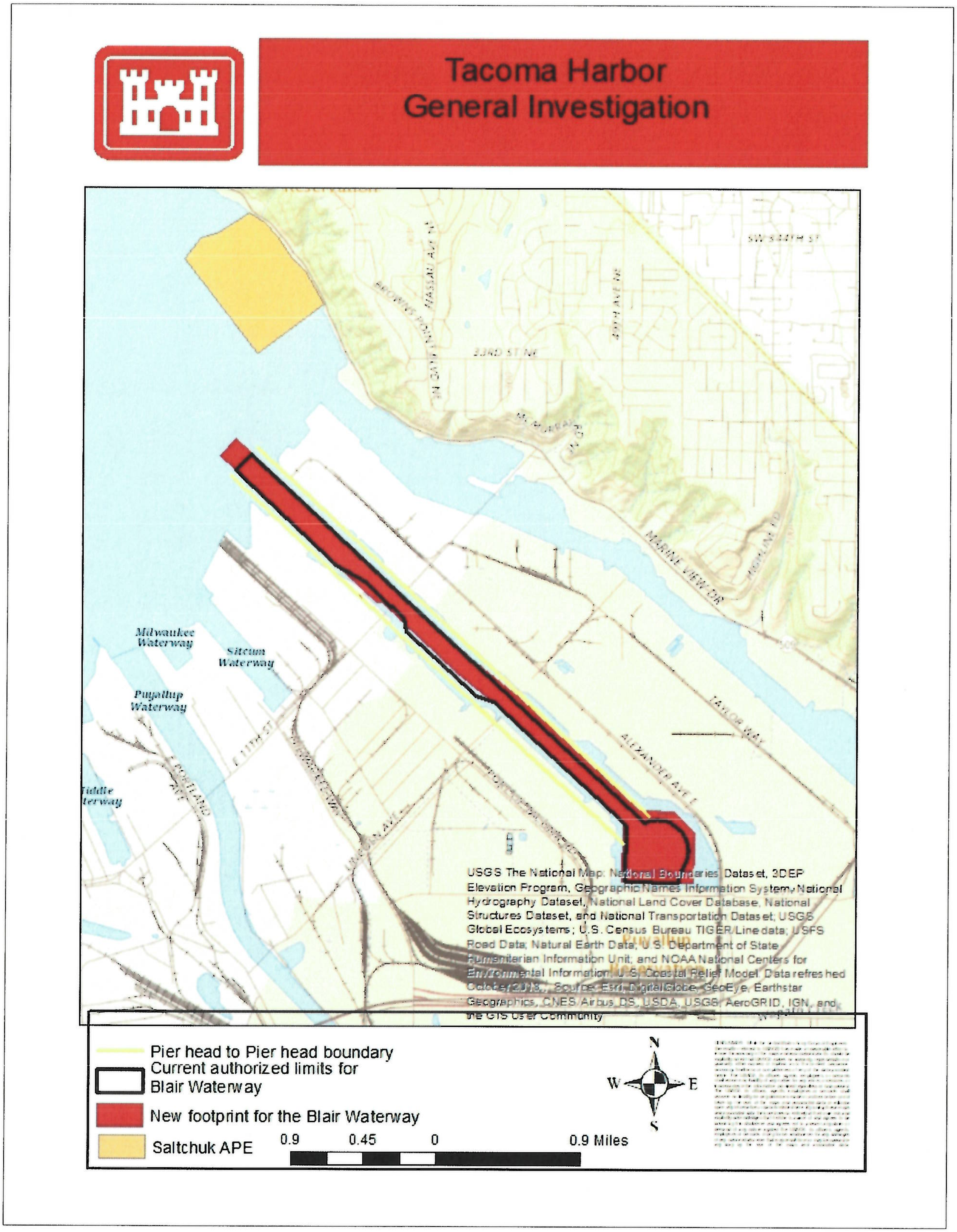
If you have any questions or desire additional information, please contact the project archaeologist, Kara Kanaby at kara.m.kanaby@usace.army.mil or (206) 764-6857. I may be contacted at laura.a.boerner@usace.army.mil or (206) 764-6761.

2 Encl

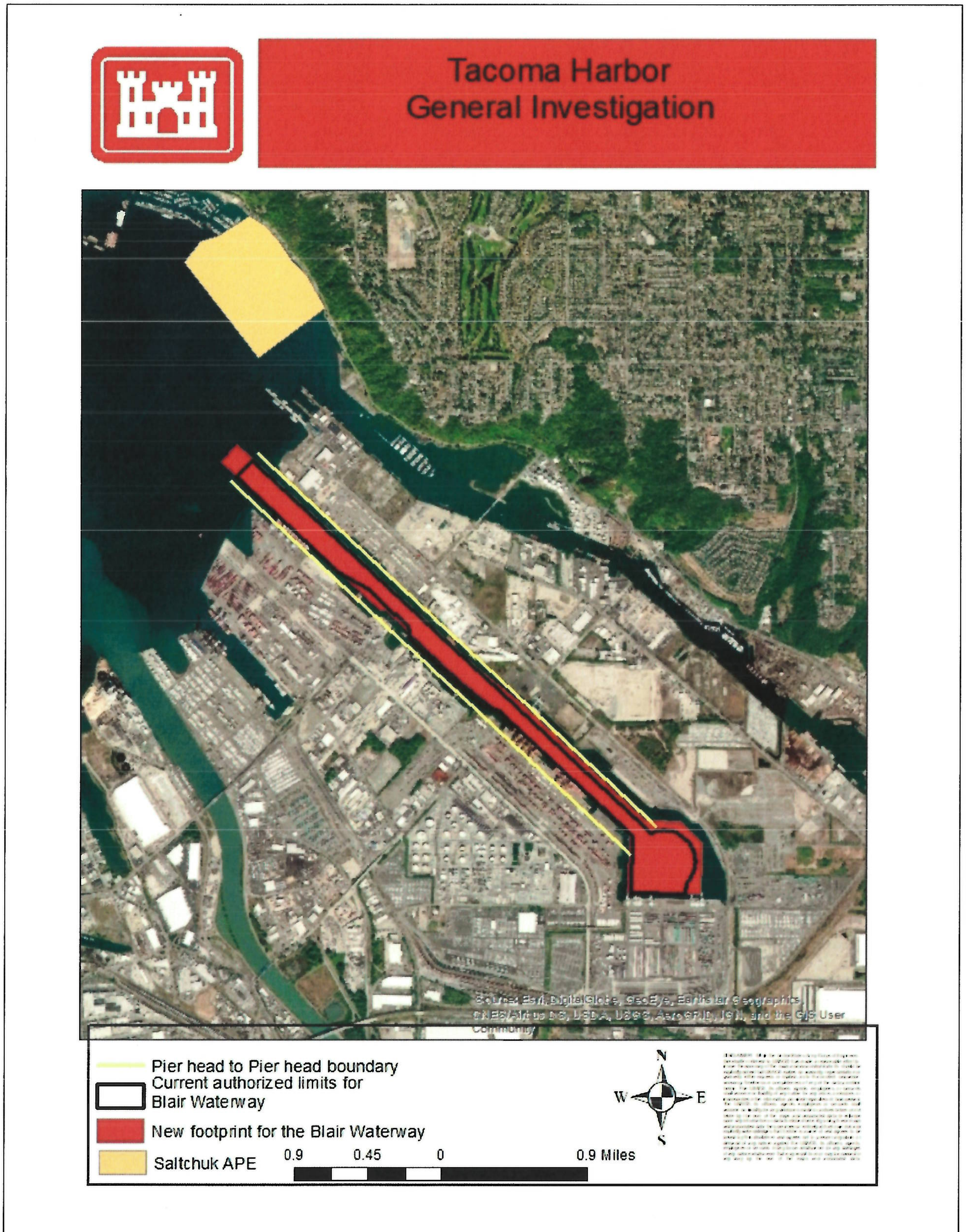
Sincerely,

LAURA A. BOERNER

Chief, Planning, Environmental and
Cultural Resources Branch
Seattle District, U. S. Army Corps of
Engineers



Enclosure 1: Revised APE



Enclosure 2: Aerial map of revised APE.

Ceragioli, Kristine S CIV USARMY CENWS (USA)

From: John Bell <John.Bell@PuyallupTribe-nsn.gov>
Sent: Friday, May 20, 2022 2:27 PM
To: Bullock, Alexander L (Xander) COL USARMY CENWS (USA); Messer, Walker L CIV USARMY CESAM (USA); Morris, Frances L CIV USARMY CENWS (USA); Leslie, Melissa L CIV USARMY CENWS (USA); Ceragioli, Kristine S CIV USARMY CENWS (USA); Boerner, Laura A CIV USARMY CENWS (USA)
Cc: Puyallup_Tribal_Council; Russ Ladley; Char Naylor; David Winfrey; George Stearns; 'tim@thompsoncg.com'; 'Eric Johnson (ejohnson@portoftacoma.com)'; 'Warfield, Tony'; Lisa Anderson; Lois Boome; Sam Stiltner
Subject: [Non-DoD Source] RE: Disposal of Blair Waterway dredge spoils – May 20 UPDATE

To the Corps of Engineers, Seattle District Office:

We understand that your office has some concern about our e-mail to you dated May 11, 2022, on the subject of the Blair Waterway widening and deepening project ("Project") and the Saltchuck site. We are providing this additional detail with the aim of addressing your concern and clearing up any confusion you may have.

- The Tribe supports the Project to widen and deepen the Blair Waterway, as long as it is done with adequate protection for the fishery resource and habitat. We are working closely with the Port of Tacoma to achieve that goal.

- The Tribe supports the concept put forward by the Port of creating off-site fisheries habitat restoration in connection with the Project. The specifics have yet to be determined, but it would enhance the fish and shellfish resources for the benefit of the community, as well as in furtherance of the Tribe's treaty fishing rights. The Tribe will work with the Port and with your office to refine the conceptual design in order to accomplish its goal in a manner that gives the best protection to and enhancement of the fishery resource.

- The Tribe vigorously opposes the use of the Saltchuck site for disposal of the dredge spoils taken from the Blair Waterway. The Tribe supports the Corps' open water disposal alternative. Any other disposal location would need to be mutually agreed-to. We spelled out the reasons for our views on this element of the project in our May 11 e-mail.

We look forward to meeting with you on May 25 to discuss these matters and provide any additional information and clarification you may need at that point.

John Bell

John Howard Bell
Puyallup Tribal Attorney
3009 East Portland Avenue
Tacoma, WA 98404
(253) 573-7871

From: John Bell
Sent: Wednesday, May 11, 2022 7:11 AM
To: 'Bullock, Alexander L' <Alexander.L.Bullock@usace.army.mil>; 'Messer, Walker L CIV USARMY CENWS (USA' <Walker.L.Messer@usace.army.mil>; 'Morris, Frances L CIV USARMY CENWS (USA' <Frances.Morris@usace.army.mil>; 'Leslie, Melissa L CIV USARMY CENWS (USA' <Melissa.L.Leslie@usace.army.mil>; 'Ceragioli, Kristine S CIV USARMY CENWS (USA' <Kristine.S.Ceragioli@usace.army.mil>; 'Boerner, Laura A CIV USARMY CENWS (USA' <Laura.A.Boerner@usace.army.mil>
Cc: Puyallup_Tribal_Council <Puyallup_Tribal_Council@PuyallupTribe-nsn.gov>; Russ Ladley <Russ.Ladley@PuyallupTribe-nsn.gov>; Char Naylor <Char.Naylor@PuyallupTribe-nsn.gov>; David Winfrey <David.Winfrey@PuyallupTribe-nsn.gov>; George Stearns <George.Stearns@PuyallupTribe-nsn.gov>; tim@thompsoncg.com; Eric Johnson (ejohnson@portoftacoma.com) <ejohnson@portoftacoma.com>; 'Warfield, Tony' <twarfield@portoftacoma.com>; Lisa Anderson <Lisa.Anderson@PuyallupTribe-nsn.gov>; Lois Boome <Lois.Boome@PuyallupTribe-nsn.gov>; Sam Stiltner <Sam.Stiltner@PuyallupTribe-nsn.gov>
Subject: Disposal of Blair Waterway dredge spoils – Saltchuck is not a suitable site

To the Army Corps of Engineers, Seattle District:

The Puyallup Tribe of Indians sends you this communication to reiterate our vigorous opposition to the use of the Saltchuck site for disposal of dredge spoils from the Blair Waterway widening and deepening project. It has come to our attention that the Corps of Engineers is not including in its analysis of that proposed project an understanding of the Tribe's total opposition to the use of the Saltchuck site for that purpose. This letter is to underline and emphasize that the disposal of dredge spoils at Saltchuck would work immediate harm on the fishery habitat and resource and would provide no assurance that the desired future benefit would ever come to pass. That part of the plan should therefore be dropped.

The Tribe does support the more limited proposal that has been made for the Saltchuck site to improve its existing condition to increase its current and uninterrupted value as habitat. It is only as a disposal site that the Tribe opposes plans for the site.

We oppose the use of the site for disposal of the dredge spoils because for two and a half years or more, the site would have its currently-existing value as fishery habitat completely lost. It would be inundated by dredge spoils for that period of time, taking out of use the site's value as habitat and delaying for an undetermined period the time when the site would provide any value to the fishery resource. The area that would be lost is in fact larger than the site on which the disposal would take place, because material suspension, tidal currents and wind drift would spread the impact to the surrounding environment.

The proposed plan is to have the site improved over its existing value to the resource by reducing depth with the dredge spoils. That proposal is problematic for several reasons. One is the toxicity of some of the dredge spoils. Two elements of the proposed approach threaten the fishery: (1) the use of the state's inadequate sediment standards to measure contamination, and (2) giving an overall 'grade' to a composite sample that will inevitably contain materials with a variety of contamination levels. The second factor in particular ignores the impact on fish of the more toxic portions of a composite sample. The offending materials will work their harm on the fish even though their neighboring spoils are more benign and the average or overall measure is within the tolerance limits. Fish will not be given a roadmap of which portions of the site to use and which to avoid.

A second reason for concern is the uncertainty over whether the grand scheme will even work. The goal of increasing the useful fishery habitat area on the site by means of the deposit of dredge spoils relies on untested technology and science that we certainly hope would be successful. But there is no way to know whether it will in fact be successful until it is tried. We do not want the limited availability of habitat in Commencement Bay to be the guinea pig for that kind of testing. If the approach turns out to be unsuccessful, the already devastated habitat of Commencement Bay will suffer yet another blow, a possibility that should not be risked or countenanced.

Finally, the length of time it would take this approach, even if successful, to make the habitat functionally available is an indeterminate number of years. That will depend on material settling, long shore drift, tidal influences on the site, wind and wave-induced erosion and the natural decomposition process of the wood waste that will be buried and continue to produce methane gas. Given the devastation worked on Commencement Bay over the decades, it is simply unacceptable to subject it to this risk of further deleterious impact.

For all of these reasons the Tribe is completely opposed to using Saltchuck as the disposal site for Blair Waterway dredge spoils. The Corps of Engineers should take that part of the proposal off its table and out of its consideration. We would be glad to meet to discuss this important subject.

Sincerely,

Russ Ladley

Russ Ladley
Fisheries and Environmental Director

Char Naylor

Char Naylor
Water Quality Manager

John Howard Bell

John Howard Bell
Tribal Attorney

John Howard Bell
Puyallup Tribal Attorney
3009 East Portland Avenue
Tacoma, WA 98404
(253) 573-7871

Ceragioli, Kristine S CIV USARMY CENWS (USA)

From: Johnson, Eric <ejohnson@portoftacoma.com>
Sent: Friday, May 20, 2022 2:29 PM
To: Bullock, Alexander L (Xander) COL USARMY CENWS (USA); Messer, Walker L CIV USARMY CESAM (USA); Morris, Frances L CIV USARMY CENWS (USA); Leslie, Melissa L CIV USARMY CENWS (USA); Ceragioli, Kristine S CIV USARMY CENWS (USA); Boerner, Laura A CIV USARMY CENWS (USA)
Cc: Puyallup_Tribal_Council; Russ Ladley; Char Naylor; David Winfrey; George Stearns; tim@thompsoncg.com; Warfield, Tony; John Bell; Lisa Anderson; Lois Boome; Sam Stiltner; Jordan, Jason; McFarland, Ryan
Subject: [URL Verdict: Neutral][Non-DoD Source] Blair Waterway Deepening Project - Port of Tacoma message
Attachments: 2022 05 Port communication to USACE.docx

Good afternoon Colonel Bullock,

Attached please find a message relating to the Blair Waterway deepening project, which follows on to the position stated earlier by the Puyallup Tribe of Indians. It is our understanding that the Tribe will also be issuing a statement that elaborates on their earlier message to Seattle District.

Thank you again for your partnership on this important project.

Eric D. Johnson
Executive Director
PORT OF TACOMA
O: 253.428.8633
www.portoftacoma.com

May 20, 2022

To the Army Corps of Engineers (USACE):

The Port of Tacoma (Port) would like to add to the recent correspondence provided to USACE Seattle District from the Puyallup Tribe of Indians (PTI) regarding the Blair Waterway Deepening Feasibility Study. This project is vital to the Port of Tacoma and The Northwest Seaport Alliance to maintain our status as a world class container terminal gateway and is important as we move to more efficient and larger vessels. Specifically, the Port feels compelled to respond to both the PTI and USACE as follows:

- The Port strongly supports and is pleased to join the PTI on their support of the Blair deepening and widening project.
- We are committed to continue to partner with the PTI and USACE and fully study fishery impacts associated with the project.
- The port continues to support the beneficial use of clean dredged material from the Blair Waterway to create habitat improvements.
- Yet we also understand the PTI's concerns regarding disposal/beneficial reuse of project dredge sediments and will respect their position.
- Building on over 30 years of fisheries project partnerships with the PTI, the Port is committed to continuing that important work.

Next week will be a major milestone for this project when the Chief's report is signed. While significant, we recognize much more work is needed to bring this project to construction. We are looking forward to working with USACE, PTI and other stakeholders to refine the project during the design phase. The Port is confident that we can work with all our partners to ensure a successful and beneficial project that protects the fishery resource and ensures the gateway's continued growth.

Thank You,

Eric D. Johnson, Executive Director
Port of Tacoma

Kramer, Donald J CIV USARMY CENWS (USA)

From:	John Bell <John.Bell@PuyallupTribe-nsn.gov>
Sent:	Wednesday, May 25, 2022 4:12 PM
To:	Morris, Frances L CIV USARMY CENWS (USA); Winkler, Jessica G CIV USARMY CENWS (USA); Boerner, Laura A CIV USARMY CENWS (USA); Kramer, Donald J CIV USARMY CENWS (USA); Kassover, Stacy J CIV USARMY CENWS (USA)
Cc:	Russ Ladley; Char Naylor; David Winfrey; George Stearns; Lisa Anderson; Eric Johnson (ejohnson@portoftacoma.com); tim@thompsoncg.com; Ryan Thompson
Subject:	[Non-DoD Source] RE: Technical Meeting Tacoma Harbor GI Study w/Puyallup Tribe

Army Corps of Engineers, Seattle District Office:

This is to communicate the Tribe's view concerning the Corps' plan to sign the Chief's Report tomorrow, May 26, after our discussion in the meeting with you this afternoon.

First, we thank you for the very useful meeting this afternoon. It gave us a much clearer picture of the documents and the process.

The Tribe does not object at this point to the Report being signed and submitted as long as it, and the documents it accompanies as part of the Corps' process, contain the following features that you indicated to us on the phone they contain:

- The baseline plan is to dispose of dredge spoils removed from the Blair Waterway during the deepening and widening project at an open water disposal site.

- On the subject of the possible use of Blair dredge spoils for creation of habitat on the Saltchuck site, the Chief's Report does no more than keep open for further study the possibility of amending the baseline plan to allow for the use of some of the dredge spoils under appropriate conditions for that purpose. As we have indicated, the Tribe adamantly opposes going forward in that way. If the idea is indeed going to be studied, the Tribe's technical staff will want to be involved to make sure the investigation considers all the important factors.

We look forward to continuing to work with the Corps and with the Port of Tacoma on the planning of this project.

John Bell for (and after consultation with) the Tribe's technical team

----

John Howard Bell
Puyallup Tribal Attorney
3009 East Portland Avenue
Tacoma, WA 98404
(253) 573-7871

-----Original Appointment-----
From: Morris, Frances L CIV USARMY CENWS (USA) [mailto:Frances.Morris@usace.army.mil]
Sent: Friday, May 20, 2022 8:12 AM
To: Winkler, Jessica G CIV USARMY CENWS (USA); Boerner, Laura A CIV USARMY CENWS (USA); Kramer, Donald J CIV USARMY CENWS (USA); Russ Ladley; Lisa Anderson; John Bell; Char Naylor; David Winfrey; George Stearns; Kassover, Stacy J CIV USARMY CENWS (USA)
Cc: Ceragioli, Kristine S CIV USARMY CENWS (USA)
Subject: Technical Meeting Tacoma Harbor GI Study w/Puyallup Tribe
When: Wednesday, May 25, 2022 1:00 PM-2:00 PM (UTC-08:00) Pacific Time (US & Canada).
Where: WebEx Virtual Meeting

Hi All

This is a technical meeting to discuss Tacoma Harbor GI project status and concerns expressed by Puyallup Tribe related to the proposal to use dredge material at the Saltchuck site.

Please feel free to forward this to anyone I may have inadvertently left off the list.

Thanks!
Lori Morris
Tribal Liaison
Seattle District USACE
Frances.morris@usace.army.mil
Office: 206-764-3625
Cell: 206-799-7311

From:	Dierich, Elizabeth V (Ginny) CIV USARMY CENWS (USA)
To:	John.Bell@PuyallupTribe-nsn.gov
Cc:	Morris, Frances L CIV USARMY CENWS (USA); Winkler, Jessica G CIV USARMY CENWS (USA); Boerner, Laura A CIV USARMY CENWS (USA); Kramer, Donald J CIV USARMY CENWS (USA); Kassover, Stacy J CIV USARMY CENWS (USA); Cc: Russ Ladley; Char Naylor; David Winfrey; George Stearns; Lisa Anderson; ejohnson@portoftacoma.com; tim@thompsoncg.com; Ryan Thompson; Bullock, Alexander L (Xander) COL USARMY CENWS (USA)
Subject:	Technical Meeting Tacoma Harbor GI Study w/Puyallup Tribe
Date:	Friday, June 3, 2022 11:17:05 AM
Attachments:	Signed Tacoma, WA Chief"s Report.pdf

Mr. Bell, Mr. Ladley, and Ms. Naylor:

Thank you for your emails of May 11 and 20, 2022 describing the Puyallup Tribe's opposition to the use of the Saltchuk site for the Tacoma Harbor feasibility study. I also appreciate your follow up email on May 25, 2022, after meeting with Seattle District staff to discuss the Tribe's concerns. Please know that I understand and acknowledge the Tribe's concerns and appreciate you taking the time to meet with my staff last Wednesday, May 25 to discuss the process we have used and will use to further evaluate the viability of the Saltchuk site for beneficial use of dredged material from the Blair Waterway.

As described last week, the Corps process for navigation studies like this requires identifying the "base plan" for dredged material suitable for in-water disposal. The base plan for disposal of this material is defined as the least cost disposal plan consistent with sound engineering practice and all Federal environmental standards. In this study, the base plan for disposal is at the Commencement Bay Dredged Material Management Program (DMMP) open-water, non-dispersive site.

Our project team then assessed potential beneficial use of dredged material at the Saltchuk site for environmental benefits. We evaluated the Saltchuk site using an existing nearshore habitat model and proposed a Beneficial Use Plan for disposal. The Beneficial Use Plan involves the placement of 1,850,000 CY of dredged material at the Saltchuk site. This placement would restore up to approximately 64 acres of nearshore intertidal, and subtidal substrate conditions for fish and wildlife species at the Saltchuk site, including Endangered Species Act listed species. This beneficial use plan would result in significantly less material being placed in Commencement Bay in the recommended plan (compared with full placement of an estimated 2,412,000 cubic yards suitable for open-water disposal) thereby preserving capacity at the Commencement Bay open-water disposal site for other uses in the future.

The site could realize the benefits of approximately 14.5 average annual habitat units (AAHUs) and create up to approximately 38 lower shore zone acres. The average annual equivalent (AAEQ) cost of the Beneficial Use Plan is $23,000 per AAHU or an AAEQ cost of $5,200 per acre. The Corps determined that the incremental cost of the Beneficial Use Plan above the Base Plan cost is reasonable in relation to the environmental benefits to be achieved.

Further consideration of the design of a potential Saltchuk beneficial use site will be conducted during the design phase. A full sediment characterization will occur during this phase to provide additional information about material suitability for Saltchuk. We will coordinate with the Puyallup Tribe during design, including review of the sampling plan, the location and placement of beneficial use material and the monitoring plan to determine the viability of the beneficial use at Saltchuck.

In response to the May 31, 2022, request for the Biological Opinion for the Tacoma Harbor (Blair Waterway) project, the ESA Section 7 Consultation is publicly accessible. The formal Biological Opinion from NMFS and the Letter of Concurrence from USFWS are including in Appendix D to the Integrated Feasibility Report/Environmental Assessment which is located on our public website https://www.nws.usace.army.mil/Missions/Civil-Works/Programs-and-Projects/Projects/Tacoma-Harbor-Navigation-Improvement/ To access the Appendix, go to the link on the left column that indicates "Appendix. D – Compliance Documents".

As stated on the call last week and noted in the ESA consultation documents the Corps will continue coordination with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, state agencies, and the Puyallup Indian Tribe as design of the recommended plan is finalized. If during the design phase the Saltchuk site is found to not be feasible, the project would revert to the base plan of full placement of an estimated 2,412,000 cubic yards at the Commencement Bay open-water disposal site. This is noted in the Chief's Report for the study.

As discussed last Wednesday, signing the Chief's Report keeps the project moving forward into the next phase, pre-construction engineering and design (PED), where more detailed data collection, analysis, and design work will occur. This work is described in the Integrated Feasibility Report/Environmental Assessment available online at Tacoma Harbor Navigation Improvement (army.mil)

LTG Scott Spellman signed the Chief's Report last Thursday, May 26, 2022 (attached). We will continue to coordinate with and consult the Puyallup Tribe as this project moves forward through the congressional authorization process and into the PED phase. In the meantime, please contact Ms. Laura Boerner, Chief, Planning, Environmental and Cultural Resources Branch at 206-764-6761 or laura.a.boerner@usace.army.mil if you have any questions about the project or implementation process.

I really appreciate the tribes collaboration and support of this project and look forward to continuing to work with you as we move into the design phase.

Elizabeth (Ginny) Dierich PE, PMP
Deputy District Engineer
Seattle District
4735 E Marginal Way S
Seattle Wa 98134-2388
Office (206) 316-3706
Cell (206) 910-3620

From: John Bell <John.Bell@PuyallupTribe-nsn.gov>
Sent: Wednesday, May 25, 2022 4:12 PM
To: Morris, Frances L CIV USARMY CENWS (USA) <Frances.Morris@usace.army.mil>; Winkler, Jessica G CIV USARMY CENWS (USA) <Jessica.G.Winkler@usace.army.mil>; Boerner, Laura A CIV USARMY CENWS (USA) <Laura.A.Boerner@usace.army.mil>; Kramer, Donald J CIV USARMY CENWS (USA) <Donald.J.Kramer@usace.army.mil>; Kassover, Stacy J CIV USARMY CENWS (USA) <Stacy.J.Kassover@usace.army.mil>
Cc: Russ Ladley <Russ.Ladley@PuyallupTribe-nsn.gov>; Char Naylor <Char.Naylor@PuyallupTribe-nsn.gov>; David Winfrey <David.Winfrey@PuyallupTribe-nsn.gov>; George Stearns <George.Stearns@PuyallupTribe-nsn.gov>; Lisa Anderson <Lisa.Anderson@PuyallupTribe-nsn.gov>; Eric Johnson (ejohnson@portoftacoma.com) <ejohnson@portoftacoma.com>; tim@thompsoncg.com; Ryan Thompson <ryan@thompsoncg.com>
Subject: [Non-DoD Source] RE: Technical Meeting Tacoma Harbor GI Study w/Puyallup Tribe

Army Corps of Engineers, Seattle District Office:

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We look forward to continuing to work with the Corps and with the Port of Tacoma on the planning of this project.

John Bell for (and after consultation with) the Tribe's technical team

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Please feel free to forward this to anyone I may have inadvertently left off the list.

Thanks!
Lori Morris
Tribal Liaison
Seattle District USACE
Frances.morris@usace.army.mil
Office: 206-764-3625
Cell: 206-799-7311

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

DAEN (1105)

MAY 26 2022

MEMORANDUM FOR THE SECRETARY OF THE ARMY

SUBJECT: Tacoma Harbor Navigation Improvement Project, Washington

1. I submit, for transmission to Congress, my report on deep draft navigation improvements for Tacoma Harbor, Washington. It is accompanied by the report of the District Commander. This report is an interim response to the study authority of Section 209 of the Rivers and Harbors Act of 1962, Public Law 87-874, stating: "The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to wind or tidal effects, to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its territorial possessions, which include the following named localities:...Puget Sound, Washington, and adjacent waters, including tributaries, in the interest of flood control, navigation, and other water uses and related land resources." Preconstruction, Engineering and Design (PED) activities, if funded, would be continued under this same authority.

2. Tacoma Harbor is at the mouth of the Puyallup River in Puget Sound's Commencement Bay, at Tacoma, Washington. The Blair Waterway is currently -51 feet Mean Lower Low Water (MLLW). In the past decade, ships calling at the Port of Tacoma have increased in size and draft at a dramatic pace. The larger vessels have draft requirements deeper than -51 feet MLLW when fully laden, and therefore face tidal delays and other transportation inefficiencies when arriving and departing the waterway. The Port of Tacoma is a rapidly expanding major port, currently ranking as the 25th largest U.S. port in terms of total tonnage (containerized and non-containerized), the 9th largest container port individually, and the 4th largest container gateway, when combined with the Port of Seattle as the Northwest Seaport Alliance. Tacoma Harbor is an essential part of the U.S. west coast and national transportation system and is a critical gateway for the import and export of goods moving between Asia and the Pacific Northwest, and the U.S. Midwest. Tacoma Harbor's channel depth of -51 feet MLLW in the Blair Waterway limits the efficiency of larger containerships (14,000 twenty-foot equivalent units (TEU) to 18,000 TEUs) that have draft requirements greater than -51 feet MLLW. As a result, the waterborne transportation system incurs higher costs as vessels either light-load and make more trips to transport the same cargo volume or fully-load and wait on high tides to transit the channel. There is insufficient capacity at other U.S. ports to divert larger containerships to deeper ports. Without the capacity to accommodate larger ships more efficiently at Tacoma Harbor, the U.S. may lose trade to deeper Canadian ports and face increasingly higher transportation costs.

3. The reporting officers recommend a project that will contribute to the economic efficiency of commercial navigation. The recommended plan is the National Economic Development (NED) Plan and includes deepening the channel project depth of the Blair Waterway to -57 feet Mean Lower Low Water (MLLW) and restoring up to 64 acres of nearshore and subtidal habitat through the beneficial use of dredged material at the Saltchuk site.

4. The project area is within the Commencement Bay, Nearshore/Tideflats Superfund Site, in Tacoma, Washington, listed by the U.S. Environmental Protection Agency (EPA) on the National Priorities List under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. §§ 9601-9675. Limited sampling conducted by USACE to support this study has indicated the presence of sediment unsuitable for open-water disposal. The EPA noted this in the Commencement Bay Nearshore/Tideflats Superfund Site Fifth Five Year Review conducted in 2020. EPA acknowledged in a letter dated 14 August 2020 that USACE could manage these sediments with the standard best management practices identified in the feasibility report for the Tacoma Harbor project, and used during typical navigation dredging projects with unsuitable material for open water disposal. During the PED Phase of the project, USACE will conduct a full sediment sampling and characterization to determine suitability of open water disposal associated with the project footprint. Given the current numerous state and Federal cleanup sites and current remedies in place, the sampling plan will have an independent review conducted by the Environmental and Munitions Center of Expertise (CEHNC) to advise that the plan is adequate and accounts for potential sources of environmental risk or liability from areas impacted by the project footprint. USACE will engage EPA Region 10 and the Toxics Cleanup Program at Washington Department of Ecology to review the sampling results in the context of CERCLA and the Commencement Bay Nearshore Tideflats Superfund project and other areas impacted by the footprint of the project. If the regulatory agencies determine that these results warrant further investigation or remedial response under CERCLA or other applicable Federal or State environmental laws, those activities would be a responsibility of the non-federal sponsor and would be coordinated with, and subject to the approval of, EPA Region 10 and the Toxics Cleanup Program at Washington Department of Ecology. Should a regulatory agency make such a decision, the non-Federal sponsor will be fully responsible for coordinating those efforts prior to USACE proceeding with the navigation project.

5. The non-federal sponsor fully supports the recommended plan. Based on Fiscal Year (FY) 2022 price levels, a 2.25 percent discount rate, and a 50-year period of analysis, the estimated project cost of the recommended plan is $295,328,000, with average annual benefits of $152,715,000; an average annual cost of $14,259,000; net benefits of $138,456,000; and a benefit-to-cost ratio of 10.7. The recommended plan

consists of the following navigation improvements to Blair Waterway:

a. Deepen the existing project channel in the Blair Waterway to -57 feet MLLW.

b. Widen portions of the existing channel in the Blair Waterway to between 450 feet to 865 feet.

c. Expand the existing turning basin at the end of the Blair Waterway to a diameter of up to 1,935 feet and deepen the turning basin to -57 feet MLLW.

d. Under the recommended plan, approximately 562,000 cubic yards of dredged material would be placed in the Commencement Bay Dredged Material Management Program (DMMP) open-water, non-dispersive site, and approximately 392,000 cubic yards would be placed at an upland facility. Additional sampling and characterization of the sediments will be conducted during the PED phase, in coordination with the EPA and other DMMP agencies, and the results may affect these estimates.

e. The recommended plan also includes beneficial use of the dredged material. Approximately 1,850,000 cubic yards of the dredged material that would otherwise be placed in Commencement Bay open water disposal site, under the least cost method, will be used to restore approximately 64 acres of nearshore intertidal and subtidal substrate conditions at the Saltchuk site for fish and wildlife species, including Endangered Species Act listed species, to provide 14.5 Average Annual Habitat Units (AAHUs). As noted above, this will also result in only 562,000 cubic yards of material being placed in Commencement Bay in the recommended plan (compared with full placement of an estimated 2,412,000 cubic yards suitable for open-water disposal), thereby preserving capacity at the Commencement Bay open-water disposal site for other uses in the future. If in the PED phase the Saltchuk site is found to not be feasible, the project would revert to the base plan of full placement of an estimated 2,412,000 cubic yards at the Commencement Bay open-water disposal site. A Monitoring and Adaptive Management Plan has been prepared to evaluate the ecological effectiveness of beneficial use of dredged material placement at the Saltchuk site during and post-construction.

6. Pursuant to Section 7 of the Endangered Species Act (ESA) of 1973, as amended, USACE initiated consultation under the Endangered Species Act on 20 March 2019 and received a letter of concurrence from the U.S. Fish and Wildlife Service on 02 February 2022 and a Biological Opinion from the National Marine Fisheries Service on 16 February 2022. The Biological Opinion included an Incidental Take Statement with Reasonable and Prudent Measures (RPMs) and Terms and Conditions (T&Cs) for USACE to implement to minimize impacts from incidental take as a result of the

proposed action. All RPMs and T&Cs resulting from this consultation will be implemented. USACE will continue coordination with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, state agencies, and the Puyallup Indian Tribe as design of the recommended plan is finalized.

7. The Port of Tacoma is the non-federal cost sharing sponsor for all features.

8. Project costs for the recommended plan are allocated to the commercial navigation purpose and to beneficial use of dredged material for ecosystem restoration and are based on October 2021 price levels.

a. Project First Cost. The estimated first cost of the recommended plan, which includes the beneficial use of dredged material, is $295,328,000. This project first cost estimate includes the cost of construction of $269,541,000; the cost of lands, easements, rights-of-way and relocations (LERRs) of $307,000; planning, engineering, and design costs of $10,530,000; and construction management costs of $14,950,000. The estimated project first cost for the general navigation features (GNF) is $285,479,000, and the estimated project first cost for the beneficial use of dredged material that is above the least cost placement is $9,542,000, which includes an estimated $142,000 for monitoring. The operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) estimate is $4,755,000 per 25-year dredge cycle or $9,510,000 over the 50-year period of analysis.

b. Estimated Federal and Non-Federal Share. The federal share of the project first cost of the recommended plan including beneficial use is estimated to be $120,701,000 and the non-federal share is estimated to be $174,627,000 (including the payment described below in Paragraph d). In accordance with the cost sharing provisions in Section 101(a) of the Water Resources Development Act (WRDA) of 1986, as amended (33 U.S.C.§ 2211(a)), which includes a 50 percent federal and an initial 50 percent non-federal cost-share for GNF greater than -50 feet MLLW (as amended by Section 1111 of WRDA 2016), the federal share of the navigation features is estimated to be $142,740,000 and the non-federal share of the navigation features is estimated to be $142,740,000. In accordance with the cost sharing provisions of Section 103(c)(7) of WRDA 1986, as amended (33 U.S.C. § 2213(c)(7)), where the cost of beneficial use is shared based on ecosystem restoration, the federal share of the beneficial use of dredged material is estimated to be $6,202,000 and the non-federal share is estimated to be $3,340,000, which is based on a 65 percent federal and 35 percent non-federal share. The non-federal sponsor is also required to provide 50 percent of the excess costs attributable to GNF maintenance over -50 feet MLLW. Operation, maintenance, rehabilitation, repair, and replacement of the beneficial use site is not anticipated at this time, but is a non-federal responsibility. The value of LERR is 100 percent non-federal and is estimated to be $307,000.

c. Should any necessary investigations or response actions under CERCLA or other applicable Federal or State environmental laws be found necessary through sampling during PED, as described under paragraph 4, above, or if contaminants that constitute hazardous, toxic or radioactive waste (HTRW) are identified during any Phase II Environmental Site Assessment associated with upland sites warranting federal or state regulatory action, the non-Federal sponsor will be 100 percent responsible for all response actions, including investigations, the conduct of removal or remedial actions, and the protection of existing remedial components, prior to construction.

d. Additional 10 Percent Payment. In addition to payment by the non-federal sponsor of its share of the total cost of design and construction of the GNFs during design and construction, the non-federal sponsor must pay an additional 10 percent of the cost of the GNFs in cash over a period not to exceed 30 years, with interest, in accordance with Section 10l(a)(2) of WRDA 1986, as amended (33 U.S.C. 221 l(a)(2)). The value of LERRs and the costs of utility relocations, should they become necessary, will be credited toward this amount in accordance with Section 10l(a)(3) of WRDA 1986, as amended (33 U.S.C.§ 221 l(a)(3)). The additional 10 percent less LERR is estimated to be $28,241,000.

e. Local Service Facilities. The associated cost for local service facilities is approximately $112,101,000 for berthing area deepening outside of the federal channel and for dock slope strengthening, which benefit from a deeper channel. These costs are 100 percent non-federal and are not included in the project first costs of the recommended plan.

9. The recommended plan was developed in coordination and consultation with federal, state, and local agencies and numerous tribes. Risk and uncertainty were addressed during the study by completing a cost and schedule risk analysis and a sensitivity analysis. Risk includes project scope, schedule, additional environmental remediation requirements due to environmental response action requirements, costs to address a range of potential outcomes of ongoing environmental compliance, and cost changes if the non-federal sponsor is unable to acquire real estate parcels owned by the Puyallup Tribe that are required for construction. The non-federal sponsor has coordinated with the Puyallup Tribe, and design analysis in PED may avoid the need to acquire this real estate for the project.

10. In accordance with USACE guidance on the review of decision documents, all technical, engineering, and scientific work underwent an open, dynamic, and rigorous review process to ensure technical quality. This includes District Quality Control review, an Agency Technical Review, and USACE policy and legal compliance review. An

exclusion from Independent External Review was granted. All comments from the above referenced reviews have been addressed and incorporated into the final documents.

11. Washington-level review indicates that the plan recommended by the reporting officers is technically sound, environmentally acceptable, and economically justified. The plan complies with all essential elements of the U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Land Related Resources Implementation Studies. The recommended plan complies with other administration and legislative policies and guidelines. The views of interested parties including federal, state, and local agencies have been considered. Additional information will be developed during the PED phase that will determine how these factors may be affected.

12. I recommend that the plan for navigation improvements for Tacoma Harbor be authorized in accordance with the reporting officers' recommended plan at an October 2021 estimated project first cost of $295,328,000 with such modifications as in the discretion of the Chief of Engineers may be advisable. My recommendation is subject to cost sharing and other applicable requirements of Federal laws, regulations, and policies. Federal implementation of the project for commercial navigation includes, but is not limited to, the following items of local cooperation to be undertaken by the non-Federal sponsor in accordance with applicable Federal laws, regulations, and policies:

a. Provide the non-Federal share of construction costs, as further specified below:

1) Provide, during design, 50 percent of the costs of design for cost-shared features of the project in accordance with the terms of the design agreement for the project;

2) Provide, during construction, 50 percent of the costs of the general navigation facilities allocated to that portion of the project with a channel depth in excess of 50 feet, and 35 percent of the costs to construct the open water beneficial use site for suitable dredged material;

b. Provide all lands, easements, and rights-of-way, including those required for relocations and dredged material placement facilities, acquire or compel the removal of obstructions, and perform or ensure the performance of all relocations, including utility relocations, as determined by the Federal government to be necessary for the construction, operation, and maintenance of the general navigation features;

c. For each relocation of a utility, or portion thereof, located in or under navigable waters of the United States that is required to accommodate a channel depth over 45 feet, pay to the owner of the utility at least one half of the owner's relocation costs, unless the owner voluntarily agrees to waive all or a portion of the non-Federal sponsor's contribution;

d. Pay, with interest over a period not to exceed 30 years following completion of construction of the general navigation features, an additional amount equal to 10 percent of the construction costs of the general navigation features less the amount of credit afforded by the Federal government for the value of the real property interests and relocations, including utility relocations, provided by the non-Federal sponsor for the general navigation features, except for the value of the real property interests and relocations provided for mitigation, which is included in the construction costs of the general navigation features;

e. For general navigation features in excess of 50 feet (MLLW), pay 50 percent of the excess cost of operation and maintenance of the project, which includes operation and maintenance of dredged material placement facilities, over that cost which the Federal government would have incurred for operation and maintenance of the project if the channel had a depth of 50 feet;

f. Ensure that the local service facilities are constructed, operated, and maintained at no cost to the Federal government, and that all applicable licenses and permits necessary for construction, operation, and maintenance of such work are obtained;

g. Give the Federal government a right to enter, at reasonable times and in a reasonable manner, upon the real property interests that the non-Federal sponsor owns or controls for the purpose of operating and maintaining the project;

h. Hold and save the Federal government free from all damages arising from design, construction, operation and maintenance of the project, except for damages due to the fault or negligence of the Federal government or its contractors;

i. Perform, or ensure performance of, any investigations for hazardous, toxic, and radioactive wastes (HTRW) that are determined necessary to identify the existence and extent of any HTRW regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, and any other applicable law, that may exist in, on, or under real property interests that the Federal government determines to be necessary for construction, operation and maintenance of the general navigation features;

j. Agree, as between the Federal government and the non-Federal sponsor, to be solely responsible for the performance and costs of cleanup and response of any HTRW regulated under applicable law that are located in, on, or under real property interests required for construction, operation, and maintenance of the project, including the costs of any studies and investigations necessary to determine an appropriate response to the contamination, without reimbursement or credit by the Federal government;

k. Perform the non-Federal sponsor's responsibilities in a manner that will not cause HTRW liability to arise under applicable law to the maximum extent practicable; and

l. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4630 and 4655) and the Uniform Regulations contained in 49 C.F.R Part 24, in acquiring real property interests necessary for construction, operation, and maintenance of the project including those necessary for relocations, and placement area improvements; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

13. The recommendation contained herein reflects the information available at this time and current departmental policies governing the formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of the national Civil Works construction program or the perspective of higher levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to Congress for authorization and implementation funding. However, prior to transmittal to Congress, the state, interested federal agencies, and other parties will be advised of any significant modifications in the recommendations and will be afforded an opportunity to comment further.

SCOTT A. SPELLMON
Lieutenant General, USA
Chief of Engineers

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232-1274

September 5, 2019

Laura A. Boerner
Chief, Planning, Environmental, & Cultural Resources Branch
P.O. Box 3755
Seattle, WA 98124-3755
ATTN: CENWS-PMP

Re: Fish and Wildlife Coordination Act Planning Aid Letter on the Corps of Engineers' National Environmental Policy Act environmental assessment (EA) for the Tacoma Harbor, WA Navigation Improvement Project, Pierce, County, Washington.

Dear Chief Boerner;

The National Marine Fisheries Service (NMFS) has reviewed the December 21, 2019 Public Notice for the proposed Tacoma Harbor deepening in the Blair Waterway of Commencement Bay in Pierce County, Washington. This Planning Aid Letter is written in response to the public notice, under the authority given to NMFS through the Fish and Wildlife Coordination Act (16 USC 661-667e; 48 Stat. 401), because trust resources within NMFS' jurisdiction will be affected by the proposed project.

These trust resources include Endangered Species Act (ESA) listed Puget Sound (PS) Chinook salmon *(Oncorhynchus tshawytscha),* PS steelhead (*O. mykiss*), Southern Resident (SR) Killer Whale (*Orcinus orca*), and designated essential fish habitat (EFH) for various life stages of Pacific Coast salmon, Pacific Coast groundfish, and coastal pelagic species. Other species that fall within the fiduciary responsibility of the Federal government are the variety of fishes and shellfishes traditionally harvested by treaty tribes.

Purpose and Need for Proposed Action

The proposal involves the deepening of the Blair Waterway in Commencement Bay, Tacoma, Washington (Figure 1). The Tacoma Harbor currently measures approximately 51 feet MLLW (mean lower low water), a measurement that is equal to the average height of the lowest tide recorded every day during a 19-year period. Initial alternatives include deepening the Blair Waterway from minus 51 feet to up to minus 58 feet Mean Lower Low Water (MLLW) and widening the existing authorized channel (330 to 520 feet wide) to better accommodate larger vessels already calling at Tacoma Harbor, such as the post-Panamax Generation 4.

The Corps and the Port recognize that channel deepening is essential to maintaining the Port's competitive position as a premier international trade gateway, particularly relative to Canadian ports. A deeper harbor would eliminate transit delays due to tidal changes and allow larger, fully-loaded ships to more efficiently and cost-effectively visit the Port of Tacoma. The Tacoma

Harbor is a major gateway for containerized traffic and the channels must have sufficient depth for partially loaded vessels to call, take on additional cargo, and leave fully loaded. Tide restrictions, light loading, or other operational inefficiencies created by inadequate channel depth currently limits the Port's competitiveness, especially when competing with nearby and naturally deep harbors in British Columbia and the outer coast.

Figure 1. Aerial Image of Blair Waterway

Sediment that is determined to be suitable for beneficial reuse will either go to open water disposal or may be used at the potential Saltchuck marine site. Saltchuck is a deeper water site located adjacent to other restoration actions. The material placed would be intended to raise the elevation to create nearshore juvenile Chinook rearing habitat (Figure 2).

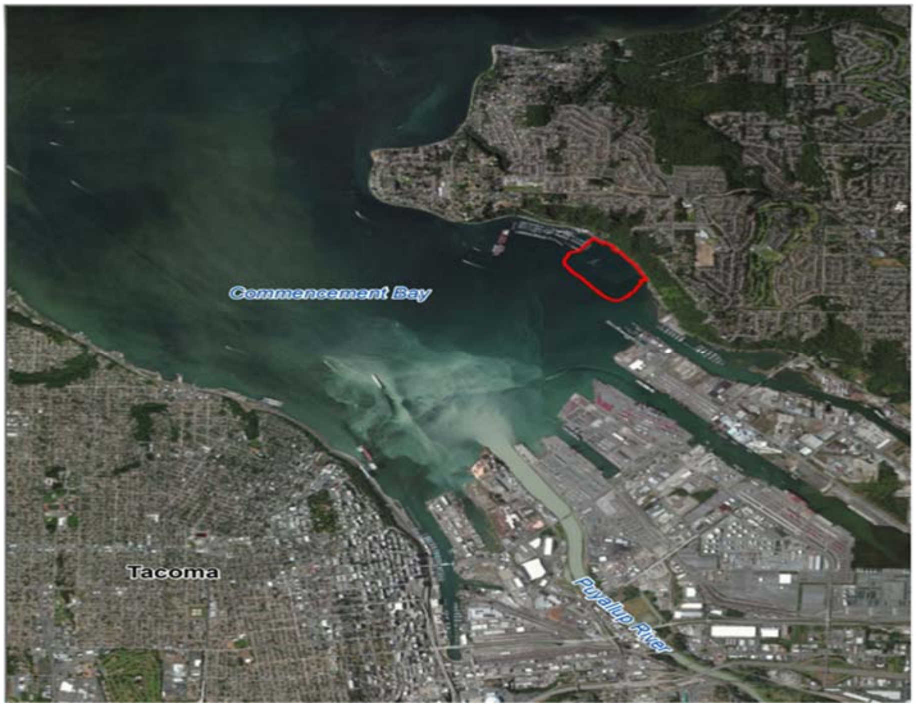

Figure 2. Location of the potential Saltchuck mitigation site

Existing Conditions

Lingering effects of more than a century of human development combined with numerous ongoing activities in the industrial waterways have contributed to the currently degraded environmental baseline conditions in Commencement Bay, including the Blair Waterway. In 1981, the U.S. Environmental Protection Agency (EPA) listed Commencement Bay as a Federal Superfund site. As a result of this, the cleanup of contaminants has been a high priority. After the completion of the dredging, the EPA deleted the Blair Waterway and all lands that drain to the Blair Waterway from the National Priorities List.

The shorelines of Commencement Bay have been highly altered using riprap and other materials to provide bank protection. Blair Waterway comprises seven percent of the total of armored shoreline that cover 71 percent of the length of the Commencement Bay shoreline. Based on shoreline surveys and aerial photo interpretation of the area, approximately five miles, or 20 percent of the Commencement Bay shoreline, is covered by wide over-water structures (Kerwin 1999). The existing project area is presently altered using riprap that provides low to medium quality feeding and refuge habitat for juvenile salmon (Spence et al. 1996).

At present, the small amount of functional salmonid habitat within Commencement Bay shorelines is gradually increasing in acreage because of habitat restoration projects and natural processes. The importance of nearshore marine habitat, as part of a restoration strategy for habitat function within the estuary, has been emphasized by the Chinook salmon habitat protection and restoration strategy for the Puyallup Watershed and is an important step toward improving the overall ecological functionality of the area.

Proposed Action and Potential Effects

The proposed project as described above involves deepening the navigational channel by dredging the Blair Waterway in Commencement Bay to accommodate loading and unloading of larger container ships. The Corps has indicated that deepening the navigational shipping channel to accommodate larger container ships is a viable alternative to meet the business needs of the Port of Tacoma. Other alternatives or measures are available or are currently being used, but these measures over the long-term do not solve the Port's issues on cost savings and reducing navigation challenges for larger ships entering the Port.

The Corps' in-water work window for Commencement Bay July 15 to February 15 which can reduce, but not avoid, effects on ESA listed species or designated critical habitat.

Potential construction-related impacts associated with dredging the Blair Waterway would include water quality impacts due to increased turbidity, suspended sediments, and contaminants. The variety of effects of increased turbidity and suspended sediment may be characterized as lethal, sublethal or behavioral (Bash et al. 2001; Newcombe and MacDonald 1991; Waters 1995). Lethal effects include gill trauma (physical damage to the respiratory structures), severely reduced respiratory function and performance, and smothering and other effects that can reduce egg-to-fry survival (Bash et al. 2001). Sublethal effects include physiological stress reducing the ability of a fish to perform vital functions (Cederholm and Reid 1987), increased metabolic oxygen demand and susceptibility to disease and other stressors (Bash et al. 2001), and reduced feeding efficiency (Bash et al. 2001; Berg and Northcote 1985; Waters 1995). Sublethal effects can act separately or cumulatively to reduce growth rates and increase fish mortality over time. Behavioral effects include avoidance, loss of territoriality, and related secondary effects to feeding rates and efficiency (Bash et al. 2001).

Do to the industrial nature of the area, dredging of the Blair Waterway has the potential to cause the release or resuspension of contaminants. The effects to aquatic life differ depending upon the type of contaminant. Metal, polyaromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs), as groupings of related contaminants, present a risk of additive or synergistic effects. Potential effects of bioaccumulation include inhibited reproduction, delayed fry emergence, liver disease or malfunction, morphological abnormalities, immune system impairment, and mortality.

Dredging will cause benthic habitat disturbance for EFH species that may forage in deep water. Juvenile salmon would not be affected as they forage almost exclusively in nearshore areas. The recovery of disturbed habitats following dredging ultimately depends upon the nature of the sediment at the dredge or disposal site, sources and types of re-colonizing animals, and the extent of the disturbance.

The dredging of the navigation channel will result in larger vessels (container ships) utilizing the Blair Waterway to load and unload at Port facilities and privately-owned industrial docks. Vessel traffic is one area that has been identified as having a potential effect on the feeding behavior of the whales. SR killer whales come into the Puget Sound on an irregular basis and for a limited amount of time usually during the winter. The amount of effect from vessel traffic on killer whales during the time they are present in Washington waters is unknown.

Coordination with Federal and State Agencies and Tribal Governments
The NMFS participated in meetings with the COE, had numerous discussions with agencies related to the Tacoma Harbor General Investigation, and coordinated with relevant resource agencies, and the Puyallup Tribe. The information provided in this letter is based on conversations with the Puyallup Tribe, WDFW, and the EPA. Many of the same concerns, conclusions, and recommendations are shared by the NMFS, the Tribe, WDFW, and the EPA. This Planning Aid Letter highlights concerns regarding potential risks and damages to fish, wildlife, and tribal trust resources associated with the Tacoma Harbor deepening project.

In addition to the coordination described above, in order to provide recommendations that benefit the fish and wildlife resources, NMFS reviewed the status of ESA-listed Species and Critical Habitats (See Appendix A for summary), and the Chinook salmon habitat protection and restoration strategy for the Puyallup Watershed. Specific recovery actions identified for Commencement Bay include restoring estuarine and nearshore habitat.

Recommendations
At the outset, in the context of this proposed action, and other federal water resource development proposals, we emphasize the necessity of upholding treaty fishing rights and other/related tribal trust responsibilities.

NMFS further recommends that the U.S. Army Corps of Engineers (COE), prior to issuing its 404 Clean Water Act permit: (1) work with NMFS, US Fish and Wildlife Service, Pierce County, Washington State Department of Fish and Wildlife (WDFW), Environmental Protection Agency (EPA), and the Puyallup Tribe to determine restoration actions to mitigate for project impacts; (2) coordinate with the NMFS throughout the development of the alternatives and design of the project to expedite the ESA section 7 consultation; (3) develop a contingency plan for possible contaminants; (4) provide a full characterization of sediment quality that will be used in nearshore placement; (5) include an analysis of vessel effects to marine mammals; and (6) maximize habitat restoration in the nearshore.

These recommendations are provided in greater detail here:

1. The Corps should work with NMFS, USFWS, Pierce County, WDFW, EPA, and the Puyallup Tribe to determine restoration actions to mitigate for project impacts, as well as impacts associated with interrelated and interdependent action such as long-term habitat loss, increased shade, changes in vessel sizes. Mitigation should meet the objectives of the current Recovery Plans for Puget Sound Chinook salmon.

2. Coordinate with the NMFS throughout the development of the alternatives and design of the project to expedite the ESA section 7 consultation.

    Early coordination can (1) provide an opportunity for the Service(s) to suggest conservation measures that can be incorporated into the project to avoid, reduce, or minimize potential adverse effects to listed species; (2) identify design alternatives or mitigation opportunities that can benefit the recovery of listed species; and (3) provide technical assistance on specific species habitat

requirements that could be incorporated into the project.

3. Develop a contingency plan to minimize water quality effects should contaminants be discovered during sediment sampling prior to dredging.

4. Because of the possibility of contaminants, sediment used in nearshore placement of dredged material at the Saltchuck marine site needs to be fully characterized to ensure fish or their prey resources will not be adversely affected. The Corps should provide a full characterization of sediment quality that will be used in nearshore placement to confirm fish or their prey resources will not be adversely affected.

5. Include an analysis of effects to marine mammals from larger vessels that will be transiting through Puget Sound to the Blair Waterway.

6. Maximize nearshore habitat restoration. Restored habitat function to areas will benefit ESA listed juvenile salmon and their prey resources, which in turn is beneficial to SRKW. Restored nearshore habitat also benefits designated EFH, and provides beneficial stewardship of treaty trust resources.

7. Perform monitoring of habitat restoration site to confirm that fish use established at baseline or improved levels, and at what time frame.

Summary and Service Position

Dredging of the Blair Waterway will retain the degraded condition of habitat in Commencement Bay that has been impacted for over 100 years, and which, despite its designation as critical habitat, does not have sufficient habitat conditions to improve conservation outcomes for ESA listed resources, and which currently fails to meet treaty obligations because consumption of fishes and shellfishes harvested from the area must be restricted to avoid human health impacts. Detrimental effects of the Blair Waterway dredging include water quality degradation, benthic effects, exposure of protected and trust species, and habitat and species disruptions associated with increased vessel size. Multiple beneficial effects would result from restored nearshore marine habitat.

Thank you for the opportunity to comment on the proposed project. If you have any questions, please contact Bonnie Shorin, of the Oregon/Washington Coastal Area Office at (360) 753-9578, or by email at Bonnie.Shorin@noaa.gov.

Sincerely,

for

Kim W. Kratz, Ph.D
Assistant Regional Administrator
Oregon Washington Coastal Office

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APPENDIX

Status of the Species

PS Chinook

This Evolutionary Significant Unit (ESU) comprises 22 populations distributed over five geographic areas. Most populations within the ESU have declined in abundance over the past 7 to 10 years, with widespread negative trends in natural-origin spawner abundance, and hatchery-origin spawners present in high fractions in most populations outside of the Skagit watershed. Escapement levels for all populations remain well below the Technical Review Team (TRT) planning ranges for recovery, and most populations are consistently below the spawner-recruit levels identified by the TRT as consistent with recovery.

Limiting factors include:

- Degraded floodplain and in-river channel structure
- Degraded estuarine conditions and loss of estuarine habitat
- Degraded riparian areas and loss of in-river large woody debris
- Excessive fine-grained sediment in spawning gravel
- Degraded water quality and temperature
- Degraded nearshore conditions
- Impaired passage for migrating fish
- Severely altered flow regime

PS Steelhead

This DPS comprises 32 populations. The DPS is currently at very low viability, with most of the 32 populations and all three population groups at low viability. Information considered during the most recent status review indicates that the biological risks faced by the Puget Sound Steelhead DPS have not substantively changed since the listing in 2007, or since the 2011 status review. Furthermore, the Puget Sound Steelhead TRT recently concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 populations. In the near term, the outlook for environmental conditions affecting Puget Sound steelhead is not optimistic. While harvest and hatchery production of steelhead in Puget Sound are currently at low levels and are not likely to increase substantially in the foreseeable future, some recent environmental trends not favorable to Puget Sound steelhead survival and production are expected to continue.

Limiting factors include:

- Continued destruction and modification of habitat
- Widespread declines in adult abundance despite significant reductions in harvest
- Threats to diversity posed by use of two hatchery steelhead stocks
- Declining diversity in the DPS, including the uncertain but weak status of summer-run fish
- A reduction in spatial structure
- Reduced habitat quality
- Urbanization
- Dikes, hardening of banks with riprap, and channelization

SR Killer Whale
The Southern Resident killer whale DPS is composed of a single population that ranges as far south as central California and as far north as southeast Alaska. The estimated effective size of the population (based on the number of breeding individuals under ideal genetic conditions) is very small — <30 whales, or about 1/3 of the current population size. The small effective population size, the absence of gene flow from other populations, and documented breeding within pods may elevate the risk from inbreeding and other issues associated with genetic deterioration. As of July 1, 2013, there were 26 whales in J pod, 19 whales in K pod and 37 whales in L pod, for a total of 82 whales. Estimates for the historical abundance of Southern Resident killer whales range from 140 whales (based on public display removals to 400 whales, as used in population viability analysis scenarios.

Limiting factors include:

- Quantity and quality of prey
- Exposure to toxic chemicals
- Disturbance from sound and vessels
- Risk from oil spills

Chinook Salmon and SR Killer Whale Critical Habitat

There is no designated PS steelhead critical habitat in the project area.

PS Chinook salmon
The NMFS designated critical habitat for the Puget Sound Chinook salmon on September 2, 2005 (70 FR 52630). One of the six PBFs of Puget Sound Chinook salmon critical habitat are in the action area:

The action area is located within the marine physical or biological features (PBF) of PS Chinook critical habitat. The PBFs for PS Chinook salmon marine critical habitat are:

(1) Water quality and quantity conditions and (2) Forage, including aquatic invertebrates and fish, supporting growth and maturation; and (3) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

Dredging activities will result in temporary degradation of water quality due to increased turbidity, suspended sediments, and possible contaminants.

SR Killer Whale
The final rule listing Southern Resident killer whales (SRKW) as endangered identified several potential factors that may have caused their decline or may be limiting recovery. These are: quantity and quality of prey, toxic chemicals which accumulate in top predators, and disturbance from sound and vessel traffic. The rule also identified oil spills as a potential risk factor for this species (73 FR 4176).

SR Killer Whales are not known to frequent the Blair Waterway. Vessel traffic transiting the Puget Sound may affect the feeding behavior of SR killer whales.

Essential Fish Habitat

The project area includes habitats that have been designated as EFH for various life-history stages of 17 species of groundfish, four coastal pelagic species, and three species of Pacific salmon.

CENWS-PMP-E **December 2019**

COASTAL ZONE MANAGEMENT ACT CONSISTENCY DETERMINATION

Tacoma Harbor, WA Navigation Improvement Project

Tacoma, Washington

Introduction. The proposed Federal action applicable to this consistency determination is the deepening of the Blair Waterway of Tacoma Harbor to -57 feet below mean lower low water (MLLW) in Tacoma, Washington. This will involve dredging of approximately 2.8 million cubic yards (cy) from the Blair Waterway. Dredged material could be placed at the Commencement Bay open-water disposal site (2.4 million cy) or an upland disposal facility for material unsuitable for open-water disposal (392,000 cy). Additional evaluation of beneficial use of dredged material at the Saltchuk site (1.85 million cy) is included in the tentatively selected plan, which would reduce the amount of material going to the open-water disposal site to about 562,000 cy. The decision to use Saltchuk will be made in the Preconstruction Engineering Design phase (PED) following a full sediment characterization. This determination of consistency with the Washington Coastal Zone Management Act (CZMA) is based on review of applicable sections of the State of Washington Shoreline Management Program and policies and standards of the Pierce County and City of Tacoma Shoreline Management Master Programs.

Consistency Review. The Coastal Zone Management Act requires states to identify "Enforceable Policies." Washington's authorities and their implementing regulations contain the state Coastal Zone Management Program's (CZMP) enforceable policies:

- The Shoreline Management Act (SMA)
- The Clean Water Act (CWA)
- The Clean Air Act (CAA)
- State Environmental Policy Act (NEPA)

The remaining two policies, the Energy Facility Site Evaluation Council and the Ocean Resource Management Act, are not applicable to this project.

State of Washington Shoreline Management Program. The Washington SMA, Revised Code of Washington [RCW] Chapter 90.58 is the core authority of Washington's Coastal Zone Management Program. This chapter enunciates the following state policy:

- To provide for the management of the shorelines of the state by planning for and fostering all reasonable and appropriate uses.
- To insure the development of shorelines in manner that promotes and enhances the public interest while allowing only limited reduction of rights of the public in the navigable waters.

- To protect against adverse effects to the public health, the land and its vegetation and wildlife, and the waters of the state and their aquatic life, while protecting generally public rights of navigation and corollary rights.

The proposed activities are consistent with this broad statement of policy. The proposed action will support the continued usage of the industrial shoreline of the Port of Tacoma. The project has been found to be in the public interest due to its cost/benefit ratio for investment of public funds and will not change the rights of navigation.

The Clean Water Act. The Corps will provide materials for review to the Washington State Department of Ecology for water quality certification under Section 401 of the Clean Water Act.

Washington Air Quality Requirements. The proposed activities do not require an Air Quality Permit.

State Environmental Policy Act (SEPA). Corps Civil Works projects comply with the National Environmental Policy Act (NEPA) and are not subject to SEPA. A draft Environmental Assessment has been prepared.

Local Shoreline Master Program. The Pierce County Shoreline Master Plan (SMP) constitutes the policies and regulations governing development and uses in and adjacent to marine and freshwater shorelines as defined in Pierce County Code Chapter 18S (https://www.codepublishing.com/WA/PierceCounty/#!/html/PierceCounty18S/PierceCounty18S.html).

Following the procedures as detailed at Pierce County Code Title 18S, this document provides information for a determination of consistency. The following outlines pertinent sections of the Pierce County SMP that apply to and implement the SMA, followed by pertinent sections of the City of Tacoma SMP. The Corps of Engineers consistency determinations are located below the relevant code in ***bold italics***.

Part I. Pierce County SMP

<u>18S.30. – General Policies and Regulations</u>
The purpose of this Chapter is to provide general development policies and regulations that are, or could be, applicable to all shoreline uses and development in all shoreline environment designations. (Ord. 2013-45s4 § 7 (part), 2015).

<u>18S.30.020 Archaeological, Cultural, and Historic Resources</u>
The intent of the Archaeological, Cultural, and Historic Resources policies and regulations is to recognize that these resources can be found throughout the County and that they are valuable because they are irreplaceable and limited. When these resources are found on shoreline sites they should be preserved, protected, and restored. Archaeological areas, ancient villages, military forts, old settlers' homes, ghost towns, historic trails, historical cemeteries, and other cultural sites and features are nonrenewable resources, many of which are in danger of being lost through present day changes in land use and urbanization.

Consistent. Based on the cultural resources impacts analysis in the Feasibility Report and Environmental Assessment (USACE 2019), no impacts to cultural or historic resources are anticipated. Archaeological monitoring results of the sediment sampling cores were negative for cultural resources.

<u>18S.30.030 Ecological Protection</u>
The intent of the Ecological Protection policies and regulations is to ensure that shoreline development is established and managed in a manner that protects existing ecological functions and ecosystem-wide process and that mitigates adverse impacts to ecological functions. This means assuring no net loss of ecological functions and processes in shorelines, and protecting critical areas designated in Title 18E PCC.
Consistent. Based on the environmental impacts analysis in the Feasibility Report and Environmental Assessment (USACE 2019), the deepening and widening of the Federal Navigation Channel will maintain its present location. Channel improvements will be designed, constructed, and managed to achieve no net loss of ecological functions.

Effects to the environment will be minor short-term disturbances and highly localized to only the navigation channels and Saltchuk. Material placement at Saltchuk will have an overall positive effect on the environment by creating juvenile salmonid habitat and improving the local sediment quality. Due to minimal change to the environment as a result of the project, no mitigation is proposed.

<u>18S.30.040 Excavation, Dredging, Filling, and Grading</u>

A. Applicability. The intent of the Excavation, Dredging, Filling, and/or Grading policies and regulations is to provide direction for shoreline excavation, dredging, filling, and/or grading associated with a principal use. This Section may contain more restrictive regulations that limit or effectively preclude a use or development that is authorized pursuant to another Section(s) and this Section shall control in the event of a conflict.

B. Policies.

    1. Prohibit fill waterward of the ordinary high water mark (OHWM) except for restoration projects, mitigation actions, beach nourishment or enhancement projects, or when necessary to support a water dependent use, public access, cleanup of contaminated sediments, or alteration of a transportation facility of statewide significance.

Consistent. The proposed fill is beneficial use of dredged material to create juvenile salmonid habitat and improve sediment quality at Saltchuk.

    2. Locate and design new development to avoid the need for fill. When fill is deemed necessary, its use should be minimized and environmental impacts mitigated.

Consistent. Fill is only necessary to construct shallow-water habitat and to improve sediment quality at Saltchuk. Construction of Saltchuk has been designed to minimize impacts to the environment. Based on the environmental impacts analysis in the Feasibility Report and

Environmental Assessment (USACE 2019), effects to the environment due to fill will be minor, short-term disturbances and highly localized to only Saltchuk. The short-term effects do not rise to the level that would require compensatory mitigation.

3. Evaluate fill projects for:

    a. Total water surface reduction;

    b. Navigation restriction;

    c. Impediment to water flow, circulation, and currents;

    d. Reduction of water quality;

    e. Destruction of habitat and natural resources systems; and

    f. Creation of hazard to the public and adjacent properties.

Consistent. Beneficial use of dredged material at Saltchuk has been evaluated for the above items in the Feasibility Report and Environmental Assessment (USACE 2019). Creation of shallow-water habitat for juvenile salmonids will reduce total water surface during some points of the tide cycle due to the creation of three islands with a maximum elevation of +4 feet MLLW. Each island is approximately 500 feet long by 250 feet wide and would not constitute a discernable loss of total water surface area in Commencement Bay, which is approximately 5 square miles. Ship simulation in PED phase will investigate navigation restrictions around Saltchuk, and the project has been designed to minimize any effects to navigation to the maximum extent practicable. Water flow, circulation, and currents will not be impeded. The project has been designed to minimize the short-term and localized reduction in water quality due to turbidity during construction. Habitat and natural resources systems will not be destroyed; rather, shallow-water habitat will be created. Saltchuk will not pose a hazard to the public or adjacent properties due to the in-water location.

4. Locate and design new development to avoid or minimize the need for maintenance dredging.

Consistent. The site of the Blair Waterway in current usage will not change. The project has been designed to minimize the need for maintenance dredging.

5. Allow dredging only for water-dependent uses and only to the extent necessary to support those uses.

Consistent. The purpose of the project is improve navigation safety and efficiency to support use of the terminals on the shoreline of the Port of Tacoma, which is a water-dependent use.

6. Allow dredging for the purpose of establishing, expanding, relocating, or reconfiguring navigation channels and basins to ensure safe and efficient accommodation of existing navigational uses.

Consistent. The purpose of the project is to improve navigation safety and efficiency of the Blair Waterway, an existing navigation channel.

7. Restrict maintenance dredging of established navigation channels and basins to the minimum necessary, and limit such dredging to the historic or a previously dredged location, depth, and width.

Consistent. Maintenance dredging is anticipated to occur every 25 years to maintain the authorized project depth.

8. Encourage the recycling of clean, drained, dredged material, for uses that benefit shoreline resources, and agricultural, forest land, and landscaping uses.

Consistent. Dependent on funding and availability, material that is suitable for beneficial reuse will be placed at Saltchuk for the benefit of shoreline resources.

9. Prohibit dredging waterward of the OHWM for the purpose of obtaining fill material.

Consistent. The purpose of dredging is to improve safety and efficiency of the Blair Waterway. Beneficial use of dredged material at Saltchuk is an opportunity to improve juvenile salmonid habitat in Commencement Bay.

10. Pierce County is concerned about potential for impacts to the environment from discharging dredged materials in Pierce County marine waters within the Nisqually Reach Aquatic Reserve. The County encourages citizen participation and engagement in the oversight of dredged material disposal through the Nisqually Reach Aquatic Reserve Implementation Committee and the Anderson Island Citizens Advisory Board (AICAB). The County shall work with DNR Aquatic Reserve Program staff to seek feedback from the Implementation Committee and the AICAB on Shoreline Conditional Use Permit applications related to dredge disposal within Reserve boundaries.

Consistent. Dredged material would go to the Commencement Bay open-water disposal site, Saltchuk beneficial use site, and/or to an upland disposal facility.

C. Regulations. These regulations are in addition to those in Title 17A PCC, Construction and Infrastructure Regulations – Site Development and Stormwater Drainage, Pierce County Stormwater Management and Site Development Manual.

Not Applicable. Stormwater control is not a component of dredging or material placement at Saltchuk.

1. The following activities are prohibited:

    a. Filling in locations that will cut off or isolate hydrologic features, except as allowed pursuant to PCC 18S.40.060, Flood Hazard Management;

    b. Solid waste landfills; and

    c. Dredging for the purpose of obtaining fill material, except for projects associated with Model Toxics Control Act (MTCA) or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) habitat restoration, or any other significant restoration effort project approved by a Conditional Use Permit.

Consistent. Placing material at Saltchuk will not cut off or isolate hydrologic features. Creation of solid waste landfills are not a component of this project, and the purpose of the project is to improve safety and efficiency of the Blair Waterway. Dredged material that is unsuitable for open-water disposal or placement at Saltchuk would go to an upland facility, which may be a solid waste landfill (e.g., the LRI Facility in Graham, WA).

2. Filling waterward of the OHWM is prohibited for the purpose of creating upland, but may be allowed when necessary to support:

   a. Water-dependent uses;

   b. Public access;

   c. Cleanup and disposal of contaminated sediments as part of an interagency environmental clean-up plan;

   d. Disposal of dredged material considered suitable under, and conducted in accordance with, the dredged material management program of the Washington State Department of Natural Resources (DNR);

   e. Expansion or alteration of transportation facilities of statewide significance currently located on the shoreline, and then only upon a demonstration that alternatives to fill are not feasible;

   f. Mitigation action, environmental restoration, beach nourishment, or enhancement project; or

   g. Public utility projects approved in accordance with an adopted transportation or utility plan or program.

Consistent. The purpose of beneficial use of dredged material at Saltchuk is to create and enhance shallow-water habitat for juvenile salmonids. Only dredged material deemed suitable for aquatic placement at Saltchuk by the Dredged Material Management Program, of which the Washington State DNR is a member, will be used.

3. Excavation, dredging, filling, and/or grading shall not occur without an authorized principal use or development.

Consistent. The principal purpose of the proposed project is to improve and maintain the safety and efficiency of the Blair Waterway.

4. Excavation, dredging, filling, and/or grading shall be limited to the minimum amount necessary for the specific use or development proposed.

Consistent. Deepening the Blair Waterway has been optimized to improve the safety and efficiency for the largest vessels projected to arrive at Port of Tacoma over the next 50 years.

5. Activities waterward of the OHWM shall only be allowed after the proponent has demonstrated that alternative locations and designs have been considered and found to be infeasible, and the dump site or destination and staging area for dredged material has been provided.

Consistent. Dredging, disposal, and material placement location alternatives have been considered in the Feasibility Report and Environmental Assessment (USACE 2019).

6. Excavation, dredging, filling, and/or grading shall not unnecessarily impact natural processes such as water flow, circulation, currents, channel migration, erosion, sediment transport, and floodwater storage, and shall not cut off or isolate hydrologic features.

Consistent. The proposed project has been designed to minimize or avoid effects to the above natural processes, as described in the Feasibility Report and Environmental Assessment (USACE 2019).

7. Dredging material, if suitable, should be utilized for beneficial shoreline resources.

Consistent. Depending on funding, the outcome of the Tacoma Harbor feasibility study and Civil Works planning process, and material availability after a full sediment suitability determination, beneficial use of suitable dredged material will be used at Saltchuk to benefit shoreline resources.

8. Stabilization measures should be designed to blend physically and visually with existing topography.

Consistent. Engineered stabilization measures in Blair Waterway would blend physically and visually with the existing industrial topography.

9. New development shall be located and designed to avoid or minimize the need for maintenance dredging.

Consistent. The proposed project has been designed to minimize the need for maintenance dredging, which is anticipated every 25 years following deepening of the Blair Waterway.

<u>18S.30.050 Shoreline Access</u>

The intent of the Shoreline Access policies and regulations is to recognize the rights of the general public to reach, touch, view and enjoy the water's edge, to travel the waters of the State, and to view the water and the shoreline from adjacent locations. These rights are a fundamental element of the Shoreline Management Act (Act).

Consistent. The proposed project will not limit the rights of the public as listed above. Access to the kayak launch near Saltchuk will be temporarily restricted during construction at Saltchuk; however, access will be fully restored after construction is complete. The Feasibility Report and Environmental Assessment (USACE 2019) provides an analysis of public health and safety. The project has been designed to minimize any effects to public health and safety to the maximum extent practicable.

18S.30.060 Scenic Protection and Compatibility

The purpose of the Scenic Protection and Compatibility policies and regulations is to preserve shoreline scenic vistas and to ensure development on shorelines is compatible with the surrounding environment, existing, and planned development.

Consistent. The proposed project will not alter the existing shoreline scenic vista due to the in-water location. The aesthetic qualities of Commencement Bay will not be affected.

18S.30.070 Shoreline Stabilization

The intent of the Shoreline Stabilization policies and regulations is to allow shoreline stabilization structures or measures where no alternatives are feasible to accommodate development along the shorelines, while preserving and improving ecological functions of the shoreline and while protecting the shoreline environment from impacts caused by development within and adjacent to geologically hazardous areas.

Consistent. To the extent that they are warranted, further design of engineered slope stabilization measures to accommodate deepening within the Blair Waterway will be refined in PED, and their use will be minimized to the extent possible. Presence of these measures will not degrade the shoreline environment within the Blair Waterway.

18S.30.080 Shoreline Modifications

The intent of the Shoreline Modification policies and regulations is to limit those actions that modify the physical configuration or qualities of the shoreline area. Shoreline modifications are those actions that modify the physical configuration or qualities of the shoreline area, usually through the construction of a physical element such as a dike, breakwater, pier, weir, dredged basin, fill, bulkhead, or other shoreline structure. They can include other actions, such as clearing, grading, or application of chemicals.

Consistent. Engineered shoreline stabilization measures to accommodate deepening within the Blair Waterway will be refined in PED, and their use will be minimized to the extent possible. Modification may include sheetpile, riprap, or another solution to be refined. The purpose of the modification is to stabilize the slope of the navigation channel, which will maintain the existing use of the shoreline area within the Blair Waterway. Clearing, grading, or application of chemicals will not be necessary. Presence of these measures will not degrade the shoreline environment within the Blair Waterway.

18S.30.090 Water Oriented Development

The intent of the Water Oriented Development policies and regulations is to ensure that water-dependent, water-related, or water-enjoyment, or a combination of such uses, is preferred in shorelines.

Consistent. A short-term, temporary closure of the kayak launch near Saltchuk would be necessary during construction of Saltchuk, but the proposed project will not prevent long-term water-oriented uses in Commencement Bay; and other sites may be utilized on a short-term basis to maintain water access during construction of Saltchuk.

18S.30.100 Water Quality, Stormwater, and Nonpoint Pollution

The intent of the Water Quality, Stormwater, and Nonpoint Pollution policies and regulations is to protect against adverse impacts to water quality and quantity.

Consistent. The Corps will provide materials for review to the Washington State Department of Ecology for water quality certification under Section 401 of the Clean Water Act. Stormwater and Nonpoint Pollution control is not a component of dredging.

Part II. City of Tacoma SMP

Chapter 6 – General Policies and Regulations
The following regulations shall apply to all uses and all districts in the City of Tacoma shoreline jurisdiction.

Chapter 6.1 – Shoreline Use
Shoreline uses refer to specific common uses and types of development (e.g. residential recreation, commercial, industrial, etc.) that may occur in the City's shoreline jurisdiction. Shoreline areas are a limited ecological and economic resource and are the setting for multiple competing uses. The purpose of this section is to establish preferred shoreline uses. These preferences are employed in deciding what uses should be allowed in shorelines and resolving use conflicts. Consistent with the Act and Guidelines, preferred uses include, in order of preference: shoreline enhancement and restoration; water-dependent uses; water-related and – enjoyment uses; and single-family development when developed without significant impacts to shoreline functions. Mixed-use developments may also be considered preferred if they include and support water-oriented uses. All uses and development must be consistent with the provisions of the environment designation in which they are located and the general regulations of this Program.
Consistent. The proposed uses are shoreline enhancement and restoration (Saltchuk beneficial use of dredged material) and water-dependent uses (navigation).

Chapter 6.2 – Site Planning
The Purpose of this chapter is to establish the City's policies related to the location and dimensions of shoreline uses. This section implements the Act's and Guidelines' policies to protect shoreline ecological functions from the adverse effects of shoreline development and use and ensure that proposed uses are developed in a manner that is compatible with a shoreline location, public access and adjacent uses. The section establishes policies and includes regulations and development standards to ensure that shoreline development considers the physical and natural features of the shoreline and assures no net loss of ecological functions.
Consistent. The deepening and widening of the Federal Navigation Channel will maintain its present location. The Blair Waterway and Saltchuk are consistent with shoreline location, public access, and adjacent uses. The Feasibility Report and Environmental Assessment (USACE 2019) has considered the physical and natural features of the shoreline. Channel improvements and Saltchuk will be designed, constructed and managed to achieve no net loss of ecological functions. Due to minimal change to the environment as a result of the project, no mitigation is proposed.

Chapter 6.3 – Archaeological, Cultural and Historic Resources
The following policies and regulations apply to archaeological and historic resources that are either recorded with the State Department of Archaeology and Historic Preservation (DAHP) and/or the City or have been inadvertently uncovered during a site investigation or construction. Archaeological sites located both in and outside shoreline jurisdiction are subject to chapter 27.44 RCW (Indian graves and records) and chapter 27.53 RCW (Archaeological sites and

records). Development or uses that could impact these sites must comply with the State's guidelines on archaeological excavation and removal (WAC 25-48) as well as the provisions of this Program. Archaeological and historic resources are limited and irreplaceable. Therefore the purpose of these policies and regulations is to prevent the destruction of or damage to any site having historic, cultural, scientific, or educational value as identified by the appropriate authorities, including affected Indian tribes.

Consistent. Based on the cultural resources impacts analysis in the Feasibility Report and Environmental Assessment (USACE 2019), no impacts to cultural or historic resources are anticipated. Archaeological monitoring results of the sediment sampling cores were negative for cultural resources.

<u>Chapter 6.4 – Marine Shoreline and Critical Areas Protection</u>

The intent of this chapter is to provide policies and regulations that protect the shoreline environment as well as the critical areas found within the shoreline jurisdiction. These policies and regulations apply to all uses, developments and activities that may occur within the shoreline jurisdiction regardless of the Shoreline Master Program environment designation. They are to be implemented in conjunction with the specific use and activity policies and regulations found in this Master Program.

The Shoreline Management Act (SMA) mandates the preservation of the ecological functions of the shoreline by preventing impacts that would harm the fragile shorelines of the state. When impacts cannot be avoided, impacts must be mitigated to assure no-net-loss of ecological function necessary to sustain shoreline resources. The SMA also mandates that local master programs include goals, policies and actions for the restoration of impaired shoreline ecological functions to achieve overall improvements in shoreline ecological functions over time.

The environment protection policies and regulations of this Master Program address general environmental impacts and critical areas. General environmental impacts include effects upon the elements of the environment listed in the State Environmental Policy Act (SEPA) (WAC 197-11-600 and WAC 197-11-666). This chapter is not intended to limit the application of SEPA.

Consistent. Based on the environmental impacts analysis in the Feasibility Report and Environmental Assessment (USACE 2019), effects to the environment will be minor short-term disturbances and highly localized. The short-term effects do not rise to the level that would require compensatory mitigation.

<u>Chapter 6.5 – Public Access</u>

Shoreline public access is the physical ability of the general public to reach and touch the water's edge or the ability to have a view of the water and the shoreline from upland locations. There are a variety of types of public access, including docks and piers, boat launches, pathways and trails, promenades, street ends, picnic areas, beach walks, viewpoints and others.

An important goal of the Shoreline Management Act is to protect and enhance public access to the state's shorelines. Specifically, the SMA states:

> *RCW 90.58.020: "[T]he public's ability to enjoy the physical and aesthetic qualities of natural shorelines of the state shall be preserved to the greatest extent feasible consistent with the overall best interest of the state and the people generally."*
>
> *"Alterations of the natural conditions of the shorelines of the state, in those limited instances when authorized, shall be given priority for …development that will provide an opportunity for substantial numbers of people to enjoy the shorelines of the state."*

Public access and use of the shoreline is supported, in part, by the Public Trust Doctrine. The essence of the doctrine is that the waters of the state are a public resource owned by and available to all citizens equally for the purposes of navigation, conducting commerce, fishing, recreation and similar uses, and that this trust is not invalidated by private ownership of the underlying land. The doctrine limits public and private use of tidelands and other shorelands to protect the public's right to use the waters of the state. The Public Trust Doctrine does not allow the public to trespass over privately owned uplands to access the tidelands. It does, however, protect public use of navigable waterbodies.
Consistent. The proposed project will not limit the rights of the public as listed above. Access to the kayak launch near Saltchuk will be temporarily restricted during construction at Saltchuk. The Feasibility Report and Environmental Assessment (USACE 2019) provides an analysis of public health and safety. The project has been designed to minimize any effects to public health and safety to the maximum extent practicable.

Chapter 6.6 – Vegetation Conservation
Vegetation conservation includes activities to protect and restore vegetation along or near marine and freshwater shorelines that contribute to the ecological functions of shoreline areas. Vegetation conservation provisions include the prevention or restriction of plant clearing and earth grading, vegetation restoration, and the control of invasive weeds and nonnative species.

Unless otherwise stated, vegetation conservation does not include those activities covered under the Washington State Forest Practices Act, except for conversion to other uses and those other forest practice activities over which local governments have authority. Vegetation conservation provisions apply even to those shoreline uses and developments that are exempt from the requirement to obtain a permit. Vegetation conservation standards do not apply retroactively to existing uses and structures.

Consistent. No upland clearing is proposed. Material placement at Saltchuk has been designed to minimize impacts to aquatic vegetation in the area.

Chapter 6.7 – Views and Aesthetics
The following provisions provide for preservation and/or protection of scenic vistas, views of the water, and other aesthetic qualities of shorelines for public enjoyment. They include policies and regulations which protect public views of the City's shorelines and waters; encourage shoreline uses to orient toward the City's shoreline resources and ensure that landscaping of the uplands are consistent with the City's vision of its shorelines.

Consistent. The proposed project will not alter the existing shoreline scenic vista due to the in-water location. The aesthetic qualities of Commencement Bay will not be affected by the proposed project, which is consistent with the current use of the area.

<u>Chapter 6.8 – Water Quality and Quantity</u>
The following section applies to all development and uses in the City's shorelines, that affect water quality. The provisions protect against adverse impacts to the public health, to the land and its vegetation and wildlife, and to the waters of the state and their aquatic life. The purpose of these policies and regulations is to prevent impacts to water quality and storm water quantity that would result in a net loss of shoreline ecological functions, or a significant impact to aesthetic qualities, or recreational opportunities. They are also meant to ensure mutual consistency between shoreline management provisions and other regulations that address water quality and storm water quantity.
Consistent. The Corps will provide materials for review to the Washington State Department of Ecology for water quality certification under Section 401 of the Clean Water Act. Stormwater and Nonpoint Pollution control is not a component of dredging.

<u>Chapter 8.3 – Fill and Excavation, Dredging and Dredge Material Disposal</u>
Fill raises the elevation or creates dry land area by the addition of sand, soil, gravel, rock, sediment, earth retaining structure, or other material waterward of the OHWM, in wetlands, or on shorelands. Dredging is the removal of material from a stream, river, lake, bay or other water body. The purposes for dredging might include navigation, remediation of contaminated materials, or material mining. Materials generated from navigational and remedial dredging may be suitable for beneficial reuse (e.g., construction of habitat features or construction of uplands) or may require disposal at appropriate disposal facilities.

<u>8.3.1 Policies</u>

A. Shoreline fill should not be authorized unless a specific use for the site is evaluated and permitted. Speculative fill should not be permitted.

Consistent. The DMMP Commencement Bay open-water disposal site has been previously permitted for disposal of dredged materials. The Saltchuk beneficial use site is dependent on funding and material availability, and would be fully permitted prior to use. The use of Saltchuk has been evaluated in the Feasibility Report and Environmental Assessment (USACE 2019).

B. Where there is a demonstrated need for shoreline fill, they should only be considered for water-dependent uses in committed port and industrial waterways or where such construction can be integrated with the existing shoreline to substantially preclude any resultant damage to marine resources or adverse effects on adjacent properties. Fill should not be permitted in identified channel migration zones.

Consistent. Shoreline fill would only occur at Saltchuk to create shallow-water habitat for juvenile salmonids and to improve sediment quality. This beneficial use of dredged material

would be integrated with the existing shoreline, and effects to the environment will be minor short-term disturbances and highly localized. Saltchuk is not in a channel migration zone.

C. The location, design, and construction of all fill should protect ecological processes and functions, including channel migration. In evaluating fill projects such factors as total water surface reduction, navigation restriction, impediment to water flow and circulation, reduction of water quality and destruction of habitat, and the effects on state-owned resources should be considered.

Consistent. Beneficial use of dredged material at Saltchuk has been evaluated for the above items in the Feasibility Report and Environmental Assessment (USACE 2019). Creation of shallow-water habitat for juvenile salmonids will reduce total water surface during some points of the tide cycle. Ship simulation in PED will investigate navigation restrictions around Saltchuk, and the project has been designed to minimize any effects to navigation to the maximum extent practicable. Water flow, circulation, and currents will not be impeded. The project has been designed to minimize the short-term and localized reduction in water quality due to turbidity during construction. State-owned resources will not be destroyed; rather, shallow-water habitat with improved substrate will be created. Saltchuk is not in a channel migration zone.

D. The perimeter of the fill should be provided with a vegetative buffer or other means to prevent erosion.

Not applicable. Placement of dredged material at Saltchuk will not require use of erosion control due to location in the sub- and intertidal zone. Additional current modeling in PED will further refine Saltchuk design to avoid and minimize material migration.

E. Uses of dredge material that can benefit shoreline resources are to be addressed through implementation of regional interagency dredge material management plans and watershed planning.

Consistent. Beneficial use of dredged material at Saltchuk will be fully coordinated through the DMMP, and the effects of watershed restoration projects have been taken into consideration.

F. Dredging of bottom materials for the primary purpose of obtaining fill, material should be prohibited.

Consistent. The purpose of the project is to improve navigation safety and efficiency at the Blair Waterway.

<u>Chapter 7.6 – Port/Industrial Use</u>

The past geologic development of the Puget Sound Basin has created one of the few areas in the world which provides several deepwater inland harbors. The use of Puget Sound waters by deep-draft vessels is increasing due in part to its proximity to the Pacific Rim countries. This increased trade will attract more industry and more people which will put more pressure on the Sound in the forms of recreation and the requirements for increased food supply.

The Port of Tacoma is a major center for waterborne traffic and as such has become a gravitational point for industrial and manufacturing firms. Heavy industry may not specifically require a shoreline location, but is attracted to the port because of the variety of transportation modes available.

In applying the regulations of this section, the following definitions are used:

- "Port" means a center for water-borne commerce and traffic.
- "Industrial" means the production, processing, manufacturing, or fabrication of goods or materials. Warehousing and storage of materials or production is considered part of the industrial process.

Some port and industrial developments are often associated with a number of uses and modifications that are identified separately in this Master Program (e.g., parking, dredging). Each use activity and every type of shoreline modification should be carefully identified and reviewed for compliance with all applicable sections.

For the purposes of determining to which uses and activities this classification applies, the use of moorage facilities, such as a wharf or pier, for the layberthing, or lay-by berthing of cargo, container, military, or other oceangoing vessels shall be permitted only where port and industrial uses are allowed. This use category shall likewise apply to facilities that handle the loading and unloading of cargo and materials associated with port and/or industrial uses. Facilities for the loading and unloading of passengers associated with passenger vessels, such as ferries, cruise ships, and water taxis shall be classified as a transportation facility or commercial activity as applicable.

Port and/ industrial facilities are intensive and have the potential to negatively impact the shoreline environment. When impacts cannot be avoided, they must be mitigated to assure no net loss of the ecological function necessary to sustain shoreline resources.
Consistent. The deepening and widening of the Federal Navigation Channel will maintain its present location. Channel improvements will be designed, constructed and managed to achieve no net loss of ecological functions. Based on the environmental impacts analysis in the Feasibility Report and Environmental Assessment (USACE 2019), effects to the environment will be minor short-term disturbances and highly localized. The short-term effects do not rise to the level that would require compensatory mitigation.

<u>Chapter 7.6.1 – Policies</u>

A. General Policies

1. Because of the great natural deep water potential of Commencement Bay, new deep water terminal and port-related industrial development is encouraged.

Consistent. Deepening and widening Blair Waterway is considered port-related industrial development.

2. Because of the exceptional value of Puget Sound shorelines for residential, recreational, resource and other economic elements requiring clean water, deep water terminal expansion should not include oil super tanker transfer or super tanker storage facilities.

Not applicable. The improvements to the Blair Waterway included in this feasibility study do not include terminal expansions for the above purposes. The proposal is only considering containerized cargo.

3. Public access and ecological restoration should be considered as potential mitigation of impacts to shoreline resources for all water-related and -dependent port and industrial uses consistent with all relevant constitutional and other legal limitations on the regulation of private property per TSMP 6.5, Public Access.

Not applicable. Based on the environmental impacts analysis in the Feasibility Report and Environmental Assessment (USACE 2019), effects to the environment will be minor short-term disturbances and highly localized. The short-term effects do not rise to the level that would require compensatory mitigation.

4. Expansion or redevelopment of water-dependent port and industrial facilities and areas should be encouraged, provided it results in no net loss of shoreline functions.

Consistent. The deepening and widening of the Federal Navigation Channel will maintain its present location. Channel improvements will be designed, constructed and managed to achieve no net loss of ecological functions.

5. Port and industrial uses and related redevelopment projects are encouraged to locate where environmental cleanup can be accomplished.

Consistent. Dredged material that is unsuitable for open-water disposal will be disposed of at an upland facility. Sediments exposed by dredging would meet DMMP requirements.

6. The preferred location for future non-water-dependent industry is in industrial areas away from the shoreline.

Not applicable. The proposed project is water-dependent.

7. The cooperative use of docking, parking, cargo handling and storage facilities should be strongly encouraged in waterfront industrial areas.

Not applicable. Changes to the use of docking, parking, cargo handling and storage facilities are not part of the proposed project.

8. Land transportation and utility corridors serving ports and water-related industry should follow the guidelines provided under the sections dealing with utilities and road and railroad construction. Where feasible, transportation and utility corridors should not be located in the shoreline to reduce pressures for the use of waterfront sites.

Not applicable. Land transportation and utility corridors are not included in the proposed project.

9. Port and industrial uses should be encouraged to permit viewing of harbor areas from viewpoints, and similar public facilities which would not interfere with operations or endanger public health and safety.

Consistent. The proposed project will not alter viewing of harbor areas from viewpoints. The Feasibility Report and Environmental Assessment (USACE 2019) provides an analysis of public health and safety. The project has been designed to minimize any effects to public health and safety to the maximum extent practicable.

10. Special attention should be given to the design and development of facilities and operational procedures for fuel handling and storage in order to minimize accidental spills and to the provision of means for satisfactorily handling those spills which do occur.

Not applicable. The design and development of facilities and operational procedures for fuel handling and storage are not included in the proposed project.

B. “S-8” Thea Foss Shoreline District

1. Improvements to existing industrial uses, such as the aesthetic treatment of storage tanks, cleanup of blighted areas, landscaping, exterior cosmetic improvements, landscape screening, and support of the Waterway environmental cleanup and remediation plan effort are encouraged.

Not applicable. The study area does not include the Thea Foss Shoreline District.

Chapter 7.6.2 – Regulations

A. General Regulations

1. Water-dependent port and industrial uses shall have shoreline location priority over all other uses in the S-7 and S-10 Shoreline Districts.

Consistent. The proposed project is a water-dependent port use.

2. The location, design, and construction of port and industrial uses shall assure no net loss of ecological functions.

Consistent. The deepening and widening of the Federal Navigation Channel will maintain its present location. The Feasibility Report and Environmental Assessment (USACE 2019) has considered the physical and natural features of the shoreline. Channel improvements and Saltchuk will be designed, constructed, and managed to achieve no net loss of ecological functions.

3. New non-water-oriented port and industrial uses are prohibited unless they meet one of the following criteria:

   a. The use is part of a mixed-use project or facility that supports water-oriented uses and provides a significant public benefit with respect to the public access and restoration goals of this Program;

b. Navigability is severely limited at the proposed site and the use provides a significant public benefit with respect to the public access and restoration goals of this Program;

c. The use is within the shoreline jurisdiction but physically separated from the shoreline by a separate property, public right-of-way, or existing use, and provides a significant public benefit with respect to the public access and restoration goals of this Program. For the purposes of this Program, public access trails and facilities do not constitute a separation.

Consistent. The proposed project is an existing, water-oriented port and industrial use, and Saltchuk provides a significant public benefit with respect to the public access and restoration goals of this Program.

4. Deep-water terminal expansion shall not include oil super tanker transfer or super tanker storage facilities.

Consistent. Oil super tanker transfer or super tanker storage facilities are not part of the proposed deepening and widening of Blair Waterway.

5. Where shoreline stabilization or in-water structures are required to support a water-dependent port or industrial use, the applicant shall be required to demonstrate:

   a. That the proposed action shall give special consideration to the viability of migratory salmonids and other aquatic species;

   b. That contaminated sediments are managed and/or remediated in accordance with state and federal laws;

   c. That public access to the water body is provided where safety and operation of use are not compromised;

   d. That shading and water surface coverage is the minimum necessary for the use.

Consistent. The Feasibility Report and Environmental Assessment (USACE 2019) documents consideration of the above items. Blair Waterway improvements and Saltchuk will be designed, constructed and managed to achieve no net loss of ecological functions. Analyses of effects to migratory salmonids and other aquatic species and public access, and the management of dredged material are included. Shading and water surface coverage is not part of the proposed project.

6. Port and industrial development shall comply with all federal, state, regional and local requirements regarding air and water quality.

Consistent. The Feasibility Report and Environmental Assessment (USACE 2019) has documented compliance with all Federal, state, regional and local requirements regarding air and water quality.

7. Where possible, oxidation and waste stabilization ponds shall be located outside the Shoreline District.

Not applicable. Oxidation and waste stabilization ponds will not be used.

8. Best management practices shall be strictly adhered to for facilities, vessels, and products used in association with these facilities and vessels.

Consistent. Best management practices (BMPs) will be implemented during the proposed project construction.

9. All developments shall include the capability to contain and clean up spills, discharges, or pollutants, and shall be responsible for any water pollution which they cause.

Consistent. Best management practices (BMPs) will be implemented during the proposed project. The Corps requires all dredging contractors to provide a Spill Prevention and Response Plan.

10. Petroleum products sump ponds shall be covered, screened, or otherwise protected to prevent bird kill.

Not applicable. Petroleum products sump ponds will not be used.

11. Procedures for handling toxic materials in shoreline areas shall prevent their entering the air or water.

Consistent. Best management practices (BMPs) will be implemented during the proposed project. The Corps requires all dredging contractors to provide a Spill Prevention and Response Plan.

B. Log Rafting and Storage

1. New log rafting and storage shall only be allowed in the "S-10" Port Industrial Area Shoreline District, the "S-11" Marine View Drive Shoreline District and in the associated portions of the "S-13" Marine Waters of the State Shoreline District.

2. Restrictions shall be considered in public waters where log storage and handling are a hindrance to other beneficial water uses.

3. Offshore log storage shall only be allowed on a temporary basis, and should be located where natural tidal or current flushing and water circulation are adequate to disperse polluting wastes.

4. Log rafting or storage operations are required to implement the following, whenever applicable:

    a. Logs shall not be dumped, stored, or rafted where grounding will occur.

    b. Easy let-down devices shall be provided for placing logs in water. The freefall dumping of logs into water is prohibited.

c. Bark and wood debris controls and disposal shall be implemented at log dumps, raft building areas, and mill-side handling zones. Accumulations of bark and wood debris on the land and docks around dump sites and upland storage sites shall be kept out of the water. After cleanup, disposal shall be at an upland site where leachate will not enter surface or ground waters.

d. Where water depths will permit the floating of bundled logs, they shall be secured in bundles on land before being placed in the water. Bundles shall not be broken again except on land or at mill sites.

e. Stormwater management facilities shall be provided to protect the quality of affected waters.

5. Log storage facilities shall be located upland and properly sited to avoid fish and wildlife habitat conservation areas.

6. Log storage facilities must be sited to avoid and minimize the need for dredging in order to accommodate new barging activities at the site.

7. Log booming shall only be allowed offshore in sub-tidal waters in order to maintain unimpeded nearshore migration corridors for juvenile salmonids and to minimize shading impacts from log rafts. Log booming activities include the placement in or removal of logs and log bundles from the water, and the assembly and disassembly of rafts for waterborne transportation.

8. Log storage and log booming facilities shall be adequately maintained and repaired to prevent log escapement from the storage site.

9. A Debris Management Plan describing the removal and disposal of wood waste must be developed and submitted to the City. Debris monitoring reports shall be provided, where stipulated.

10. Existing in-water log storage and log booming facilities in critical habitats utilized by threatened or endangered species classified under ESA shall be reevaluated if use is discontinued for two (2) years or more, or if substantial repair or reconstruction is required. The evaluation shall include an alternatives analysis in order to determine if logs can be stored upland and out of the water. The alternatives analysis shall include evaluation of the potential for moving all, or portions of, log storage and booming to uplands.

Not applicable. Log storage and log booming are not proposed.

<u>Chapter 8.3.2 – Regulations</u>

A. Regulations - Fill and Excavation

1. Fill placed waterward of the OHWM is prohibited except for the following instances.:

a. Water-dependent use;

b. Public access;

c. Clean-up and disposal of contaminated sediments as part of an interagency environmental clean-up plan;

d. Disposal of dredged material in accordance with a DNR Dredged Material Management Program;

e. Expansion or alteration of transportation facilities of statewide significance currently located on the shoreline (if alternatives to fill are shown not to be feasible).

Consistent. Disposal of dredged material at the Commencement Bay open-water disposal site and material placement at Saltchuk will be in accordance with the Dredged Material Management Program, of which the Washington State DNR is a member.

2. Fill waterward of the OHWM shall be permitted for ecological restoration and enhancement projects, provided the project is consistent with all other provisions of this program.

Consistent. The proposed fill is beneficial use of dredged material to enhance juvenile salmonid habitat and improve sediment quality at Saltchuk. The proposed project is consistent with all other provisions of this program.

3. Fill and excavation must avoid impacts to buffers exception for those instances in section 10.3 above and restoration actions, when consist with all other provisions of this Program.

Consistent. Construction of Saltchuk has been designed to minimize impacts to the environment. Based on the environmental impacts analysis in the Feasibility Report and Environmental Assessment (USACE 2019), effects to the environment due to fill and excavation will be minor, short-term disturbances and highly localized. The short-term effects do not rise to the level that would require compensatory mitigation.

4. Fill is prohibited within the Puyallup River, except for environmental remediation and habitat improvement projects.

Not applicable. Fill will not be placed within the Puyallup River.

5. Fill and excavation shall be considered only where such construction can be integrated with the existing shoreline.

Consistent. Construction of Saltchuk will be integrated with the existing shoreline for the benefit of juvenile salmonids.

6. Fill and excavation shall not be authorized unless a specific use for the site has been evaluated and permitted; speculative fill and excavation shall be prohibited in all Shoreline Districts.

The DMMP Commencement Bay open-water disposal site has been previously permitted for disposal of dredged materials. The Saltchuk beneficial use site is dependent on funding and material availability, and would be fully permitted prior to use. The use of Saltchuk has been evaluated in the Feasibility Report and Environmental Assessment (USACE 2019).

7. Applications for fill or excavation shall address methods which will be used to minimize damage of the following types:

a. Biota:

i. Reduction of habitat;

ii. Reduction of feeding areas for shellfish, fishlife, and wildlife;

iii. Reduction of shellfish, fishlife, and wildlife reproduction areas; and

iv. Reduction of fish migration areas.

Consistent. Based on the environmental impacts analysis in the Feasibility Report and Environmental Assessment (USACE 2019), effects to the environment due to fill and excavation will be minor, short-term disturbances and highly localized. The short-term effects do not rise to the level that would require compensatory mitigation.

b. Physical:

i. Alteration of local current;

ii. Wave damage;

iii. Total water surface reduction;

iv. Navigation restriction;

v. Impediment to water flow and circulation;

vi. Reduction of water quality;

vii. Loss of public access;

viii. Elimination of accretional beaches;

ix. Erosion; and

x. Aesthetics.

Consistent. Based on the environmental impacts analysis in the Feasibility Report and Environmental Assessment (USACE 2019), effects to the environment due to fill and excavation will be minor, short-term disturbances and highly localized. The short-term effects do not rise to the level that would require compensatory mitigation.

8. All perimeters of fills shall use vegetation, retaining walls, or other means for erosion control.

Not applicable. Placement of dredged material at Saltchuk will not require use of erosion control due to location in the sub- and intertidal zone. Additional current modeling in PED will further refine Saltchuk design to avoid and minimize material migration.

9. Only materials that comply with State Water Quality Standards may be used in permitted fill projects.

Consistent. The Corps will provide materials for review to the Washington State Department of Ecology for water quality certification under Section 401 of the Clean Water Act.

10. Dust control measures, including plants and vegetation where feasible, shall be taken in all fill and excavation projects.

Not applicable. Proposed fill and excavation will take place in water.

B. Regulations - Dredging and Dredge Material Disposal

1. Dredging and dredge material disposal shall avoid or minimize significant ecological impacts; impacts that cannot be avoided shall be compensated for to achieve no net loss of ecological functions.

Consistent. The deepening and widening of the Federal Navigation Channel will maintain its present location. Channel improvements and Saltchuk construction will be designed, constructed and managed to achieve no net loss of ecological functions. Due to minimal change to the environment as a result of the project, no mitigation is proposed.

2. Dredging to establish, expand, relocate, or reconfigure navigation channels are permitted only where needed to accommodate existing navigational uses and then only when significant ecological impacts are minimized or compensated for.

Consistent. The proposed dredging would take place in the existing Blair Waterway. Channel improvements will be designed, constructed and managed to achieve no net loss of ecological functions. Due to minimal change to the environment as a result of the project, no mitigation is proposed.

3. New non-water-dependent development that would result in the need for new dredging shall be prohibited.

Not applicable. The proposed project does not include new non-water-dependent development that would result in the need for new dredging.

4. Dredge disposal within river channel migration zones is prohibited.

Not applicable. Dredge disposal would only take place at the DMMP Commencement Bay open-water disposal site, Saltchuk beneficial use site, or at an upland disposal facility.

5. Maintenance dredging of established navigation channels and basins is restricted to maintaining previously dredged and/or existing channels and basins at their authorized location, depth, and width.

Consistent. After deepening and associated widening, maintenance dredging of the established navigation channel would only maintain the authorized project depth and width.

6. Deposit of dredge materials shall only be permitted in an approved disposal site, for habitat improvement, to correct material distribution problems which are adversely affecting fish and shellfish resources, where land deposition would be more detrimental to shoreline resources than water deposition, as a cap for contaminated sediments, or a fill used in conjunction with an approved environmental remediation project. Where deposit of dredge material is allowed upland, it shall avoid buffers and wildlife habitat and be subject to the regulations of fill in TSMP 8.3.2(A).

Consistent. Dredge material disposal would only take place at the DMMP Commencement Bay open-water disposal site, Saltchuk beneficial use site for habitat improvement, or at an upland disposal facility.

7. Dredging of bottom materials for the primary purpose of obtaining fill materials shall not be permitted, except for projects associated with MTCA or CERCLA habitat restoration, or any other significant restoration effort approved by a Shoreline Conditional Use Permit. In such cases, placement of fill must be waterward of the OHWM.

Consistent. The purpose of the project is to improve navigation safety and efficiency at the Blair Waterway.

8. Returned water from any dredge material disposed of on land shall meet all applicable water quality standards in accordance with applicable water quality regulations.

Consistent. The Corps will provide documentation for review to the Washington State Department of Ecology for water quality certification under Section 401 of the Clean Water Act to provide information about the fate of dredge material destined for upland disposal. Upland disposal would occur at a facility authorized to receive dredged materials that are unsuitable for aquatic disposal. This facility is responsible for environmental compliance upon receipt of dredged materials.

9. Sides of dredged channels for port and industrial use shall be designed and constructed to prevent erosion and permit drainage.

Consistent. The Feasibility Report and Environmental Assessment (USACE 2019) provides a geotechnical analysis of the channel design and identified areas where engineered solutions may be necessary to prevent erosion.

10. On-site containment facilities shall only be permitted in the "S-10" Port Industrial Area Shoreline District, where such on-site containment facilities shall be conditional uses.

Consistent. On-site containment facilities would be located in the "S-10" Port Industrial Area Shoreline District, and would comply with all conditions for use.

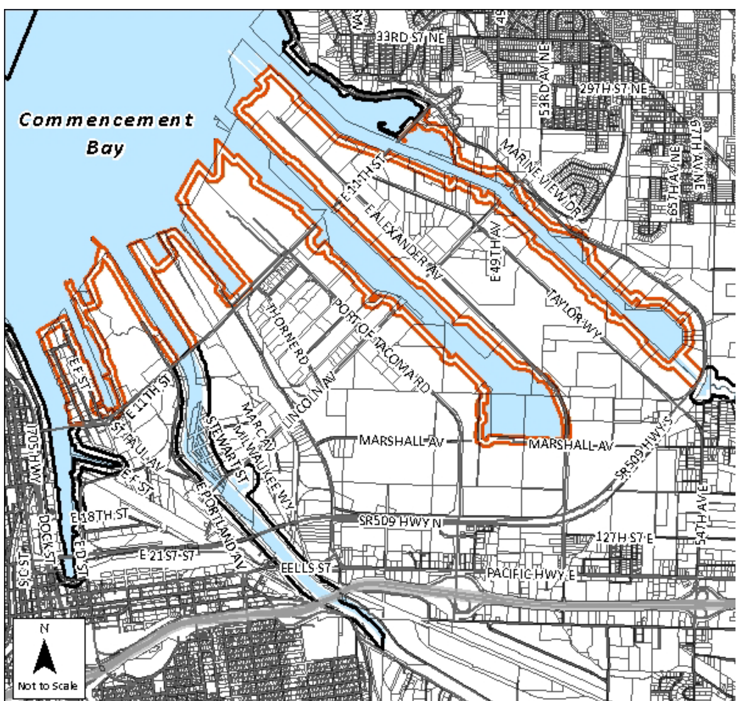
Chapter 9.12 – S-10 Port Industrial Area (HI)

A. The intent of the S-10 Port Industrial Area Shoreline District is to allow the continued development of the Port Industrial Area, with an increase in the intensity of development and a greater emphasis on terminal facilities within the City.

Consistent. The purpose of the project is to improve navigation safety and efficiency of the Blair Waterway, an existing navigation channel with terminal facilities.

B. District Boundary Description. The S-10 Shoreline District extends from the E 11th Street right- of-way on the Thea Foss Waterway, to the Hylebos Waterway, including only those areas upland 200’ of the OHWM and except that portion of the Puyallup River southeast of East 11th Street and including that portion of Hylebos Waterway and Hylebos Creek waterward of SR 509.

C. Map of District. Refer to Figure 9-12 below for a map of the S-10 Port Industrial Area Shoreline District Shoreline District boundaries:



D. Shoreline District S-10: Port Industrial, High Intensity

Figure 9-12. Port Industrial Area

1. District-Specific Use and Modification Regulations. Table 9-2 lists permitted uses, prohibited uses and uses permitted through issuance of a shoreline conditional use permit.

Consistent. All proposed project components within the Port Industrial Area are permitted uses.

2. District-Specific Development Standards. Developments in the S-10 Port Industrial Area Shoreline District shall comply with the development standards included in Table 9-2 and the general regulations included in this Chapter.

Consistent. All proposed project components within the Port Industrial Area are permitted uses and are consistent with the development standards and general regulations.

Chapter 9.13 – S-11 Marine View Drive (UC)

A. The intent of the S-11 Marine View Drive Shoreline District is to encourage the development of water-related parks, open space, and recreation facilities, to allow development of marinas and related facilities, water-oriented commercial uses, and residential uses that are compatible with the existing shoreline processes and functions and that result in a net gain of shoreline functions over time.

Consistent. The Saltchuk beneficial use site does not prevent upland development of water-related parks, open space, and recreation facilities, and is anticipated to result in net gain of shoreline functions over time.

B. District Boundary Description. The S-11 Shoreline District boundaries include that area upland within 200' of the OHWM and from centerline of the 11th Street Bridge north to the City Limit at Eastside Dr. NE (extended).

C. Map of District. Refer to Figure 9-13 below for a map of the S-11 Marine View Drive Shoreline District Shoreline District boundaries:

Figure 9-13. Marine View Drive

1. District-Specific Use Regulations. Table 9-2 lists permitted uses, prohibited uses and uses permitted through issuance of a shoreline conditional use permit.

Consistent. All proposed project components within the Marine View Drive Shoreline District are permitted uses.

2. District-Specific Development Standards. Developments in the S-11 Marine View Drive Shoreline District shall comply with the development standards included in Table 9-2 and the general regulations included in this Chapter.

Consistent. All proposed project components within the Marine View Drive Shoreline District are permitted uses and are consistent with the development standards and general regulations.

<u>Chapter 9.15 – S-13 Marine Waters of the State (A)</u>

A. The intent of the S-13 Marine Waters of the State Shoreline District is to maintain these water bodies for the use by the public for navigation, commerce and recreation purposes and to manage in-water structures in a consistent manner throughout the City's shorelines.

Consistent. The purpose of the proposed project is to improve navigation safety and efficiency of the Blair Waterway.

B. District Boundary Description. The S-13 Shoreline District boundary includes all marine waters waterward from the ordinary high water mark to the seaward City limit common to the City of Tacoma and Pierce County, except that area lying within the Town limits of the Town of Ruston. S-13 also includes the portion of the Puyallup River waterward of the OHWM and downstream of 11th Street.

C. Map of District. Refer to Figure 9-15 below for a map of the S-13 Marine Waters of the State Shoreline District boundaries:

Figure 9-15. Marine Waters of the State

D. District-Specific Use Regulations. Table 9-2 lists permitted uses, prohibited uses and uses permitted through issuance of a shoreline conditional use permit. Permitted uses and activities are also subject to the district-specific regulations listed below:

1. The following regulations shall apply to overwater uses and development within the S-13 Shoreline District:

   a. New uses and development in the S-13 Shoreline District that are associated with an upland shoreline district shall only be permitted where the use or development is also permitted in the upland Shoreline District. In determining whether an in-water use or development is associated with an upland shoreline district, those uses or development occurring between ordinary high water mark and the Outer Harbor Line shall be considered 'associated' with the upland zoning. Uses or development occurring entirely beyond the outer harbor line shall be permitted in accordance with the provisions of the S-13 Shoreline District. The in-water use or development will be considered 'associated' with whichever upland Shoreline District is closest or that district with which the use or development has a direct physical connection. Where two or more shoreline districts are equidistant from a proposed use or development that does not have a physical upland connection, the more restrictive zone shall apply.

   b. New overwater residential structures are prohibited. This prohibition does not apply to live-aboards, which must comply with the regulations in 7.4.2(K).

   c. New over-water structures shall only be permitted for water-dependent uses, restoration projects, and public access.

   d. New structures for non-water-dependent or non-public access uses are strictly prohibited.

   e. The size of new over-water structures shall be limited to the minimum necessary to support the structure's intended use.

Not applicable. New structures are not proposed.

   f. Non-water-oriented uses shall only be permitted on existing over-water structures as part of a permitted mixed-use development that contains a water-dependent component.

Not applicable. Non-water-oriented uses are not proposed.

   g. Water-oriented commercial uses shall only be permitted overwater on existing overwater structures.

Consistent. Water-oriented commercial use of the Blair Waterway would continue on existing overwater structures.

h. Improvement or modifications to residential or non-water-oriented commercial uses on existing overwater structures shall be permitted; provided, that the modifications do not result in an increase in overwater coverage or shading, that the improvements are designed consistent with Washington Department of Fish and Wildlife standards to limit impacts on the aquatic environment and fisheries habitat, do not adversely affect the public use of the shoreline area or surface waters, and are consistent with the standards in Chapter 2.5.

Not applicable. Improvement or modifications to residential or non-water-oriented commercial uses are not proposed.

i. All modification of existing uses on recognized overwater structures shall occur in a manner consistent with all provisions of this program as well as building, fire, health, and sanitation codes.

Not applicable. Modification of existing uses on recognized overwater structures is not proposed.

E. District-Specific Development Standards. Developments in the S-13 Marine Waters of the State Shoreline District shall comply with the regulations and standards included the Table 9-2 and the general regulations included in this Chapter.

Consistent. The proposed project complies with Table 9-2 and general regulations in this Chapter.

Conclusion. Based on the above evaluation, the Corps has determined that the proposed Tacoma Harbor Navigation Improvement Project is consistent with the enforceable policies of the approved coastal zone management programs of Washington State, including the enforceable policies as specified in the local planning documents for Pierce County and the City of Tacoma that are incorporated in the approved programs. The action is, therefore, consistent with the State of Washington's CZMP to the maximum extent practicable.

Reference Report:

USACE (U.S. Army Corps of Engineers). 2019. Tacoma Harbor, WA Navigation Improvement Project: Draft Integrated Feasibility Report and Environmental Assessment. Available online: https://www.nws.usace.army.mil/Missions/Civil-Works/Programs-and-Projects/Projects/Tacoma-Harbor-Navigation-Improvement/

Substantive Compliance for Clean Water Act Section 404

Tacoma Harbor, WA Navigation Improvement Project Feasibility Study, Pierce County, April 2022

1. Introduction. The purpose of this document is to record the U.S. Army Corps of Engineers' (Corps) evaluation and findings regarding this project pursuant to Section 404 of the Clean Water Act (CWA).

The following actions are covered by this document: deepening and widening the existing Federal navigation channel at the Blair Waterway in the Port of Tacoma with disposal in the following manner:

(a) Disposal of up to approximately 2,400,000 cubic yards (cy) of suitable material dredged from the Blair Waterway in the Port of Tacoma at the Dredged Material Management Program (DMMP) Commencement Bay open-water disposal site;
(b) Placement of up to 1,850,000 cy of suitable dredged material dredged from the Blair Waterway in Saltchuk for beneficial use in Commencement Bay; and
(c) Material that is determined to not be suitable for open-water disposal at either of the above open-water disposal locations, would be transported by barge to a transloading facility to be dewatered and hauled by truck to an appropriate upland disposal site. Current estimates indicate that this may involve approximately 392,000 cy of material.
(d) For a conservative analysis, slope stability measures at four points along the Blair Waterway with the most fill material are considered here. This includes 4-ton riprap with a D50 of four feet (i.e., 50% of the rock diameters will be less than four feet) in a single layer from the slope toe to the daylight edge. This would add approximately 100,000 tons of riprap total among the four areas. A secant pile wall installed with an auger (i.e., a large drill) is also included in this conservative estimate.

Per 33 CFR Part 323.2(d)(iii), incidental fallback during the proposed dredging process to deepen and widen the existing navigation channel in the Blair Waterway is not considered a discharge of dredged material; therefore, it is not discussed in the following analysis. Subsequent disposal of future maintenance dredging of the Federal navigation channel is not included within the following analysis.

The information contained in this document reflects the findings of the project record. Specific sources of information included the following:

a. Puget Sound Dredged Disposal Analysis (PSDDA) Unconfined, Open-Water Disposal Sites for Dredged Material Phase I (Central Puget Sound), Final Environmental Impact Statement. Prepared by the DMMP, 1988.

b. Puget Sound Dredged Disposal Analysis (PSDDA) Unconfined, Open-Water Disposal Sites for Dredged Material Phase II (North and South Puget Sound), Final Environmental Impact Statement, Prepared by the DMMP, 1989.

c. DMMP Reauthorization of Dredged Material Management Program Disposal Site, Commencement Bay, Washington: Supplemental EIS. Prepared by SAIC for the DMMP, 2009.

d. Biological Evaluation for the Continued Use of Multiuser Dredged Material Disposal Sites in Puget Sound and Grays Harbor. Prepared by the U.S. Army Corps of Engineers, Seattle District, June 2015.

A Biological Opinion was issued by the National Marine Fisheries Service (NMFS) for the project dated December 17, 2015; a letter of concurrence for the project was issued by the U.S. Fish and Wildlife Services (USFWS) dated July 28, 2015.

e. U.S. Army Corps of Engineers. 2015. Biological Evaluation. Continued use of Multiuser Dredged Material Disposal Sites in Puget Sound and Grays Harbor. 111pp+ Appendices.

f. U.S. Army Corps of Engineers. 2019. Draft Integrated Feasibility Report and Environmental Assessment–Tacoma Harbor, WA. U.S. Army Corps of Engineers, Seattle District.

g. DMMP 2019. DMMP advisory determination regarding the potential suitability of proposed dredged material from the Blair Waterway in Tacoma Harbor for unconfined open-water disposal at the Commencement Bay disposal site or for beneficial use. June 25, 2019. 404(b)(1) Evaluation (see below).

h. U.S. Army Corps of Engineers. 2019. 404 Public Notice. December 18, 2019.

i. Army Corps of Engineers. 2019. Submittal of 401 WQC request to Certifying Authorities – Ecology. December 18, 2019.

j. Public Interest Review (see below).

This document addresses the substantive compliance issues of the Clean Water Act 404(b)(1) Guidelines [40 CFR §230.12(a)] and the Regulatory Programs of the Corps of Engineers [33 CFR §320.4(a)]. This document also integrates a review of factors underlying a determination of whether executing the project would be in the public interest, pursuant to Clean Water Act Section 404 and rules and regulations published as 33 CFR Part 335, “Operation and Maintenance of Army Corps of Engineers Civil Works Projects Involving the Discharge of Dredged or Fill Material into Waters of the U.S. or Ocean Waters”; 33 CFR Part 336, “Factors to be Considered in Evaluation of Army Corps of Engineers Dredging Projects Involving the Discharge of Dredged Material into Waters of the U.S. and Ocean Waters”; 33 CFR Part 337, “Practice and Procedure”; and 33 CFR Part 338, “Other Corps Activities Involving the Discharge of Dredged Material or Fill into Waters of the U.S.”

2. Project Background. Tacoma Harbor is a top 25 container port in the U.S. and ninth for cargo value. In 2017, the harbor had a container throughput of over two million twenty-foot equivalent units (TEUs), including incoming and outgoing units. As one of the top 25 container ports, it is of national importance for trade, and it is important to the national and local economies that it maintains its ability to receive calls as ships get larger. The largest ship that has called at the Port is the 13,800 nominal TEU capacity ship *Thalassia Axia*.

The proposed action is to achieve transportation cost savings (increased economic efficiencies) by conducting navigation improvements at Tacoma Harbor to deepen and widen the existing Federal navigation channel. For analysis of potential environmental impacts of the range of alternatives, the Corps is analyzing a range of alternatives that consider varying length, width, and depth of improvements, including an economically optimized plan that would require less total dredging than the maximum depth analyzed. The proposed action is to deepen the existing Federal channel in Blair Waterway from -51 feet Mean Lower Low Water (MLLW) to -57 feet below MLLW with channel widths ranging from 450 feet to 864 feet, and the turning basin expanded from 1,682 feet to 1,935 feet.

Table 1. Federally authorized and proposed channel widths by channel station (STA)* at Blair Waterway.

Stations along the channel	**Authorized widths (ft)**	**Proposed width (ft)**

STA -5 to STA 0		865
STA 0 to STA 12	520	800
STA 12 to STA 44	520, 343	520
STA 44 to STA 52	520	520
STA 52 to STA 79	520,330	520
STA 79 to STA 100	330	450
STA 100 to STA 116	330, 1,682	525
STA 116 to STA 140	1,682	1,935

*Stations and widths are rounded in this table because widths are approximate. Precise stations are found in Table 2.

This analysis is based off of the feasibility-level sediment sampling and partial DMMP testing conducted in February – June 2019 to evaluate material for open-water disposal and beneficial use. Reference Section 3.3.3 of the final Integrated Feasibility Report/Environmental Assessment (IFR/EA) and Appendix B for further information. The Corps will conduct a full suitability determination of Blair Waterway sediments during Pre-construction, Engineering, and Design (PED), and based on this further analysis, determine if further NEPA documentation is warranted.

Deepening the waterway would require dredging up to approximately 2.8 million cy from the Blair Waterway and would take up to four years. In-water work would only occur within the authorized work windows established by State and Federal resource agencies to minimize potential impacts to important fish, wildlife, and habitat resources. The in-water work window for material disposal at the Commencement Bay open water disposal site is from August 16 through February 15, based on avoiding impacts to the vulnerable life stages of sensitive species, including migration, spawning, and rearing. In-water work windows for other locations of Commencement Bay is from July 16 through February 15. As a conservation measure as part of the ESA consultation, however, the agency has indicated that it will apply the in-water work window of Commencement bay open water disoposal site at all locations of activity in Commencement Bay. These quantities assume the proposed depth of -57 MLLW, a quantity representing the average rate of accumulation between the current channel survey and the initiation of construction, and that the contractor removes all of the 2-foot allowable overdepth while dredging the channel.

Preliminary suitability testing of sediments in the Blair Waterway classified them as loam to silt loam in non-native sediments and as sand to loamy sand in native sediments (DMMP 2019). Samples identified as native have a higher percentage of sand and a lower percentage of fines than the non-native and unidentified material, consistent with the expected characteristics of the native material. The approximate breakdown of dredged material of native, non-native, and suitability for open-water disposal volumes for each increment appears in Table 2.

Disposal of suitable dredged material would occur at the DMMP Commencement Bay authorized open-water placement site for a portion of the total quantity. While environmentally beneficial use of dredged material is not the least-cost disposal option, the recommended plan includes beneficial use of the dredged material as a form of beneficial reuse at Saltchuk, located approximately 1 mile northeast of Blair Waterway. The Corps evaluated effects and costs of multiple placement scenarios at Saltchuk. The Corps used an existing nearshore habitat model to assess the incremental benefit of a beneficial use alternative to demonstrate the ecological lift between pre- and post-beneficial use of dredged material. The recommended plan includes placement of some material suitable for open water at the Saltchuk beneficial use site (Scenario E).

Placement at the Saltchuk site will be based on dredged material suitability determination before construction. Material placement at Saltchuk would restore up to 64 acres of nearshore intertidal and subtidal substrate conditions for fish and wildlife species, including ESA-listed species. Of the 64 acres, approximately 8 acres (13%) are covered in wood waste. Five scenarios at Saltchuk were evaluated, which consist of three benches that successively build on each other, then island creation:

- **Scenario A** (No Action): no beneficial use of dredged material;
- **Scenario B**: Build the First Bench to -20 MLLW;
- **Scenario C**: Build the First Bench to -20 MLLW and the Second Bench to -10 ft MLLW;
- **Scenario D**: Build the First Bench to -20 MLLW, the Second Bench to -10 ft MLLW, and the Third Bench to -5 ft MLLW;
- **Scenario E (Recommended Plan)**: Build the First Bench to -20 MLLW, the Second Bench to -10 ft MLLW, and the Third Bench to -5 ft MLLW, and create islands on top of the three benches.

Additional information, figures, and economic analysis of the Saltchuk scenarios are available in the final IFR/EA (Section 3.6.2.2 and Appendix C). Section 3.6.2.2 describes the full range of potential slope stability measures in a screening table, and full placement at Saltchuk (under scenario E) would reduce the quantity of material going to the Commencement Bay open-water disposal site by approximately 1,850,000 cy of dredged material. Disposal at the Commencement Bay open-water disposal site would then be estimated at approximately 562,000 cy, and placement at Saltchuk is estimated at approximately 1,850,000 cy. The remaining estimated 392,000 cy of material not suitable for in-water disposal would be transported to a suitable upland disposal facility, such as the LRI landfill.

Table 2. Volume breakdown by material and suitability for NED alternative, dredge depth = -57 MLLW

Channel Reach*	Native Material	Non-Native Material	Suitable for In-Water Disposal	Un-suitable for In-Water Disposal
Blair Waterway	CY	CY	CY	CY
HUSKY -5+00.00 TO 41+85.18	550,000	123,000	600,000	74,000
WUT 41+85.18 TO 108+40.43	823,000	360,000	934,000	249,000
TURNING BASIN 108+40.43 TO 137+24.11	858,000	90,000	878,000	69,000
Total	2,231,000	573,000	2,412,000	392,000

*Stationing appears under each channel reach

The resulting channel depth would better accommodate the larger ships that are anticipated to call at Tacoma Harbor over the 50-year study period (the design vessel is a PPX4 containership with a nominal TEU intake of approximately 15,500 to 19,200 TEUs).Maintenance dredging is expected to be required once every 25 years.

Side slopes would be 2:1 throughout the proposed channel, with potential for additional stabilization at the four areas called out in Figure 3-4 of the IFR/EA. Feasibility-level ship simulation and additional engineering analysis identified areas that would need side slope stabilization for the proposed wider navigation channel. As such, they would be general navigation features. Stabilization needs will be confirmed as the design is refined. HTRW material remains in place in the uplands at the Lincoln Avenue Ditch and Former Lincoln Avenue Ditch adjacent to the east side of Blair Waterway (Figure 3-4 of the IFR/EA), with institutional controls in place to limit disturbance of the site in the upland (upland is land elevated above shore land, in an area above where water flows). Based on conceptual design information, the Corps assumes there is enough distance between the proposed navigation channel and existing institutional controls that extend approximately 30 feet from the top of the bank to allow for an engineering solution that completely avoids the remaining contamination in this upland area. Detailed design for the proposed action would be completed in PED.

3. Project Need. This project is needed because existing authorized depths for the Blair Waterway do not meet the draft requirements of today's fleet of container ships. Due to inadequate current depths, ships often light load or experience tidal restrictions, causing lost transportation efficiencies and lost cost efficiencies at Tacoma Harbor. Ships departing Tacoma are not realizing economies of scale afforded by the larger ships currently being deployed (up to 14,000 TEUs) and even larger ships in the future.

4. Project Purpose. The purpose of the proposed Federal action is to achieve transportation cost savings (increased economic efficiencies) at Tacoma Harbor. Depths of the Blair Waterway and the Sitcum Waterway result in container ships often experiencing tidal restrictions due to inadequate channel depth. These tidal restrictions are operational inefficiencies and are economic inefficiencies that translate into costs for the national economy.

5. Availability of Less Environmentally Damaging Practicable Alternatives to Meet the Project Purpose. The alternatives evaluated for this project were as follows:

a. *Alternative 1 (No Action)*. The No-Action Alternative is analyzed as baseline conditions and the future without-project conditions as a reference condition for comparison of the action alternatives. Taking no action, in this case, would mean continuing standard operations at Tacoma Harbor with no improvements to the navigation channel. All physical conditions existing at the time of this analysis are assumed to remain, and it is assumed that standard and routine maintenance operations would be executed to maintain access for ships to reach the harbor's terminals.

b. *Alternative 2 (Blair Waterway Deepening to -58 MLLW).* To analyze a range of depths for improving navigation, the study team determined the deepest channel would be -58 MLLW. Under this alternative, the proposal analyzed is the following:

- Deepen the existing channel from an authorized depth of -51 MLLW to -58 MLLW
- Expanded channel widths ranging from 450 feet to 865 feet (Table 1)
- Expand the turning basin boundary to a diameter of 1,935 feet (Table 1)

The quantities of sediment that would need to be dredged to achieve this improvement are approximately 3.2 million cy from the Blair Waterway. These quantities assume the proposed depth of -58 MLLW, a quantity representing the average rate of accumulation between the current channel survey and the initiation of construction, and that the contractor removes all of the 2-foot allowable overdepth while dredging the channel. In-water disposal of suitable dredged material would occur at the Commencement Bay DMMP authorized open-water placement site or Saltchuk. The quantity estimated for open-water disposal is approximately 2,783,000 cy from the Blair Waterway. The capacity at Saltchuk is 1,850,000 cy. The remaining 428,000 cy in the Blair Waterway that does not meet open-water disposal criteria would be disposed at a suitable upland facility authorized to accept the material. The dredging is estimated to take up to 4 years to complete, partly due to limiting the work to the in-water work windows for protection of early life stages of sensitive fish species. Approximately 100,000 tons of riprap and 762 linear meters of secant pile wall is the greatest extent of potential side slope strengthening.

c. *Alternative 2a (Blair Waterway Deepening through Husky Terminal to -58 MLLW).* Alternative 2a applies the same depths and widths as Alternative 2 to allow access for larger ships to Husky Terminal. Under this alternative, the proposal analyzed is the following:

- Deepen the existing channel from the entrance to just past Husky Terminal (STA –5+00.00 to STA 41+85.18) from an authorized depth of -51 MLLW to -58 MLLW
- Expanded channel widths ranging from 520 feet to 864 feet (Table 1)

The quantities of sediment that would need to be dredged to achieve this improvement are approximately 780,000 cy from the Blair Waterway. These quantities assume the proposed depth of -58 MLLW, a quantity representing the average rate of accumulation between the current channel survey and the initiation of construction, and that the contractor removes all of the 2-foot allowable overdepth while dredging the channel. Disposal of dredged material would occur at Saltchuk or authorized open-water placement sites if Saltchuk is not used. The quantity estimated for open-water disposal or Saltchuk is approximately 697,000 cy from the Blair Waterway. The remaining 83,000 cy in the Blair Waterway that does not meet open-water disposal criteria would be disposed at a specific upland facility authorized to accept the material. The dredging is estimated to take about 4.5 months within approximately1 year to complete, partly due to limiting the work to the in-water work windows for protection of early life stages of sensitive fish species. No slope stabilization is anticipated for Alternative 2a.

d. *Alternative 2b (Blair Waterway Deepening to -57 MLLW)*. The plan that reasonably maximizes economic net benefits is the National Economic Development Plan. Under this alternative, the proposal analyzed is the following:

- Deepen the existing channel from an authorized depth of -51 MLLW to -57 MLLW (STA –5+00.00 to STA 137+24.11)
- Expanded channel widths ranging from 330 feet to 865 feet (Table 1)
- Expand the turning basin from 1,682 feet to 1,935 feet

The quantities of sediment that would need to be dredged to achieve this improvement are approximately 2.8 million cy from the Blair Waterway. These quantities assume the proposed depth of -57 MLLW, a quantity representing the average rate of accumulation between the current channel survey and the initiation of construction, and that the contractor removes all of the 2-foot allowable overdepth while dredging the channel. Disposal of dredged material would occur at authorized open-water placement sites or Saltchuk. The quantity estimated for open-water disposal is approximately 2,412,000 cy from the Blair Waterway. The capacity at Saltchuk is 1,850,000 cy. The remaining 392,000 cy in the Blair Waterway that does not meet open-water disposal criteria would be disposed at a appropriateupland facility authorized to accept the material. The dredging is estimated to take up to 4 years to complete, partly due to limiting the work to the in-water work windows for protection of early life stages of sensitive fish species. Based on preliminary analysis and results which will be confirmed as the design is refined in PED, this alternative includes additional evaluation of beneficial use of dredged material at the Saltchuk site. Additionally, should the final design indicate additional side-slope stabilization is warranted at the four areas identified in Figure 3-4 of the IFR/EA, approximately 100,000 tons of riprap and 762 linear meters of secant pile wall is the greatest extent of potential side slope strengthening.

Findings. The Corps rejected Alternative 1 because it would not meet the project purpose and need. Alternative 2a was not selected due to the opportunity to further improve safety, reduce risk of grounding, and gain greater transportation efficiency with Alternatives 2 and 2b. Alternative 2b is the National Economic Development Plan; this alternative meets the purpose and need for action, provides economic benefits to the region and nation, and reduces risk of grounding or the need for light-loading. Further, based on the slightly shorter time to dredge to a shallower depth, Alternative 2b is slightly less environmentally damaging than Alternative 2, and still provides enough material for a best buy beneficial use scenario at Saltchuk (Scenario E). Alternative 2b is the least environmentally damaging practical alternative that meets the purpose and need when considering only open-water placement at the DMMP Commencement Bay disposal site or a combination of open-water and placement at Saltchuk (Scenario E) for considering the benefits that would accrue from the beneficial use of material placement at Saltchuk.

6. Significant Degradation, Either Individually or Cumulatively, to the Aquatic Environment

Impacts on Ecosystem Function. Benthic habitat in the Commencement Bay DMMP open-water disposal site and Saltchuk will be disturbed by the disposal of dredged material onto the substrate within the footprint of each respective disposal site. Current velocities are slow enough at this site that material will not distribute beyond the site. The Corps has assessed potential effects from open-water disposal and determined that they will be localized to previously-disturbed areas solely within the footprint of the Commencement Bay DMMP disposal site, short in duration (occurs during disposal, and because actual disposal takes only minutes per episode, the disposal site will sustain a short duration effect), and minor in spatial scope due to the non-dispersive disposal site nature and release within a specified zone. Turbidity has been determined to be a negligible effect, according to DMMP documents (DMMP 2015). Disposal at the DMMP site and Saltchuk means that any benthic species present are at risk of displacement and potential smothering; however, organisms re-populate the area within days to weeks, and the habitat characteristics remain stable according to DMMP monitoring. The effects of disposal operations on salmonids will be reduced and/or avoided through implementation of timing restrictions. Due to these measures, negative effects to the aquatic environment would not be significant either individually or cumulatively.

Slope strengthening among four locations in Blair Waterway may be necessary (Section 3.5 of the IFR/EA). The installation of slope strengthening would create a temporary disturbance but would not substantially degrade the habitat quality of the already highly industrial waterfront. This habitat is not high quality aquatic habitat for juvenile salmonids or benthic invertebrates due to existing stabilization such as riprap from about +10 MLLW to -3 MLLW and built structures such as docks. The greatest extent of slope stabilization would be riprap from +10 MLLW to -58 MLLW with a secant pile wall. Presence of engineered slope strengthening along about 8% (762 linear meters total) of the approximately 8,700 linear meters of overall Blair Waterway shoreline in areas of similar, existing development would not substantially degrade the habitat quality of this highly industrial and stabilized waterway.

Impacts on Recreational, Aesthetic and Economic Values. The waterways are part of an industrialized port, and no significant adverse effects on recreation or aesthetics are anticipated. Although the waterways are "working waterfronts," there are recreational opportunities for the public. However, the proposed work would not interfere with the public's enjoyment of a working waterfront environment, except on a short-term, limited basis at the Saltchuk site. Throughout the dredging cycle, the dredge would be visible from the shore, but the project area is comprised of industrial waterways with continual vessel traffic, so the presence of a temporary dredge would not degrade the aesthetics of the existing industrial environment. There would be a positive economic impact to water-dependent businesses and others in the region that rely on access to the water.

Findings. The Corps has determined that there would be no significant adverse effects to aquatic ecosystem functions and values under the preferred alternative.

7. Appropriate and Practicable Measures to Minimize Potential Harm to the Aquatic Ecosystem

a. *Impact Avoidance Measures*. Potential effects of disposal operations on juvenile salmonids will be avoided through the implementation of timing restrictions. The in-water work window for material disposal at the Commencement Bay open-water disposal site is August 16 through February 15 to avoid the outmigration period of juvenile Chinook salmon (*Oncorhynchus tshawytscha*), a species listed as threatened under the Endangered Species Act. This timing restriction, designated by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS), is protective of bull trout (*Salvelinus confluentus*) foraging in Commencement Bay (subadults and adults moving into and out of the estuary) and migrating juvenile Chinook salmon and steelhead (*O. mykiss*). The Washington Administrative Code (WAC) and Corps' Regulatory Program authorize all other in-water work in Commencement Bay, including dredging, to occur July 16 through February 15 (WAC 220-660-330); all in-water work windows will be coordinated with Federal and local agencies. As a conservation measure as part of the ESA consultation, however, the agency has indicated that it will apply the in-water work window of Commencement bay open water disoposal site at all locations of activity in Commencement Bay. All dredged materials disposed at the Commencement Bay open-water site and placed at Saltchuk must meet rigorous testing requirements according to the DMMP standards and natural resource agency input. This avoids impacts that may be caused by contaminated or unsuitable sediments. If slope stabilization is necessary, impact hammers would not be used; instead, an auger or vibratory hammers would be used if a secant pile wall is necessary, and placement of riprap does not generate significant noise. This avoids negative effects from noise to fish and wildlife.

b. *Impact Minimization Measures*. The Commencement Bay open-water site was chosen because the deposition of dredged material in that location would have minimal impacts to the aquatic environment and represents the shortest transport distance from Blair waterway. Material placement at Saltchuk would create a beneficial habitat for ESA-listed species. In addition, the dredged material is disposed of at a time of year when ESA-listed species are not likely to be present. Only the minimum amount of slope stabilization material would be used.

c. *Compensatory Mitigation Measures*. There will be no mitigation measures because the work will have no more than a negligible adverse change to any habitat characteristics whether or not material is placed at Saltchuk or for slope stabilization in the Blair Waterway.

Findings. The Corps has determined that all appropriate and practicable measures have been taken to minimize potential harm.

8. Other Factors in the Public Interest.

a. *Fish and Wildlife*. The Corps is coordinating with State and Federal agencies, as well as tribes, to assure careful consideration of fish and wildlife resources. The Corps prepared a Biological Assessment in accordance with the ESA. Effects determinations for ESA-listed species and their designated critical habitat appear in Section 4.14.4 of the IFR/EA. USFWS concurred with the Corps' effect determinations of "not likely to adversely affect" (NLAA) listed species on February 2, 2022 (Appendix D and Section 6.2 of the IFR/EA). NMFS issued a BiOp February 16, 2022 (Appendix D of the IFR/EA), which concurred with the Corps' effects determinations except NLAA for steelhead; instead, NMFS determined the action is likely to adversely affect steelhead. In addition, NMFS' action area extends farther into Puget Sound where Humpback whale, Central America DPS and Mexico DPS, could be present and determined the action is NLAA the species whereas the Corps determined the action would have no effect. The Corps will assure full compliance with the ESA prior to and during project implementation (Section 6.2 of the IFR/EA).

b. *Water Quality*. The Corps will seek a Section 401 Water Quality Certification (WQC) from the Department of Ecology (Ecology). Should further analysis and design in PED determine additional side-slope stabilization measures are warranted, to the extent this activity would also result in jurisdictional activity under Section 404 of the CWA that is not administered by Ecology, the Corps will also seek a Section 401 WQC to address this activity from the Puyallup Tribe. The Corps will abide by applicable conditions in a WQC issued by a Certifying Authority under Section 401 of the CWA that are determined to be necessary to ensure compliance with applicable State or Tribal water quality standards. See Appendix D of the IFR/EA for applicable correspondence.

c. *Historic and Cultural Resources*. National Historic Preservation Act, Section 106 consultation is underway. The Corps has submitted to the State Historic Preservation Office (SHPO) a determination of no historic properties affected with the stipulation that future cultural resources monitoring will be conducted during geotechnical testing of soils that will occur during the PED phase. See Appendix D of the IFR/EA for all cultural resources letters.

d. *Activities Affecting Coastal Zones*. The Corps prepared a Coastal Zone Management Act Consistency Determination for the Tacoma Harbor, WA Navigation Improvement Project during feasibility-level design phase and submitted it to Ecology December 18, 2019 for early review and coordination. The evaluation demonstrates the proposed work complies with the policies, general conditions, and general activities specified in the Pierce County Shoreline Management Master Plan (current as of October 2018; https://fortress.wa.gov/ecy/ezshare/SEA/FinalSMPs/PierceCounty/PierceCo/PierceCoSMPAllOct2018.pdf). The proposed action is consistent to the maximum extent practicable with the State of Washington Shoreline Management Program. See Appendix D of the IFR/EA for applicable Consistency Determination.

e. *Environmental Benefits*. The long-term benefit of this action is an approximately 24 percent reduction in the number of large ships calling at Tacoma Harbor by reducing annual ship calls from 819 at present to 740 by the year 2035. This will reduce total greenhouse gas emissions and pollutants that are factors for regional air quality. Beneficial use of dredged material will improve habitat at Saltchuk for juvenile Chinook salmon and benthic organisms.

f. *Navigation*. Minor, temporary disruption of navigation traffic may result from dredging and disposal operations. The dredge may impinge on the total width available to vessel traffic in Blair waterway. Impacts to navigation during disposal would be minimal at the Commencement Bay DMMP site since the disposal site are located in a much wider area, and vessels would be able to avoid the barge. The project would allow larger ships access to the Blair waterway in a more operationally efficient and reliable manner. A detailed Ship Simulation will further investigate impacts to navigation traffic around Saltchuk during the PED phase.

A Notice to Mariners will be issued before dredging, and disposal operations are initiated. The action will improve the channel for use by deep draft vessels and improve safety by enlarging the entrance reaches to the Blair Waterway. Therefore, the USACE has determined that only a minor, temporary disruption of traffic will result from disposal operations.

Findings. The Corps has determined that this project is within the public interest.

9. Conclusions. Based on the analyses presented in the Feasibility Report and Environmental Assessment, as well as the following 404(b)(1) Evaluation and General Policies for the Evaluation of the Public Interest, the Corps finds that this project complies with the substantive elements of Section 404 of the Clean Water Act.

404(b)(1) Evaluation [40 CFR §230] and General Regulatory Policies Analysis [33 CFR §320.4]

404(b)(1) Evaluation [40 CFR§230]

Potential Impacts on Physical and Chemical Characteristics (Subpart C)

1. **Substrate [230.20]** The surface substrate at the Commencement Bay DMMP open-water disposal site consists of fine grain materials of marine and freshwater origin. Surface substrate at Saltchuk is composed of a coarse substrate that transitions to sand and silt near MLLW. Lower shore zone and deeper habitat includes wood waste. Materials disposed of at the DMMP Commencement Bay open-water disposal site are of similar particle size and larger. The DMMP Commencement Bay open-water disposal site is a non-dispersive site, and therefore bathymetric surveys are conducted to monitor the accumulation of dredged material (DMMP 2009). Material placement at Saltchuk will be native material from the Blair Waterway that will improve the substrate conditions for benthic organisms, a prey item of ESA-listed Chinook salmon. Blair Waterway side slopes are several types of sand to silt, with armoring typically from +10 MLLW to -3 MLLW. Slope stabilization may consist of riprap from +10 to -57 MLLW.

2. **Suspended Particulate/Turbidity [230.21]** The discharge of dredged material at the DMMP Commencement Bay open-water disposal site and Saltchuk will result in a temporary increase in turbidity and suspended particulate levels in the water column, particularly in near-bottom waters. Turbidity may be generated during slope stabilization construction. Sand and most silts would sink rapidly to the bottom, while a small percentage of finer material is expected to remain in suspension. The proportion of non-native material that is loam to silt loam is expected to remain in suspension the longest. Increases in turbidity associated with disposal operations will be minimal (confined to the areas in the immediate vicinity of the disposal sites) and of short duration (currents will disperse any suspended material within hours of disposal).

3. **Water Quality [230.22]** No significant water quality effects are anticipated. During disposal and material placement operations at Saltchuk, a localized turbidity plume may persist for a short period during the descent of dredged material through the water column. A minor reduction in dissolved oxygen may be associated with this plume, primarily during disposal of silty sediments. Because disposal operations at the DMMP Commencement Bay open-water site and for the first two benches of Saltchuk consist of a series of instantaneous, discrete discharges over the dredging schedule, any water quality effects should be short lived (hours) and localized (immediate vicinity). Material placed at Saltchuk for the third bench and islands will likely be assisted with a flat top barge and excavator, and BMPs will be implemented as applicable to minimize turbidity. This placement at Saltchuk will be discrete discharges localized to Saltchuk; BMPs may include slowing material placement, dropping it close to the bottom, or other measures. All of the sediments for in-water disposal will have been tested and approved for open-water and aquatic disposal under the guidelines of the DMMP administered by the Corps, U.S. Environmental Protection Agency, Ecology, and Washington Department of Natural Resources. Additional input from natural resource agencies will be incorporated for the suitability of material placed at Saltchuk. Material that is determined not to be suitable for in-water disposal will be disposed of in an approved upland disposal site and thus will not impact water quality. Ecology sets limitations on the amount of sediment that is allowed to be re-

suspended during the placement of dredged materials (and other in-water activities). The USACE will seek a WQC from Ecology, and will comply with applicable water quality conditions and criteria in a manner consistent with Section 401 of the CWA and its implementing regulations, including an associated water quality monitoring plan(s). Should further analysis and design in PED determine additional side-slope stabilization measures are warranted, to the extent this activity would also result in jurisdictional activity under Section 404 of the CWA that is not administered by Ecology, the Corps will also seek a Section 401 WQC to address this activity from the Puyallup Tribe. See Appendix D of the IFR/EA for applicable correspondence.

4. **Current Patterns and Water Circulation [230.23]** The disposal of material dredged from the Blair Waterway and side slope stabilization fill will not obstruct flow, change the direction or velocity of water flow/circulation, or otherwise change the dimensions of the receiving water body. Most dredged material placed at the disposal site will remain in the disposal site or Saltchuk and not re-enter the water column.

5. **Normal Water Fluctuations [230.24]** The disposal of material dredged from the Blair Waterway and side slope stabilization material will not impede normal tidal fluctuations. The Commencement Bay open-water disposal site is located in water deeper than 200 feet. This site is in deep enough water (deeper than 200 feet) that currents and tidal flows will not be affected. Saltchuk is a site for beneficial use of dredged material and intended to create shallow water habitat for juvenile salmonids. The placement of material at Saltchuk will not impede normal tidal fluctuations.

6. **Salinity Gradients [230.25]** The disposal and placement of material dredged from the Blair Waterway and side slope stabilization material will not divert or restrict tidal flows and thus will not affect salinity gradients.

Potential Impacts on Biological Characteristics of the Aquatic Ecosystem (Subpart D)

1. **Threatened and Endangered Species [230.30]** Pursuant to Section 7 of the ESA, the Corps prepared a Programmatic Biological Evaluation in December 2015 to assess potential effects of disposal at the DMMP multiuser sites on protected species (DMMP 2015; https://usace.contentdm.oclc.org/utils/getfile/collection/p266001coll1/id/9083). This document concluded that continued disposal at the multiuser disposal sites, including Commencement Bay, is not likely to adversely affect ESA-listed species: Puget Sound (PS) Chinook salmon (Oncorhynchus tshawytscha) Evolutionary Significant Unit (ESU), PS Steelhead (O. mykiss), PS/Georgia Basin DPSs of bocaccio (Sebastes paucispinis), canary rockfish (S. pinniger), and yelloweye rockfish (S. ruberrimus), the Southern Distinct Population Segment (DPS) of Pacific eulachon (Thaleichthys pacificus), Coastal/Puget Sound Bull Trout (Salvelinus confluentus) the Southern DPS of North American green sturgeon (Acipenser medirostris), the Southern Resident (SR) killer whale DPS (Orcinus orca), humpback whale (Megaptera novaeangliae), and Marbled Murrelet (Brachyramphus marmoratus), and have no effect to the leatherback sea turtle (Dermochelys coriacea). The document concluded the proposed action would not result in the destruction or adverse modification of designated critical habitat for PS Chinook salmon, PS Steelhead, Coastal/PS Bull Trout, PS/Georgia Basin bocaccio, canary rockfish, and yelloweye rockfish, Southern green sturgeon, or SR killer whale, and have no effect on marbled murrelet or leatherback sea turtle critical habitat. It was submitted to both the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) for their concurrence. NMFS

concurred with the finding, with the exception of the three ESA-listed rockfish species. Canary rockfish have since been delisted (82 FR 7711). NMFS provided a Biological Opinion to conclude the ESA consultation process for the multiuser disposal sites on December 17, 2015. The USFWS provided a letter of concurrence with the Corps' findings on July 28, 2015. This programmatic consultation under Section 7 of the ESA fulfills the consultation requirements for aquatic disposal of sediments dredged for the proposed action. The Corps submitted a Biological Assessment to NMFS and USFWS in March 2020 to assess potential effects of beneficial use of dredged material at Saltchuk and potential side slope stabilization on protected species. Effects determinations for ESA-listed species and their designated critical habitat appear in Section 4.14.4 of the IFR/EA. Consultation has concluded (Section 6.2 of the IFR/EA). USFWS concurred with the Corps' effect determinations of "not likely to adversely affect" (NLAA) listed species on February 2, 2022 (Appendix D and Section 6.2 of the IFR/EA). NMFS issued a BiOp February 16, 2022 (Appendix D of the IFR/EA), which concurred with the Corps' effects determinations except NLAA for steelhead; instead, NMFS determined the action is likely to adversely affect steelhead. In addition, NMFS' action area extends farther into Puget Sound where Humpback whale, Central America DPS and Mexico DPS, could be present and determined the action is NLAA the species whereas the Corps determined the action would have no effect.

2. **Aquatic Food Web [230.31]** Turbidity associated with disposal or construction operations may interfere with feeding and respiratory mechanisms of benthic, epibenthic, and planktonic invertebrates. Some sessile invertebrates at the DMMP Commencement Bay disposal site and Saltchuk will suffer mortality from disposal of dredged material. Species characteristic of these sites and Blair Waterway side slopes are opportunistic species, often small, tube-dwelling, surface-deposit feeders that exhibit patchy distribution patterns in space and time. Several studies have found that benthic infauna recolonize disposal sites quickly (several months) but that they may never reach mature equilibrium because of the frequent burying of organisms during disposal of dredged material. More mobile epibenthic organisms are expected to escape the immediate area without significant injury. Potential effects of disposal operations on salmonids will be reduced and/or avoided through implementation of timing restrictions. The same effects are expected for side slope stabilization in the Blair waterway.

3. **Wildlife [230.32]** Noise associated with disposal operations and side slope stabilization may have an effect on bird and marine mammals in the project area. The effects of any sound disturbance would likely result in displacement of animals, but not injury. Increases in turbidity associated with dredged material disposal could reduce visibility directly below and for a short distance down-current from the bottom-dump barge, thereby reducing foraging success for any animals in the area. Any reduction in the availability of food would be highly localized and would subside rapidly upon completion of the disposal operations and side slope construction. Disposal operations and side slope construction are not expected to result in a long-term reduction in the abundance and distribution of prey items. No breeding or nesting areas for birds will be directly affected. Impacts associated with placement of materials and side slope construction to harbor seals and sea lions that use the waters around the placement sites and Blair Waterway side slopes are expected to be localized and temporary. Animals would likely avoid the dredge and its impact area. Even if an individual(s) changes their behavior in response to noise generated from the action, the limited exposure time to the clamshell hitting the bottom (roughly four to five seconds every 15-20 seconds) would not result in any long-term impacts to the individual or seal and/or sea lion populations.

Potential Impacts to Special Aquatic Sites (Subpart E)

1. **Sanctuaries and Refuges [230.40]** Not applicable

2. **Wetlands [230.41]** Dredged material will not be discharged in wetlands. Use of the designated disposal site will not alter the inundation patterns of wetlands in the project area.

3. **Mudflats [230.42]** Dredged material will not be discharged onto mudflats. Use of the designated disposal site will not alter the inundation patterns of nearby mudflats.

4. **Vegetated Shallows [230.43]** Dredged material will not be discharged onto or directly adjacent to vegetated shallows. A small patch of eelgrass is present near the Hylebos Waterway near Saltchuk. Additional information about current patterns at Saltchuk will inform the appropriate best management practices to employ during material placement at Saltchuk. Beneficial use of dredged material at Saltchuk is expected to improve substrate quality for aquatic vegetation.

5. **Coral Reefs [230.44**] Not applicable.

6. **Riffle and Pool Complexes [230.45]** Not applicable.

Potential Effects on Human Use Characteristics (Subpart F)

1. **Municipal and Private Water Supplies [230.50]** Not applicable.

2. **Recreational and Commercial Fisheries [230.51]** Some sport fishing for shrimp and salmon occurs near the Commencement Bay disposal site. Crab harvest by the Puyallup Tribe occurs near the mouth of the Blair Waterway. Work is timed and located to minimize effects to fishing seasons in the disposal area, Blair Waterway, and Saltchuk, as well as critical migration periods for salmonids.

3. **Water-related Recreation [230.52]** Commencement Bay is approximately five square miles with the DMMP disposal site centrally located. Therefore, the presence of the disposal barge and side slope construction would not pose an obstruction to recreational vessel traffic and would have no appreciable effect on recreational vessel traffic. A kayak launch near Saltchuk will likely be closed temporarily during construction, but numerous other kayak launching sites are available around Commencement Bay.

4. **Aesthetics [230.53]** Disposal and placement operations and side slope construction will not change the appearance of the project area. Localized, temporary increases in noise, lighting, and turbidity will occur while equipment is operating but are not expected to be significant.

5. **Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves [230.54]** Not applicable.

Evaluation and Testing (Subpart G)

1. **General Evaluation of Dredged or Fill Material [230.60]** The material to be disposed of is predominantly loam to silt loam (non-native material) and sand to loamy sand (native material). The areas to be dredged have undergone a feasibility-level testing, and further testing will occur

during PED; and in accordance with DMMP guidelines, only material that is within DMMP guidelines would be disposed of in-water. Those materials that do not meet DMMP guidelines will be disposed of in an approved upland disposal site. Further coordination with State resource agencies and tribes will occur as to the suitability of material at the Saltchuk site. Only clean materials from an approved source would be used for side slope stabilization.

2. **Chemical, Biological, and Physical Evaluation and Testing [230.61]** The sediments in the footprint of the proposed dredging areas in the Blair Waterway will undergo additional testing conducted in accordance with DMMP procedures. It is anticipated that the majority of material in the dredge area will meet DMMP guidelines, and most of the dredged material will be suitable for open-water disposal at the DMMP Commencement Bay site or placement at Saltchuk. Testing of the material to be dredged will occur immediately preceding dredging and disposal actions. Any material determined not suitable for open-water disposal willbe disposed of in an approved upland site. Only material that meets DMMP guidelines will be disposed of in the Commencement Bay open-water disposal site or placed at Saltchuk. Only clean materials from an approved source would be used for side slope stabilization.

Action to Minimize Adverse Effects (Subpart H)

1. **Actions Concerning the Location of the Discharge [230.70]** The effects of the discharge are minimized by the choice of the DMMP disposal site and the beneficial use placement site. The DMMP disposal site has been designated for dredged material discharge. The discharge will not disrupt tidal flows. The location of the proposed discharge has been planned to minimize negative effects to the environment. The choice of Saltchuk as a site for beneficial use of dredged material is based on anticipated use by juvenile salmonids and will ultimately be beneficial. The effects of discharge at Saltchuk will be highly localized and temporary and will not disrupt tidal flows. Only clean materials from an approved source would be used for side slope stabilization.

2. **Actions Concerning the Material to be Discharged [230.71]** Concentrations of chemicals of concern in the materials to be discharged at the DMMP Commencement Bay open-water disposal site and Saltchuk are low. Therefore, no treatment substances nor chemical flocculates will be added before disposal. The potency and availability of any pollutants present in the dredged material should be maintained. Only clean materials from an approved source would be used for side slope stabilization.

3. **Actions Controlling the Material after Discharge [230.72]** Because only the dredged materials that have been approved for non-confined open-water disposal by the inter-agency DMMP will be placed at the disposal site, no containment levees or capping are necessary. Material is expected to remain in place at Saltchuk based on the dredged material characteristics and low currents at the site, but current modeling for Saltchuk during PED phase will further refine the material placement design. Side slope stabilization would be engineered to stay in place.

4. **Actions Affecting the Method of Dispersion [230.73]** The disposal site has been selected by taking into account currents and circulation patterns to minimize dispersion of the discharge. Standard best management practices will be employed during material placement at Saltchuk to minimize dispersion of the discharge. Placement of side slope stabilization would be intentional and limited to Blair Waterway side slopes.

5. **Actions Related to Technology [270.74]** Appropriate machinery and methods of transport of the material for discharge and placement of materials will be employed. All machinery will be properly maintained and operated.

6. **Actions Affecting Plant and Animal Populations [270.75]** The Corps has coordinated with the local Native American tribes and the State and Federal resource agencies to assure there will be no greater than minimal effects to fish and wildlife resources.

7. **Actions Affecting Human Use [230.76]** The discharge will not result in damage to aesthetically pleasing features of the aquatic landscape. The discharge will not increase incompatible human activity in remote fish and wildlife areas.

8. **Other actions [230.77]** Not applicable.

<u>General Policies for the Evaluation of Permit Applications [33 CFR §320.4]</u>

1. **Public Interest Review [320.4(a)]** The Corps finds these actions to be in compliance with the 404(b)(1) guidelines and not contrary to the public interest.

2. **Effects on Wetlands [320.4(b)]** No wetlands will be altered by the disposal of material from dredging operations.

3. **Fish and Wildlife [320.4(c)]** The Corps has coordinated with the local Native American tribes and the State and Federal resource agencies to assure there will be no greater than minimal effects to fish and wildlife resources.

Water Quality [320.4(d)] The Corps will seek a 401 WQC and will abide by applicable conditions in a Section 401 WQC in a manner consistent with Section 401 of the CWA and its implementing regulations, to ensure compliance with Washington State water quality standards. Should further analysis and design in PED determine additional side-slope stabilization measures are warranted, to the extent this activity would also result in jurisdictional activity under Section 404 of the CWA where Section 401 is not administered by Ecology, the Corps will also seek a Section 401 WQC to address this activity from the Puyallup Tribe, and abide by a 401 WQC to address tribal water quality standards.

4. **Historic, Cultural, Scenic, and Recreational Values [320.4(e)]** The Corps has consulted with representatives of interested tribes, the State Historic Preservation Office, and other parties and anticipates finding that no historic properties will be affected. No wild and scenic rivers, historic properties, National Landmarks, National Rivers, National Wilderness Areas, National Seashores, National Recreation Areas, National Lakeshores, National Parks, National Monuments, estuarine and marine sanctuaries, or archeological resources will be affected by the proposed work.

5. **Effects on Limits of the Territorial Sea [320.4(f)]** Not applicable.

6. **Consideration of Property Ownership [320.4(g)]** A portion of Saltchuk is located on Washington Department of Natural Resources aquatic lands. The Corps has two perpetual rights-of-way, composed of two tracts, from the Port of Tacoma in the Blair Waterway. The Blair waterway is historically navigable-in-fact, and thus subject to the navigational servitude, up to the 11th Street

intersection. The Corps has exercised navigational servitude on the current footprint of the Blair navigation channel not included in the two above tracts. Other portions of the Blair Waterway are owned by the Port of Tacoma, Puyallup Tribe of Indians, and the U.S in trust for the Puyallup Tribe of Indians. The Port of Tacoma is responsible for obtaining all real estate and will do so before material placement at Saltchuk.

7. **Activities Affecting Coastal Zones [320.4(h)]** The Corps prepared a Coastal Zone Management Act Consistency Determination for the Tacoma Harbor Navigation Improvement Project during feasibility-level design phase. The proposed work complies with the policies, general conditions, and general activities specified in the Pierce County Shoreline Management Master Plan. The proposed action is consistent to the maximum extent practicable with the State of Washington Shoreline Management Program.

8. **Activities in Marine Sanctuaries [320.4(i)]** Not applicable.

9. **Other Federal, State, or Local Requirements [320.4(J)]**

a. *National Environmental Policy Act (NEPA)*. A draft Integrated Feasibility Report and Environmental Assessment (IFR/EA) was prepared to satisfy the documentation requirements of NEPA. A 60-day public review period for the draft IFR/EA took place beginning December 18, 2019.

b. *Endangered Species Act*. In accordance with Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended, federally funded, constructed, permitted, or licensed projects must take into consideration effects to federally listed or proposed threatened or endangered species. A Programmatic Biological Evaluation (PBE) was submitted to USFWS and NMFS in May 2015 for continued disposal at the DMMP multiuser sites. The Corps received a letter from USFWS on July 28, 2015, concurring with the determinations made in the PBE and a Biological Opinion from NMFS on December 17, 2015, which concludes the requirements for Section 7 consultation regarding the aquatic disposal of dredged materials associated with this project. A Biological Assessment that includes an analysis of material placement at Saltchuk was submitted to USFWS and NMFS for their consultation under Section 7(a)(2) of the Endangered Species Act. Effects determinations for ESA-listed species and their designated critical habitat appear in Section 4.14.4 of the IFR/EA. USFWS concurred with the Corps' effect determinations of "not likely to adversely affect" (NLAA) listed species on February 2, 2022 (Appendix D and Section 6.2 of the IFR/EA). NMFS issued a BiOp February 16, 2022 (Appendix D of the IFR/EA), which concurred with the Corps' effects determinations except NLAA for steelhead; instead, NMFS determined the action is likely to adversely affect steelhead. In addition, NMFS' action area extends farther into Puget Sound where Humpback whale, Central America DPS and Mexico DPS, could be present and determined the action is NLAA the species whereas the Corps determined the action would have no effect (Section 6.2 of the IFR/EA).

c. *Clean Water Act*. The Corps must demonstrate compliance with the substantive requirements of the Clean Water Act. Public Notice CENWS-PMP-18-22, a Joint Aquatic Resources form, and draft Water Quality Monitoring Plan will serve as the basis for pre-coordination, and the Corps will seek a Section 401Water Quality Certification (WQC) from Ecology during the design phase. The Corps will abide by the applicable conditions in the WQC in a manner consistent with Section 401 of the Clean Water Act and its implementing regulations to ensure compliance with State water quality standards.

d. *Coastal Zone Management Act*. The Coastal Zone Management Act of 1972, as amended, requires Federal agencies to carry out their activities in a manner which is consistent to the maximum extent practicable with the enforceable policies of the approved Washington Coastal Zone Management Program. The Corps prepared a Coastal Zone Management Act Consistency Determination for the Tacoma Harbor Navigation Improvement Project during the feasibility-level design phase. The evaluation demonstrates the proposed work complies with the policies, general conditions, and general activities specified in the Pierce County Shoreline Management Master Plan. The proposed action is consistent to the maximum extent practicable with the State of Washington Shoreline Management Program.

e. *Marine Protection, Research, and Sanctuaries Act.* Not applicable

f. *National Historic Preservation Act*. The National Historic Preservation Act (16 USC 470) requires that the effects of proposed actions on sites, buildings, structures, or objects included or eligible for the National Register of Historic Places must be identified and evaluated. The Corps is consulting with the SHPO, Muckleshoot Indian Tribe, Nisqually Indian Tribe, Puyallup Tribe of Indians, Snoqualmie Tribe, Squaxin Island Tribe, and Confederated Tribes and Bands of the Yakama Nation under Section 106 of the NHPA. On October 19, 2018, the Corps sent an APE letter to the SHPO describing the project and APE. The SHPO responded on October 30, 2018, and agreed with the APE. On October 29, 2018, the Corps sent letters to the SHPO, Muckleshoot Indian Tribe, Nisqually Indian Tribe, Puyallup Tribe of Indians, Snoqualmie Tribe, Squaxin Island Tribe, and Confederated Tribes and Bands of the Yakama Nation describing the project and asking if there are any properties of cultural or religious significance that would be affected by the project. On March 26, 2019, the Corps sent a letter to the SHPO and aforementioned Tribes, providing a project update and revising the APE. The SHPO responded on April 8, 2019, concurred with the revised APE. To date, the Corps has not received a response from the Tribes regarding Section 106. A determination and findings letter and modified APE was submitted to SHPO on November 6, 2019, requesting concurrence with the Corps' determination offinding no adverse effects to historic properties, under a condition of monitoring during sediment characterization during the PED phase. On November 07, 2019, the SHPO provided a concurrence of "no effect", and this response was further clarified by the SHPO on April 27, 2021 via email message as being "no adverse effect" to historic properties.

g. *Fish and Wildlife Coordination Act*. The Fish and Wildlife Coordination Act (16 USC 470) requires that wildlife conservation receive equal consideration and be coordinated with other features of water resource development projects. The Corps initiated coordination for consideration of fish and wildlife species at the outset of the feasibility study and hosted a meeting with all relevant natural resource agencies on September 16, 2019. Further coordination occurred throughout the feasibility phase via email and phone with NMFS, USFWS, WDFW, and other agencies. The Corps received a Planning Aid Letter on September 5, 2019. Results of the coordination and FWCA recommendations detailing full compliance appear in Appendix C and D of the IFR/EA.

11. Safety of Impoundment Structures [320.4(k)] Not applicable.

12. **Floodplain Management [320.4(l)]** Disposal operations will not alter any floodplain areas.

13. **Water Supply and Conservation [320.4(m)]** Not applicable.

14. **Energy Conservation and Development [320.4(n)]** Not applicable.

15. **Navigation [320.4(o)]** This project will maintain and improve the navigability of the Blair Waterway for use by deep draft vessels. The disposal activities at the Commencement Bay open-water disposal site will not impede navigation. A detailed Ship Simulation will investigate navigation traffic around Saltchuk during the PED phase.

16. **Environmental Benefits [320.4(p)]** The long-term benefit of this action is an approximately 24 percent reduction in the number of large ships calling at the Port of Tacoma by reducing annual ship calls from 576 at present to 440 by the year 2035. This will reduce total greenhouse gas emissions and pollutants that are factors for regional air quality. The beneficial use of dredged material at Saltchuk will create shallow water habitat for juvenile salmonids and improve substrate quality over 64 acres.

17. **Economics [320.4(q)]** The economic benefits of the proposed action are important to the local and regional economies, and the action contributes to the National Economic Development Plan. The economic analysis is documented in the IFR/EA.

18. **Mitigation [320.49(r)]** Potential effects of construction operations will be avoided and minimized through the implementation of timing restrictions. No compensatory mitigation is required for the project.

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
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711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

January 27, 2021

U.S. Army Corps of Engineers Seattle District
ATTN: Laura Boerner
Chief, Planning, Environmental,
And Cultural Resources Branch
P.O. Box 3755
Seattle, WA 98124-3755

Re: Tacoma Harbor Navigation Improvement Project - Feasibility Study

Dear Laura Boerner:

The State of Washington Department of Ecology (Ecology) appreciates the early coordination efforts by the U.S. Army Corps of Engineers (Corps) concerning the Tacoma Harbor Improvement Project. Ecology has received and reviewed the following documentation as part of the pre-application coordination:

- Draft Joint Aquatic Resources Form;
- Draft Water Quality Monitoring Plan;
- Draft Coastal Zone Management Act Consistency Determination;
- Draft 404 (b)(1) Evaluation; and
- Draft Feasibility Report and Environmental Assessment.

Ecology has reviewed the project proposal and supports the continued development of the proposed projects and plans. The purpose of the project is to perform navigation improvements in the Tacoma Harbor.

Based upon the review of the proposed project during the feasibility phase and the additional information, Ecology is optimistic that the Corps will be able to design the projects with the necessary measures for the protection of water quality as long as they follow and meet the requirements of the attached Dredge Material Management Program (DMMP) Advisory Memorandum for Blair Waterway. Additionally, the Corps must submit a final version of the document above that addresses the comments in the attached comment document (attachment 1), and includes more complete design details and analysis.

Ongoing coordination between the Corps and Ecology, should enable the Corps to provide the necessary documentation to move through the Section 401 Water Quality Certification (WQC) request and Coastal Zone Management Act Federal Consistency process in preparing its Consistency Determination for Ecology's review and decision prior to construction.

Ecology is providing this letter in support of the Corps' continued efforts to seek funding for this important project. Please be advised that this letter does not substitute for or prejudge Ecology's Section 401 Water Quality Certification and Coastal Zone Management Federal Consistency decisions which will be issued in the future.

We look forward to continuing coordination on these proposals as you move into the formal permitting phase. Please contact Loree' Randall (lora461@ecy.wa.gov), if you have any questions.

Sincerely,

Brenden McFarland
Shorelands & Environmental Assistance Program

ecc: Michael Scuderi, Seattle District Corps
Loree' Randall, Ecology
Perry Lund, Ecology
Laura Inouye, Ecology
Terry Swanson, Ecology
Lori Kingsbury, Ecology
ecyrefedpermits@ecy.wa.gov

Attachment #1
Tacoma Harbor Improvement Project
Ecology Comments on Draft Documents
January 27, 2021

Draft - CZMA Consistency Determination – December 2019

Page	Comment
2	Under the Clean Water Act – The Corps will need to address all Clean Water Act actions in addition to Section 401. For example Section 402 NPDES permits for upland disposal is needed.
2	The State Environmental Policy Act (SEPA) is not an enforceable policy, therefore reference to SEPA throughout the document can be deleted.
5	*RE: Stormwater control.* Ecology will need to review the upland disposal location and transloading plan as part of the CZMA and Section 401 review process. Additionally, the upland transload facility will need to be a "permitted" facility… if not specifically permitted as a transload for contaminated sediments.
6	*RE: dredged material management program.* There is reference to DMMP being DNR's program. This reference is not correct. The DMMP is a multi-agency group and is not specific to DNR. This should be corrected throughout the document.
8	*RE:18S.30.080 Shoreline Modifications.* What about the Saltchuk site? It is our understanding that it will have modification, while we understand they should be beneficial, it should be assessed and identified in this document.
9	*RE: 18S.30.100 Water Quality, Stormwater, and Nonpoint Pollution.* It should be made clear about the transloading facility most be a permitted facility throughout the document. Also there should be some discussion of the transfer of unsuitable material for upland disposal and not just referring to what will be reviewed under Section 401.
13	*RE: Stormwater and Nonpoint Pollution control is not a component of dredging.* While stormwater is not a component of dredging it is a component of upland disposal and should be address and some general information provided, specifically about using a permitted facility for upland disposal transfer.
14	*RE: fully coordinated through the DMMP.* DMMP is may not be the appropriate group to provide the review and decision regarding the beneficial use at Saltchuk. Suggest convening a meeting with State and Federal fisheries agencies and Ecology.
24	*RE: On-site containment facilities.* What on-site containment facilities are associated with dredging and disposal of this project? Please provide more information.

Draft - JARPA – December 2019

Page	Comment
5	*5. j* – Should list all the waterbodies within or adjacent to the project location - Commencement Bay, Blair Waterway, Hylebos Waterway, Foss Waterway.
7	6e. Says the dredging is estimated to take three years to complete, but then 6f has only 2.5 years. Is there are reason for the difference? If not should be consistent throughout the document.
13	*RE: Will the in-water construction work comply with the State of Washington water quality standards for turbidity? Yes*. Ecology has some concerns if this is true for the

	Saltchuk placement of material. And would like to have more information and/or discussion.
14	*RE: Will this project be designed to meet the Washington Department of Ecology's most current stormwater manual? Not applicable.* Ecology is not sure that "Not applicable" is appropriate because of the upland transloading.

Draft – 404b1 – December 2019

Page	Comment
1	*RE: (a)Disposal of up to 2,800,000 CY of suitable material.* 2.4 MCY suitable, 2.8 MCY total, according to other documents. Also interesting to note that this is the only place where they suggest that all the material MIGHT go to the open water disposal site.
2	Table 1. Would be nice to somehow correlate these stations with channel reaches in Table 2.
4	As noted above - RE: Channel Reach in table 2. Please tie to Table 1 channel stations.
6	*RE: this site in 6. Significant Degradation*. As mentioned in JARPA, need to discuss potential currents at Saltchuk, because they might need extended area of mixing there.
7	*RE: Turbidity has been determined to be a negligible effect according to DMMP documents (DMMP 2015).* DMMP 2015 ONLY applies to the DMMP disposal site. This section infers that DMMP documents cover Saltchuk as well, which is misleading and therefore additional information is needed for Saltchuk.
13	*RE: project area in Aesthetics.* Not the dredge area, but Saltchuk would change if they go with the entire plan and should be covered in this document.

Draft – DFREA Main Report – December 2019

Page	Comment
1	*RE: Blair Waterway Alternatives.* This description is the same throughout all documents, but do not match stations in most of the maps, which appear to run ~500.00-865.00.
2	*RE: (392,000 CY) removed.* DMMP SDM indicated that sideslopes were at highest risk of failure, so addition of more sideslope under alternative 2 may result in higher upland disposal estimates for added material. Can the Corps show how these values were calculated (upland vs in-water)?
2	*RE: 1.2 million to $10.6 million above the base plan disposal of suitable material at Commencement Bay*. Does the base plan for disposal at commencement bay include full bathymetric surveys for every 500,000 CY (corps historically overs this cost), plus a full site monitoring If all material goes there (historically covered by disposal tipping fees charged to the Port, currently $0.45/CY but may be increasing)? At 0.45 per CY, this would be just under 1.1 million.
2	*RE: NED Plan first cost $242,274,000*. Doesn't match NED cost-benefit table. We could not figure out where this value came from.
2	*RE: O&M material disposal is assumed for Commencement Bay open-water disposal site unless determined to be unsuitable for open-water disposal.* The only table with benefit-cost ratio assumes NO beneficial re-use. Shouldn't this be considered, or is the Corps not serious about looking into the beneficial use site? If the Corps is serious about the beneficial use site, should another table be added including that option for comparison?

3	*RE: NED Plan Cost and Benefit Summary (October 2019 Price Level, FY20 Discount Rate) Table.* Can't match these values to discussion above.
4	*RE: Stations STA 116 to STA 140.* These station #'s do not match stations on most of the maps.
4	*RE: thus not a suspected source of hazardous, toxic, and radioactive waste (HTRW).* Note that Ecology's wood waste guidance (Pub # 09-09-0044) states that wood waste, treated or not, can result in SMS exceedances due to both physical presence and due to decomposition/degradation products such as phenols, benzoic acid, benzyl alcohol, and sulfides. Thus, left at the surface the wood waste CAN be a source of toxics. (LI)
8	*RE: referenced (Figures 1-3 and 1-4).* Removed 1-3, 1-3 is proposed disposal locations.
9	*RE: referenced (Figures 1-7).* Changed to 1-8. Figure 1-7 is Map of stormwater outfalls around the Blair Waterway.
32	*RE: Figure 3-2 Current Authorization/ No Action Alternative for Blair Waterway.* Please correct station ID to match alternatives. Somewhere provide "translation" for old and new markers so the new stations can be matched to the ones used in the SDM.
33	*RE: HTRW material remains in place in the uplands at the Lincoln Avenue Ditch and Former Lincoln Avenue Ditch adjacent to the east side of Blair Waterway…* Should there be other sites added, including early business center, and CERCLA sites?
33	*RE: Table 3-3 Current Federally Authorized and Alternative 2 Widths by Channel Station (STA) at Blair Waterway.* Throughout document, a lot of figures use the old station IDs. Please correct and provide "translation" between old and new station ID's.
34	*RE: Figure 3-3 Alternative 2 Blair Waterway Deepening.* Fix station IDs in this figure, these appear to be the old reference points.
35	*RE: The Corps estimates there would be one O&M dredge event every 25 years.* Would this hold true for added area at the mouth (stations -5 to 5)? Creating a basin at the mouth may result in faster accumulation rates in the new area. There is no discussion regarding this in the document.
37	*RE: O&M dredging after deepening is assumed to be minimal based on historic information.* Again, need analysis on the new section added between stations -5 to 5?
37	*RE: Alternative 2b - Blair Waterway Deepening to -57 MLLW.* Missing side slope strengthening requirements. Assumed this was same as Alt 2, but in section 5, discussion indicates only 3 of the 4 areas identified as needing strengthening under 2 apply to 2b.
40	*RE: Alternative 2b (-57 MLLW) maximizes net benefits and has the greatest return on investment for NED.* Is this described/discussed elsewhere? Seems like an important point. If so, point to section.
49	*RE: cost-effective scenario for dredged material disposal.* Other aspects: if all material goes to Commencement Bay over 3-year period, this would trigger at minimum bathymetric survey of disposal site at end of each dredge season- this is covered by Corps. Site monitoring, triggered by volume or if off-site material is found, is covered by disposal site funds covered by current 0.45/CY charge to Ports for use of the site. If material migrates off site, as has happened in the past at this location, then disposal BMPs may slow down the schedule. Thus, the more material going to Saltchuk, the less likely there will be unpredicted impacts from disposal site management.
55	*RE: At this rate (280,000 CY/year), the site will reach capacity in 51 years*. If Saltchuk is not used, then 10 years of the 50 year capacity will be used in the 3 years of project

	construction. Still not an issue, but this should be acknowledged that it is 10x higher rate than the 30-year average.
59	*RE: Land Based Transportation/Traffic, The same amount of material would move through the area in the future with- and without-project conditions.* Does this assume transload facility is outside of the project area? If sites within the Bay are under consideration, discussion of potential sites and impacts are completely missing in this document. Unless rail is used, this could result in elevated truck traffic.
64	*RE: (see Appendix H for map of sites).* We would like to see this, as well as other appendices. Are they available?
70	*RE: Figure 4-4 Thalassa Axia in Blair Waterway.* We note the turbidity plume, which is reference in several areas- the project could result in lower plumes associated with traffic both due to deeper draft and reduced ship calls.
75	*RE: Lowest Observed Water Level, -4.73.* MINUS 4 tide?!? Can you confirm when this occurred? Or is there a typo? The lowest tide we heard of is about -2.5.
77	*RE: Additional slope stabilization.* What would this entail? Can more discussion be add and options should probably be listed here.
79	*RE: The No-Action Alternative would have no effect on the long-term levels of temperature, turbidity…* Wouldn't transiting of large vessels result in turbidity plumes without increasing depths? Referring to the photo in figure 4-4.
90	*RE: 4.11 4.11 Hazardous, Toxic, and Radiological Waste.* Maps and information for these sites are in missing appendices. Can at least a map be inserted into this section? Early Business Center is not currently a MTCA sediment site, but there are ongoing discussions, and Ecology TCP has submitted comments regarding areas to avoid. Probably should add in discussion on this.
91	*RE: All contaminated sediments were removed…* "contaminated" = above DMMP screening level. TBT was left in place, although at lower concentrations.
94	*RE: as evidenced by turbidity generated as the largest ships transit the waterway.* See comments regarding water quality. If no action takes place, turbidity increases due to lower clearance as ships try and transit during high tides.
96	*RE: 4.12.5 4.12.5 Cumulative Impacts on Benthic Organisms*. You might mention beneficial impact of removing contaminated surficial sediments?
101	*RE: Effects of dredging and Saltchuk construction on…* Construction discussed as far as possible adverse impacts, never discuss the benefits of the habitat creations to the fish. (LI)
102	*RE: Slope strengthening among four locations in Blair Waterway may be necessary (Section 3.5).* What actually does this mean as far as the actual stabilization itself? Armoring? Just shallower slopes?
103	*RE: However, the combined effect is not anticipated to be a measurable cumulative effect on fish populations.* A measurable ADVERSE impact to fish not expected, but should potential benefits be summarized? Reduced ship traffic, resulting in lower associated noise and turbidity? Potential habitat benefits from Saltchuk?
109	*RE: None of these factors would be affected…* Adverse impacts not expected, if Saltchuk option is completed, improvements would be made.
115	*RE: Slope strengthening such as sheet piles, secant walls, or other vertical slope strengthening solutions at four locations in Blair Waterway may be necessary (Section 3.5).* This is the first time actual potential slope strengthening solutions are listed.

	Section 3.5 only mentions the need, and where. Need to have more information about this.
121	*RE: aquatic disposal may be re-suspended under Alternative 2.* Suggest adding in "over the three year construction period"
126	*RE: Figure 5-1 Tentatively Selected Plan (TSP).* Need to add in the new station ID #s -5 to 135.
127	*RE: As shown, 1,140 feet, 2,010 feet, and 2,090 feet of slope strengthening are required for all depths below -54 MLLW at Husky, WUT, and PCT, respectively.* Note that section 3.5 identified 4 areas under Alt 2, and did not discuss differences for Alt 2b. Please add discussion of reduced slope strengthening needs for 2b in the appropriate section 3.5 area.
127	*RE: A contained, flat deck material barge would transport unsuitable material to a transloading facility where it would be dewatered and mechanically re-handled for disposal at a designated landfill site.* We assume that the selected site is outside this project area, as transloading here would result in a lot of truck traffic.
128	*RE: The remaining capacity of the open-water disposal site (14,310,000 CY) can accommodate this material…* It does use up 10 years' worth of average annual disposal in a 3-year period, another reason for beneficial use.
134	*RE: Hydraulics and Geomorphology, Deepening the Blair Waterway would cause a need for O&M dredging approximately every 25 years.* Confirm that the widening at the mouth will have similar dredging needs and that creating a deeper area will most likely accumulate, this was never directly discussed.
137	*RE: that point the Corps will develop a disposal plan and identify a transloading facility.* Note that use of any facility in the project site that does not use rail transit would result in increased traffic, which is not evaluated in this document.
150	*RE: Provide 50% of the total cost of construction of the GNFs attributable to dredging to a depth in excess of -50 MLLW but not in excess of -57 MLLW as further specified below.* Does this cover to -57, or the -57+2 that is proposed? The phrase "not in excess of -57" infers that the Corps covers the entire cost of advanced maintenance.

Draft – WQMP – November 2019

Page	Comment
	Deficiencies that need to be addressed: 1. For unsuitable material, elevation at early warning would require BMP 2. Exceedance at the Point of Compliance means STOP. 3. For unsuitable material, Ecology should be notified within 2 hours, not 24.
	4. We suggest and would like to discuss the need for metered monitoring at the Saltchuk mitigation site similar to dredging. Also there may be a need to seek an extended area of mixing at Saltchuk.
	3. At this time Ecology does not agree with the need of an extended area of mixing at the dredge site, since all dredging there (Port and other maintenance dredging) has been able to meet the 150 ft. POC. If the rationale behind the request is that they cannot safely monitor at the early warning, then monitor at 150 ft. only and stop if exceedance noted, wait for exceedance to pass, then implement additional BMPs prior to restarting. We

	look forward to further discussion on this. Additionally we would like to see the documentation that supports the need for this.
3	*RE: Heading for "Frequency of Monitoring".* Added (Suitable material).
4	*RE: Locations and Frequency for Unsuitable Material.* Frequency: in addition to the first 5 days, metered monitoring should occur twice weekly for the unsuitable material.
5	*RE: Corps will notify Ecology by phone within 24 hours after there has been a measured exceedance.* 2 hours for unsuitable material.
5	*RE: Corps will then notify the dredging contractor that a measured exceedance occurred and request that the dredging contractor implement BMPs, as appropriate and applicable, to reduce turbidity.* For unsuitable material, exceedance should stop work until turbidity exceedance is resolved, additional BMPs should then be implemented prior to restarting work.
5	*RE: In the event of exceedances such that dredging is temporarily stopped during the first 5 days of monitoring.* Please drop "such that dredging is temporarily stopped". Confirmed exceedances will re-trigger restart of 5 days, even if dredging is allowed to continue (suitable material).
5	*RE: heading for "Step 2: Increased monitoring".* Added "monitoring (suitable material only; initial confirmed exceedance in unsuitable material = stop work)" Please also add in plume chasing if turbidity is more than 2X standard- find the downstream extent of the plume, and the duration of the downstream exceedance, if present.
5	*RE: heading for "Step 3: Stop dredging or disposal".* Added "(again, suitable material only; initial exceedance in unsuitable material stops work)"
7	*RE: The normal schedule of water quality sampling will resume as per specific requirements above.* The 5-day metered monitoring is re-started.
7	*RE: Ecology must be informed by phone within 24 hours for an exceedance…* Within 2 hours when material being dredged is unsuitable.
7	*RE: Any shut downs will be documented…* Or confirmed exceedances
7	*RE: …the Corps will submit the water quality monitoring data and a summary report to Ecology.* Ecology should receive weekly reports, unless otherwise specified by the Ecology project manager.
7	*RE: The Corps will notify Ecology within 24 hours if an exceedance occurs.* 2 hours for unsuitable material.

June 25, 2019

Prepared by:
Dredged Material Management Office
Seattle District, U.S. Army Corps of Engineers

MEMORANDUM FOR: RECORD

SUBJECT: DMMP ADVISORY DETERMINATION REGARDING THE POTENTIAL SUITABILITY OF PROPOSED DREDGED MATERIAL FROM THE BLAIR WATERWAY IN TACOMA HARBOR FOR UNCONFINED OPEN-WATER DISPOSAL AT THE COMMENCEMENT BAY DISPOSAL SITE OR FOR BENEFICIAL USE.

1. Introduction. This memorandum reflects the consensus advisory determination of the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, Washington State Department of Ecology, Washington State Department of Natural Resources, and the Environmental Protection Agency) regarding the potential suitability of up to 2.5 million cubic yards (cy) of dredged material from the Blair Waterway for open-water disposal at the Commencement Bay disposal site or for potential beneficial use.

   The DMMP agencies cooperatively manage eight open-water disposal sites in Puget Sound. The disposal site in closest proximity to Tacoma Harbor is the non-dispersive site located in Commencement Bay. Dredged material evaluation guidelines for disposal at the Commencement Bay site can be found in the DMMP Dredged Material Evaluation and Disposal Procedures User Manual (DMMP, 2018). These procedures are summarized in Exhibit A of this memorandum.

   Blair Waterway is an authorized federal navigation channel located in Tacoma, Washington. The existing authorized dimensions of the waterway are 520 ft wide from the mouth to 11th Street, 345 ft wide through the 11th Street reach, 520 ft from 11th Street to Lincoln Avenue, 330 ft from Lincoln Avenue to the turning basin, and a 1300 ft turning basin, all to a depth of -51 feet MLLW. During the last deepening event in 2000-2001, the waterway was dredged to -51 feet MLLW, plus 2 ft of overdepth. Due to minimal accumulation of sediments since then, mudline elevations within the existing navigation channel remain at -51 ft MLLW or deeper.

   The U.S. Army Corps of Engineers (USACE) and Port of Tacoma (POT) are conducting a feasibility study to investigate potential deepening and widening alternatives for the Blair Waterway (Figure 1). Depths up to -58 feet MLLW, plus 2 feet of overdepth, are being evaluated. This DMMP memorandum presents and evaluates sediment characterization data collected from Blair Waterway with the purpose of advising USACE and POT regarding the probable suitability of sediment from Blair Waterway for open-water disposal or beneficial use.

   Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the U.S. EPA designated the Commencement Bay Nearshore/Tideflats Superfund site in 1983. The site includes three main components: remediation of the sediments and source control for Commencement Bay waterways, remediation of Tacoma Tar Pits, and remediation of the Asarco Smelter Facility and surrounding impacted areas. Multiple waterways within Commencement Bay are covered under the sediment operable unit for the Superfund Site. Blair Waterway was originally included under the sediment and source control operable unit, but was delisted by the U.S. EPA in 1996 because it was

cleaned up under an agreement known as the Puyallup Land Claim Settlement between EPA, the Port of Tacoma, and the Puyallup Tribe. Another notable Superfund action in Blair Waterway included dredging of tributyltin (TBT) contaminated sediments at Pier 4 as part of a Time Critical Removal Action. This action was completed in 2016 under the regulatory authority of the U.S. EPA and included removal of 71,000 cubic yards of contaminated sediment in conjunction with the redevelopment of Pier 4.

Project summary and tracking information is shown in Table 1.

Table 1. Project Summary

Project ranking	Channel: Low-moderate
	Sideslopes: Moderate
Proposed dredging volume	2.5 million cy
Maximum proposed dredging depth	- 58 ft MLLW, plus 2 feet overdepth
Sampling Dates	February 18 – February 22, 2019
EIM Study ID	POTBD19

2. Sediment Evaluation Strategy for the Tacoma Harbor Feasibility Study. Several factors were taken into consideration in development of a sediment evaluation strategy for the Blair Waterway.

DMMP Recency Guidelines – The DMMP recency guidelines specify the length of time that sediment characterization data remain adequate and valid for decision-making without further testing. The length of the recency period is determined by the rank of a project, the rank being driven by the available information on chemical and biological-response characteristics of project sediments and the number, kinds, and proximity of chemical sources (existing and historical). Blair Waterway has a split ranking; the existing navigation channel is ranked low and areas outside the navigation channel have project-specific rankings based on site characteristics (DMMP, 2018). For the purpose of this advisory evaluation, the DMMP agencies agreed to consider the entire project area as having an overall rank of low-moderate. The recency period for low-moderate-ranked areas is six years. Since it was unlikely that construction would occur within six years following sediment sampling for the feasibility study, a decision was made to wait until the Preconstruction Engineering Design (PED) phase of the project to conduct a full DMMP characterization for final decision-making. More limited sediment characterization would be done during this feasibility study.

Level of Effort – Since full DMMP characterization will not be completed until PED, the study team needed to determine the level of effort that would be adequate to support the evaluation of alternatives during feasibility. In consultation with the DMMP agencies, the study team decided that a 20% level of effort would suffice. Additionally, bioassays and bioaccumulation testing were not conducted for this effort. This level of effort was selected to provide a meaningful representation of levels and patterns of contamination in Blair Waterway, without incurring the expense of a full characterization.

3. DMMP Sampling and Testing Requirements. DMMP sampling and testing requirements are dependent on the rank of the project. As indicated previously, Blair Waterway was ranked “low-moderate” for this evaluation in order to determine the appropriate level of sampling. For low-moderate-ranked projects, one field sample must be taken for every 8,000 cy of sediment.

   Typically the dredge prism would be divided up into dredged material management units (DMMUs) based on the design of the project. A DMMU is a volume of sediment that can be independently dredged from adjacent sediment and for which a separate disposal decision can be made. Allowed volumes per DMMU are based on rank, surface versus subsurface DMMUs, and homogeneity/heterogeneity of the sediments. However, since the study is in the feasibility phase a specific dredge design has not been developed. The dredged material volume and prism associated with the selected alternative will not be known until the feasibility study has been completed.

   For the purposes of sediment characterization conducted during feasibility, the dredged material volume associated with maximum proposed dredging was calculated, along with the number of field samples required for full DMMP characterization, see Table 2 below. The number of field samples required for full characterization was multiplied by 0.20 (for a 20% level of effort), resulting in a need for 63 field samples for the advisory-level characterization.

Table 2
Sampling Rationale

Waterway	Total Volume (cubic yards)[1]	Rank[2]	Total Number of Cores	Total Number of Samples Required for Full Characterization	20% of Total Number of Samples Required for Advisory-level Characterization
Blair Navigation Channel	2,247,500	Low-moderate: 8,000 cy/sample	20 (2 to 3 samples analyzed per core)	313	63
Side slopes	209,500		5 (2 to 3 samples analyzed per core)		

Notes:
1. The total estimated volume including navigation channel and side slopes is 2,457,000 cy.

To provide higher-resolution data for the feasibility study, a decision was made to not composite individual samples, as is often done in DMMP sediment characterization, but to instead analyze individual field samples. To get a good spatial distribution, 25 sampling locations were identified throughout the waterway (Figure 2). The location of the sampling stations was determined in coordination with the Port of Tacoma, the Port’s contractor, the DMMP agencies and the Puyallup Tribe. Due to elevated concern over the quality of the material in the sideslopes, 5 sampling locations were placed in the side slopes in to characterize these areas at a sampling intensity closer to a moderate-rank level. For a moderate-rank project one sample is required for every 4,000 cy of material. The estimated volume of the sideslopes is 209,500 cy – so 11 samples are needed to sample the sideslopes at 20% of the “moderate-ranked” intensity. Thus the 5 identified cores, with 2 to 3 samples each (a single core can provide multiple depth interval samples), was sufficient to meet the 20% level of effort for the side slopes. The additional samples collected in the side slopes were subtracted from the total number of samples needed in the rest of the waterway, so that the total number of samples analyzed equaled 63.

Native Material – An additional goal of sampling was to determine the elevation of the native horizon. Previous deepening of Blair Waterway was to -51 ft MLLW plus 2 ft of overdepth. The native horizon was expected to be around -53 ft MLLW.

The native horizon was identified based on evaluation of the core lithology by sampling personnel familiar with the characteristics of the native sediments in Tacoma Harbor. Based on review of uplands geotechnical boring and available sediment cores in the Blair Waterway, the native unit was expected to consist of moist, medium dense to dense, gray to grayish brown, fine to medium sand with various amounts of silt and trace shell hash and occasional interbeds of moist, medium stiff, light gray, clayey silt.

4. Sampling. Field sampling took place February 18-22, 2019 using a vibracore sampler. Cores were processed at the Port of Tacoma facility at the head of the Sitcum Waterway in Tacoma, WA and samples were then transported to ARI in Tukwila, WA and submitted for analysis. Figure 2 shows the target and actual coring locations and Table 3 gives the station coordinates and other core collection data. Samples were collected within 10 feet of the target location coordinates, with the following exceptions:
   - Location C-8 was moved 85 feet northeast due to core refusal on a hard, uneven bottom, likely riprap
   - Location C-13 was moved 41 feet to the southeast to avoid contact with buried sewer lines
   - Location C-25 was shifted 84 feet due to the presence of a cargo vessel for the extent of field sampling operations

   The approved sampling and analysis plan (Anchor QEA, 2019a) was followed to the maximum extent possible. Additional deviations from the SAP were reported in the final sediment characterization report (Anchor QEA, 2019b), including:
   - Holding cores overnight before processing, which was done to minimize the number of field sampling days. Cores held overnight were securely stored upright on the sampling vessel behind a locked gate. Ambient overnight temperatures during the sampling period ranged from 3.3 to 5 ºC, with an average of 4.3 ºC. These holding conditions are in accordance with standard custody and temperature requirements for holding sediment cores.
   - As a result of holding cores overnight, additional compaction of some cores occurred between the time they were collected and processed. This additional compaction was not accounted for in the core logs and depths reported in the data report and in this advisory memo.
   - Due to the difficulty of collecting cores in the sideslopes, only three cores were collected from sideslopes instead of the five that were originally planned. During SAP development C-1 was initially considered a sideslope sample, but during finalization of the sampling plan that location was moved to the edge of navigation channel and therefore was not considered a side slope sample. Location C-8 was moved out of the sideslopes during sampling due to difficulty coring. Nine samples were analyzed for the full DMMP list of chemicals from the three sideslope samples (C-12, C-13, and C-17) in Round 1, and an additional four samples were analyzed for conventionals and dioxins/furans in Round 2. In total, 13 sideslope samples were analyzed, sufficient to meet the sampling intensity for a moderate rank.

Core intervals collected for sampling were determined based on the core lithology to avoid excessive testing of the native material while simultaneously ensuring that the native material was adequately tested. The following guidelines were used:

- At least two samples (depth intervals) from each core were analyzed.
- Samples were analyzed from the top down, and no more than three samples per core were analyzed.
- Minimum sample size was a 2-foot interval, in order to have sufficient volume of sediment for all analyses.
- The length of the top non-native interval was determined by the depth of the native horizon. As many 2-foot intervals as could be delineated were collected and analyzed from the non-native layer.
- At a minimum the surface non-native or mixed interval and the top interval of native material were analyzed.
- In sideslope samples, the first interval of native material was analyzed as long as it was within the top three depth intervals of the core. If not, the native intervals were archived and analysis was only triggered if there were SL or BT exceedances in the shallower interval.

6. Chemical Analysis.

To avoid excessive testing of native sediments a tiered testing approach was used. Analysis by the analytical laboratory occurred in two rounds. Round 1 included 57 samples identified based on the core lithology. All Round 1 samples included testing of the full suite of DMMP COCs, including conventionals, metals, semivolatiles, pesticides, PCBs, bulk TBT and dioxins/furans. Table 4 lists the sediment samples that were analyzed in Round 1 and Round 2. Six analyses were triggered for Round 2 based on the results of Round 1, as described below:

- Location C-2: This location did not have any SL or BT exceedances, but TBT increased with depth from 7.35 μg/kg in the 0-2 ft sample to 17.3 μg/kg in the 2-4 ft sample. Based on proximity to historically elevated TBT concentrations at depth (2016 EPA TBT Time Critical Removal Action) and the observed increasing concentrations with depth, Round 2 chemistry results were triggered in the next two deeper samples to evaluate the chemical trend. Results were non-detect in both intervals.
- Location C-12: Dioxin/furan concentrations were above 10 pptr TEQ in the 0-2 ft, 2-4 ft, and 4-6 ft intervals (56.21, 54.47, and 17.74 pptr TEQ, respectively). Round 2 chemistry samples were triggered in the next two deeper samples and were below the SL of 4 pptr TEQ. Additionally, total PCBs were above the SL of 130 μg/kg in the 0-2 ft interval (173.3 μg/kg), but below the SL in the 2-4 ft interval.
- Location C-13: Dioxin/furan concentrations were above 4 pptr TEQ in the 0-2 and 2-4 ft intervals (5.34 and 7.73 pptr TEQ, respectively) and above 10 pptr TEQ in the 4-6 ft interval (11.88 pptr TEQ). Round 2 chemistry samples were triggered in the next two deeper samples. The 6-8 ft. interval was above 4 pptr TEQ (7.64 pptr TEQ), and the 8-10 interval was below 4 pptr TEQ.

Tables 5 and 6 present the sediment conventionals and chemistry results, respectively. Figure 3 shows boxplots of TOC, percent sand and percent fines for the project. Samples were grouped into one of three categories based on core lithology: 1) samples that were identified as native, 2) samples from cores where the native layer was undetermined and 3) samples identified as non-native material.

Samples identified as native have a higher percentage of sand and lower percentage of fines than the non-native and unidentified material, consistent with the expected characteristics of the native material. The depth (in ft MLLW) of the native layer as identified during core processing is shown in Figure 4.

A total of 8 cores out of the 25 collected contained one or more samples with at least one SL or BT exceedance. The other 17 cores did not contain any samples with SL or BT exceedances. Figure 5 provides a summary of all the detected and undetected SL exceedances from all analytical results. The non-native surface intervals of C-3 and C-11 had nondetected exceedances of the SL for total chlordane (when all five total chlordane constituents were reported at the lower method detection limit). There were three cores with detected exceedances of SLs: C-7 was above the SL for hexachlorobutadiene in the 2-4 foot (native) interval, C-10 was above the BT for TBT in the 2-4 foot (non-native) interval, and C-12 was above the SL for total PCBs in the non-native surface interval.

Dioxin/furan results are summarized in Table 7. Elevated dioxins/furans were found throughout the mouth and middle sections of the waterway. Dioxin concentrations above 4 pptr TEQ and less than 10 pptr TEQ were found in non-native samples in cores C-7, C-8, C-10, C-11 and C-12. Dioxin concentrations above the bioaccumulation trigger of 10 pptr TEQ were found in three cores: C-12, C-13 and C-15. As mentioned above, additional samples from C-12 and C-13 were triggered in Round 2 to identify the vertical extent of elevated dioxin/furan concentrations. In all cores, samples were analyzed at deeper intervals until dioxin/furan concentrations less than 4 pptr TEQ were found. All native samples contained dioxins/furans less than 4 pptr TEQ, and all samples (both non-native and native) from the head of the waterway had dioxin/furan concentrations less than 4 pptr TEQ.

7. <u>DMMP Advisory Suitability Evaluation</u>. A DMMP suitability determination is typically based solely on the evaluation guidelines found in the DMMP User Manual current at the time of testing. However, the dredged material evaluation guidelines used by the DMMP agencies are constantly evolving as technological and scientific advances are made. Those changes could include updates to the bioaccumulation triggers or testing guidelines. However, there are no such changes currently pending. Therefore the DMMP agencies used the current evaluation guidelines to determine the potential suitability of Blair Waterway sediments for open-water disposal.

Tables 8 and 9 present the results of the DMMP evaluation, along with the rationale for determining the potential suitability or unsuitability of each sample for open-water disposal. In these tables, samples were separated into those identified as native sediment (Table 9) and those identified as non-native or undetermined sediment (Table 8). Sample ID refers to the intervals of sediment core starting with A at the top of each core. For each station/interval tested, one of the following determinations was provided:

Suitable – No SL or BT exceedances; dioxins/furans below 4 pptr TEQ.

Likely Suitable – No SL or BT exceedances occurred; dioxins/furans below 10 pptr TEQ but above 4 pptr TEQ.

Possibly Suitable – Detected or undetected SL exceedances and dioxins/furans < 10 pptr TEQ.

Unsuitable – BT exceedance and/or dioxins/furans > 10 pptr TEQ, with or without other SL exceedance.

To facilitate the use of this information in the estimation of quantities of suitable and unsuitable dredged material for the Tacoma Harbor Deepening feasibility study, the DMMP agencies adopted a probability approach for the Blair Waterway. Sampling stations with similar suitability characteristics in the non-native intervals of sediment were grouped to form three distinct sections within the waterway (Table 8; Figure 6) regardless of whether they were on the sideslope or in the channel. To establish a logical segmentation of the waterway for planning purposes, numerical probabilities were assigned to each station and those probabilities averaged and rounded down to the nearest 5%. Numeric probabilities were assigned as follows:

- suitable = 100% probability of being suitable for open-water disposal
- likely suitable = 75%
- possibly suitable = 50%
- unsuitable = 0%

At the head of the waterway all samples in all cores were below SLs and dioxins/furans were less than 4 pptr TEQ. All of this material was classified as suitable and the average suitability probability was 100%.

The middle portion of the waterway had the lowest suitability probabilities. Three cores, C-12, C-13 and C-15 contained unsuitable material due to dioxins/furans above 10 pptr TEQ and one core, C-10, contained unsuitable material due to TBT. One sample in core C-11 contained possibly unsuitable material due to a non-detect exceedance of total chlordane and dioxins/furans between 4-10 pptr TEQ. In all of these cores, lower intervals of the core were analyzed until clean material was confirmed. Overall, the average suitability probability for surface non-native material in the middle portion of the waterway is 63.6%.

The mouth of the waterway was largely suitable, with only one sample (C-3) with a possibly suitable classification due to a single non-detect exceedance of total chlordane. The average suitability probability for surface non-native material in the mouth of the waterway is 92.9%.

The same probability approach was applied to the native sediments. Among all sediments throughout the waterway that were identified as native material, only one sample was classified as possibly suitable (due to a single exceedance of hexachlorobutadiene in C-7) and the rest were classified as suitable. Therefore, the average suitability probability of identified native sediments is 98.1%

The predictive ability of the feasibility-level sediment characterization completed for the deepening study does not match the mathematical precision of the calculated probability averages. Therefore, the calculated averages were rounded down to the nearest 5%. The rounded probability values are found in Tables 8 and 9 and illustrated in Figures 6 and 7.

In summary, the non-native sediments showed a range of contaminant concentrations. The probability of suitability for open-water disposal was estimated by the DMMP agencies in the non-native sediments to be 90% suitable in mouth, 60% suitable in the middle and 100% suitable in the head, as shown in

Figure 6. Nearly all identified native sediment is suitable for open-water disposal, with an average probability of being suitable for open-water disposal of 95%.

This advisory determination only applies to the areas identified and documented in this document. Additional areas not considered here, especially in the sideslopes and/or near outfalls, may have a different sediment contaminant profile. The results from the sideslope samples in this study as well as historical information from cutback projects throughout Blair Waterway give a strong indication that material outside of the navigation channel (i.e. closer to shore) considered in this advisory memo is more likely to be unsuitable. The DMMP agencies recommend a more conservative assumption of the probability of suitability for areas outside the areas evaluated in this advisory memo.

8. Suitability for Beneficial Use. The DMMP agencies do not determine the suitability of material for beneficial use projects. It is up to the project proponents, the site receiving the material, and other interested stakeholders including applicable resource agencies and Tribes to determine the physical and chemical suitability of dredged materials for a beneficial use site.

However, typically the first step taken to evaluate sediments for beneficial use is comparison against the State's Sediment Quality Standards (SQS), which has been done in Tables 10 and 11. Many of the SQS standards are in organic carbon normalized units. Ecology's recommendation for organic carbon normalizing is to only use this approach for sediments with TOC concentrations between 0.5 – 3.5% (Ecology, 2017). Samples were divided into two groups, those with TOC between 0.5 – 3.5% (12 samples) and those with TOC less than 0.5% (51 samples). There were no samples with TOC greater than 3.5%.

For the 12 samples with TOC greater than 0.5%, results are compared to SQS and are shown in Table 10. Non-detect results for two chemicals, 1,2,4-trichlorobenzene and hexachlorobenzene, were above the SQS as initially reported by the laboratory. As is typically done by the DMMP agencies when there is a non-detect exceedance, the results are re-evaluated by the analytical laboratory to see if there was any evidence that the compounds of interest were detected at levels between the method detection limit (MDL) and the method reporting limit (MRL). If there is no evidence, then the results are reported as non-detect at the lower MDL. For these samples (and all samples in the project) there was no evidence that 1,2,4-trichlorobenzene or hexachlorobenzene were detected above the MDL, so the results for these two compounds were reported at the lower level, as indicated in Table 10.

11 of the 12 samples in Table 10 were less than the SQS. Sample C-12-A exceeds the SQS for PCBs and is not suitable for beneficial use. All other samples are below SQS, indicating that they would likely be suitable for beneficial use.

For the 51 samples with TOC less than 0.5%, results are compared to the dry weight based SQS values and are shown in Table 11. The dry-weight SQS values are based on the same apparent effects thresholds (AET) as the DMMP SLs, and are the same for all but two chemicals. The dry-weight SQS for pentachlorophenol is 360 µg/kg, lower than the DMMP SL of 400 µg/kg, and the dry-weight SQS for acenaphthylene is 1300 µg/kg, higher than the DMMP SL of 560 µg/kg. With only one exception, all samples for all chemicals, including pentachlorophenol, are less than the dry-weight SQS, indicating these sediments would likely be suitable for beneficial use. Sample C-7-B had a

detected concentration of hexachlorobutadiene above the dry-weight SQS, indicating that this material is likely not suitable for beneficial use.

Comparison to SQS is not the only consideration in assessing beneficial use. Based on initial coordination with other resource agencies and the Puyallup Tribe, the following assumptions were also taken into consideration:

- If material is unsuitable for the Commencement Bay open-water disposal site then it is also unsuitable for beneficial use
- NMFS' proposed PAH level for the protection of fish of 2,000 µg/kg[1] is appropriate for aquatic beneficial use
- Only material with dioxin less than 4 pptr TEQ is appropriate for beneficial use

Table 12 shows the average percent likelihood of suitability for beneficial use of this material based on all these considerations. The results are summarized below:

Table 12. Summary of Beneficial Use Suitability for Tacoma Harbor

Area	Average percent likelihood of suitability for beneficial use
Mouth	85%
Middle	40%
Head	100%
Native	95%

9. Sediment Exposed by Dredging. The sediment to be exposed by dredging must either meet the State of Washington Sediment Quality Standards (SQS) or the State's Antidegradation standard (Ecology, 2013) as outlined by DMMP guidance (DMMP, 2008).

This sediment core characterization in the Blair Waterway clearly demonstrated that contamination decreases with depth. With the exception of cores C-7, C-10, and C-13, the highest COC concentrations were found at the top of the core with contamination decreasing with depth. For C-7, there was elevated hexachlorobutadiene in the 2-4 foot layer that was not observed at the surface, but the layer below, representing -54 to -56 ft MLLW, was less than SL and SQS. For C-10, TBT was elevated (but below screening levels) in the 2-4 foot layer but decreased with depth and was no longer detected at depths below -53 ft MLLW. For the sideslope sample C-13, dioxins appeared to be highest in the 4-6 foot layer (11.88 pptr TEQ), and was below 4 pptr TEQ in the 8-10 foot layer (-47 to -49 ft MLLW).

At the current level of sampling density and dredge design, it is difficult to determine antidegradation within the side slope regions, although the data gathered in this characterization indicates that antidegradation can be met without need for cover. This uncertainty is being addressed by new rankings for sideslopes during full characterization.

The available information indicates that it is highly likely that antidegradation will be met in the

[1] The National Marine Fisheries Service (NMFS) proposed a screening level of 2,000 µg/kg total PAH for the protection of fish at the Regional Sediment Evaluation Team annual meeting in November 2014.

navigation channel once native material is reached.

10. Underlying Assumptions. Several key assumptions were made by the DMMP agencies in conducting this advisory suitability evaluation. These assumptions are discussed in the following paragraphs.

Dioxins/Furans - Samples with concentrations of dioxins/furans at or below 4 pptr TEQ were deemed suitable for open-water disposal, as this concentration is the site management objective for nondispersive disposal sites. Concentrations of dioxins/furans between 4 and 10 pptr TEQ were considered likely to be eligible for open-water disposal because there is a large volume of clean native material that would be dredged during deepening, and this material can be used to bring the project volume-weighted average below the site management objective of 4 pptr TEQ. USACE planners will need to plan for the additional volume of clean sediment required to meet the volume-weighted average guidelines at the Commencement Bay disposal site. This will likely reduce the amount of material available for beneficial use. It was also assumed that dredging and disposal will be sequenced such that suitable dredged material with relatively higher concentrations of dioxins/furans will be placed first at the Commencement Bay site, followed by native material with very low concentrations, thereby leaving a surface layer of sediment at the disposal site with a low dioxin/furan concentration. Dioxin/furan concentrations above 10 pptr TEQ were determined to be unsuitable for open-water disposal. DMMUs with dioxin/furan concentrations above 10 pptr TEQ would need to pass bioaccumulation testing in order to qualify for open-water disposal. The DMMP agencies made the conservative assumption for the purpose of this evaluation that either bioaccumulation testing for dioxins/furans would not be conducted or, if tested, these samples would fail bioaccumulation testing.

Bioassays – Bioassay testing was not conducted for this advisory-level characterization due to schedule restrictions. Therefore the assignment of potential suitability of samples with SL exceedances was based on the experience and best professional judgment of the DMMP agencies assuming that bioassays would be conducted during full characterization. There were only two samples with SL exceedances with no other exceedances (i.e. they did not have dioxin above 4 pptr TEQ or other BT exceedance) – one detected exceedance of hexachlorobutadiene and one non-detect exceedance of total chlordane. Based on prior experience testing sediments with minor SL exceedances of these chemicals, the DMMP assigned both of these samples a 50% chance of being suitable for open-water disposal.

11. DMMP Guidance for Full Characterization and Dredging. As indicated previously, full characterization of potential dredged material from the Blair Waterway must be completed in order to complete a suitability determination for this project prior to dredging. The testing results from this feasibility study indicated that the appropriate ranking for full characterization is variable throughout the waterway. Therefore, unless new information becomes available in the interim, sampling requirements for full characterization will be based on rank according to the following chart:

Sediment Category	Waterway Area	Rank
Sideslopes	Head	Moderate to High
	Middle	High
	Mouth	Moderate to High
Surface material	Head	Low-Moderate
	Middle	Moderate to High
	Mouth	Low-Moderate to Moderate
Confirmed native material	Throughout waterway	No further testing, except for confirmatory testing around C-7 and where full characterization identifies SL/BT failures at the native/non-native boundary

Two of the three side slope cores (C12, C13) were determined to be unsuitable without further testing (bioaccumulation for dioxins for both; PCB toxicity for C12). Since most of the nearshore areas are not often dredged, and are closer to sources of contamination, DMMP is assigning ranks to the sideslopes that are higher than originally assigned for sampling for this advisory determination. For the full determination, it will be important to have sufficient dredge design details to inform where sideslopes will either be dredged or will slough due to dredging along the base of the slope, so that appropriate sediment locations and depths are characterized.

The concentrations of chemicals of concern in the identified native material were far below the DMMP SLs, with only one exception. There was a detected exceedance of SL for one chemical in a single sample in the middle section of the waterway (C-7). Therefore, throughout the project area, confirmed native sediment will be assumed to be suitable for open-water disposal by the DMMP agencies and will be exempt from analysis during full characterization with two exceptions: native material around C-7 which will require confirmatory testing to verify its suitability, and where full characterization identifies SL/BT failures at the native/non-native boundary. Samples from native material DMMUs will need to be collected and archived pending results of overlying DMMUs.

There is also a high probability of encountering BT exceedances for dioxin, and to a lesser extent TBT, during full characterization, particularly in the middle portion of the waterway and in sideslopes. Bioaccumulation testing requires large volumes of sediment and the testing is costly. Whether and when to collect adequate volumes of sediment to conduct this testing will be up to USACE and the Port of Tacoma.

DMMUs that are found unsuitable for open-water disposal will need to be disposed in an appropriate upland facility. To ensure that the unsuitable material is separated from the suitable material during dredging, a minimum one-foot vertical buffer and an appropriate horizontal buffer will need to be added to the unsuitable portions of the dredge prism. This means that in areas where the top four feet are found unsuitable for open-water disposal, at minimum the top five feet of sediment will need to be dredged and taken upland. The one-foot vertical buffer is not the same as the overdepth allowance. If the dredging contract includes one foot of overdepth, the dredge cut would be five feet, plus one foot of overdepth. USACE planners will need to include the horizontal and vertical buffers in volume calculations for upland disposal.

Since the last deepening of the Blair Waterway in 2000/2001, maintenance dredging has not occurred in the navigation channel, and has occurred in the berthing areas three times for different areas: at GP Gypsum, Husky Terminal and Washington United Terminal. Therefore, there is a good chance that debris will be encountered during dredging. This debris must be removed from sediment prior to disposal at the Commencement Bay open-water disposal site. The dredger will likely be required to screen the surface non-native sediments in areas with suitable material using a grid with a maximum opening size of 12 inches by 12 inches. Native material and material found unsuitable for open-water disposal will not need to be screened. However, if large (greater than 12 inches by 12 inches) woody debris or other large natural debris is found in native sediments, this debris will need to be removed from the dredged material prior to disposal at the Commencement Bay open-water disposal site.

The DMMP agencies are in the process of revising the disposal site monitoring program for all disposal sites in Puget Sound. The process is expected to be completed within a few years, but there are many unknowns at this time. Currently the following changes are reasonably likely to have an impact on future use of the disposal sites:

Disposal tipping fees - DNR is likely to pursue an increase in the disposal tipping fee within the next 5-10 years. The current tipping fee of $0.45/cy was last increased in 1994. It is premature to estimate what the increased fee might be.

Preventing off-site migration of dredged material - Off-site migration has historically been an issue at the Commencement Bay disposal site, even resulting in the need to temporarily shut down use of the site after significant off-site migration. For projects disposing of a large amount of material in a short period of time there is an increased concern over off-site migration.

In 2009 the DMMP agencies completed a supplemental EIS (SAIC, 2009) for reauthorization of the Commencement Bay open-water disposal site. The preferred alternative chosen for management of the disposal site, Alternative 2, included increasing the cumulative disposal volume of the site to 23 million cubic yards (mcy) with three coordinate shifts within the target area and consideration of the need to implement institutional controls on disposal to better manage the site. Institutional controls considered and studied included specific requirements for tug/barge orientation or direction during disposal and disposal during a specified portion of the tidal cycle.

Due to the potential large volume of material from this project that could be disposed at the Commencement Bay site, additional measures will need to be taken to ensure that the disposed material is not migrating off-site. The DMMP agencies recommend physical monitoring of the site before the start of the project to get a baseline and subsequent physical monitoring of the site after every 500,000 cy disposed or at the end of each dredging year, whichever is more frequent. Physical monitoring includes a multibeam bathymetric survey and SPI monitoring.

If results of the physical monitoring indicate that significant off-site migration is occurring, the DMMP agencies will consider implementation of institutional controls to better manage the site.

12. References.

Anchor, 2019a. *Sampling and Analysis Plan – Dredged Material Characterization – Tacoma Harbor Deepening Study.* Prepared by Anchor QEA, LLC for Port of Tacoma, February 2019

Anchor, 2019b. *Sediment Characterization Data Report – Dredged Material Characterization – Tacoma Harbor Deepening Study*. Prepared by Anchor QEA, LLC for Northwest Seaport Alliance, April 2019

DMMP, 2018. *Dredged Material Evaluation and Disposal Procedures (Users Manual)*. Prepared by the Seattle District Dredged Material Management Office for the Dredged Material Management Program, December 2018.

DMMP, 2011. *Marine Sediment Quality Screening Levels: Adopting RSET Marine SLs for Use in DMMP.* A Clarification Paper prepared by Laura Inouye (Ecology) and David Fox (USACE) for the Dredged Material Management Program, June 2011.

DMMP, 2010. *Dredged Material Management Program New Interim Guidelines for Dioxins*. December 6, 2010.

DMMP, 2008. *Quality of Post-Dredge Sediment Surfaces (Updated).* A Clarification Paper Prepared by David Fox (USACE), Erika Hoffman (EPA) and Tom Gries (Ecology) for the Dredged Material Management Program, June 2008.

Ecology, 2013. *Sediment Management Standards – Chapter 173-204 WAC*. Washington State Department of Ecology, February 2013.

Ecology, 2017. *Sediment Cleanup User's Manual II (SCUM II), Guidance for Implementing the Cleanup Provisions of the Sediment Management Standards, Chapter 173-204 WAC.* Prepared by the Toxics Cleanup Program, Department of Ecology. Final originally published March 2015, revised December 2017.

SAIC, 2009. *Reauthorization of Dredged Material Management Program Disposal Site at Commencement Bay, Supplemental Environmental Impact Statement.* Prepared by SAIC for the Dredged Material Management Program, August 2009.

10. Agency Signatures.

The signed copy is on file in the Dredged Material Management Office.

Concur:

Date — Kelsey van der Elst - Seattle District Corps of Engineers

Date — Justine Barton - Environmental Protection Agency

Date — Laura Inouye, Ph.D. - Washington Department of Ecology

Date — Abby Barnes - Washington Department of Natural Resources

Copies furnished:

DMMP signatories
Kristine Koch, EPA Superfund RPM
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Dan Berlin, Anchor QEA
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Donald Kramer, USACE Planner
Kristen Kerns, USACE Risk Assessor
Daniel Bernal, USACE Coastal Engineer
Walker Messer, USACE Economist
Kaitlin Whitlock, USACE Biologist

Exhibit A – DMMP Evaluation Procedures

The DMMP evaluation procedures are fully described in DMMP (2018). This exhibit includes information about several key elements relevant for the Blair Waterway suitability evaluation.

Ranking:

For DMMP dredged material evaluations, dredging projects are assigned to one of four possible ranks: high, moderate, low-moderate, or low. These ranks reflect the potential for adverse biological effects or elevated concentrations of chemicals of concern. The higher the rank, the higher the concern, and the more intense the sampling and testing requirements needed to adequately characterize the dredged material. Project or area ranking is based on the available information on chemical and biological-response characteristics of the sediments, as well as the number, kinds, and proximity of chemical sources (existing and historical).

DMMUs:

Tiered testing is conducted for smaller units within the area to be dredged. These units are termed Dredged Material Management Units (DMMUs). A DMMU is the smallest volume of dredged material capable of being dredged independently from adjacent units and for which a separate disposal decision can be made.

Full Characterization:

Full DMMP characterization includes minimum sampling and testing requirements, which are typically based on the rank, volume and depth of the dredging project. For example, in a moderate-ranked area, field samples are restricted to representing no more than 4,000 cubic yards and each DMMU can represent no more than 16,000 cubic yards of dredged material in the surface layer (0-4 feet below mudline). In subsurface sediment (> 4 feet below mudline), field samples are restricted to representing no more than 4,000 cubic yards, but DMMUs can represent up to 24,000 cubic yards, depending on site-specific conditions. Best professional judgment may need to be applied in addressing certain scenarios, for example areas with increasing contamination with depth or adjacent to a cleanup site. Full characterization typically results in a DMMP suitability determination.

Tiered Testing:

The DMMP dredged material suitability determination process consists of four tiers of evaluation and testing. A brief discussion of these tiers follows.

Tier 1 analysis involves the review of existing sediment data and site history, including all potential sources (e.g., outfalls, spills, etc.) for sediment contamination. The Tier 1 evaluation informs the sediment evaluation process for the project.

Tier 2 analysis consists of chemical testing of sediment samples. Table 5 includes the chemicals of concern analyzed in DMMP projects at the time of the Blair Waterway sediment characterization

in 2019. This list includes metals, semivolatiles, pesticides and PCBs, which are all considered standard chemicals of concern. Certain other chemicals of concern, including dioxins/furans and tributyltin, are analyzed in areas that are of concern for these chemicals.

Tier 3 consists of biological testing. DMMUs with exceedances of the chemical screening levels (SLs) or bioaccumulation triggers (BTs) listed in Table 5 require biological testing in Tier 3 to determine their toxicity and/or bioaccumulation potential respectively.

If the Tier 2 analysis indicates that all chemical concentrations are below the SLs and BTs, then no biological testing is necessary. If there is one or more SL exceedance, the DMMU is subjected to a suite of Tier 3 bioassays, consisting of an amphipod mortality test, a larval development test, and the juvenile infaunal growth test. If one or more BT is exceeded, the DMMU is subjected to bioaccumulation testing for the chemical/s exceeding BT.

Tier 4 evaluations are conducted only if standard chemical and biological evaluations are insufficient to determine the suitability of dredged material for open-water disposal. A Tier 4 assessment is a special, non-routine evaluation which might include time-sequenced bioaccumulation or tissue analysis of organisms collected from the area to be dredged. Tier 4 could also include a risk assessment. Tier 4 assessments are rarely needed.

Dioxin Guidelines:

The DMMP agencies implemented revised dioxin/furan guidelines in 2010 for dredged material disposed at the eight multiuser open-water disposal sites in Puget Sound. Implementation of the revised guidelines followed a 3-year study, which included analysis of dioxins/furans in sediment and tissue samples collected from the five non-dispersive sites, as well as determination of background sediment concentrations of dioxins/furans at non-urban sites throughout the Sound (including Hood Canal, the San Juan Islands and the Strait of Juan de Fuca).

The background sediment concentration was determined to be 4 pptr TEQ. The TEQ is the summation of all 17 congeners of dioxins/furans having 2005 World Health Organization Toxic Equivalency Factors. The revised dioxin guidelines for Puget Sound disposal sites are based on this background concentration.

The non-dispersive site management objective is 4 pptr TEQ. DMMUs with dioxin/furan concentrations below 10 pptr TEQ are allowed for disposal as long as the volume-weighted average concentration of dioxins/furans in material from the entire dredging project does not exceed 4 pptr TEQ. DMMUs exceeding 10 pptr may still be placed at non-dispersive sites if they pass bioaccumulation testing that show that the dioxins/furans are not bioavailable. The dioxin concentrations of DMMUs passing bioaccumulation testing are not included in the volume-weighted average.

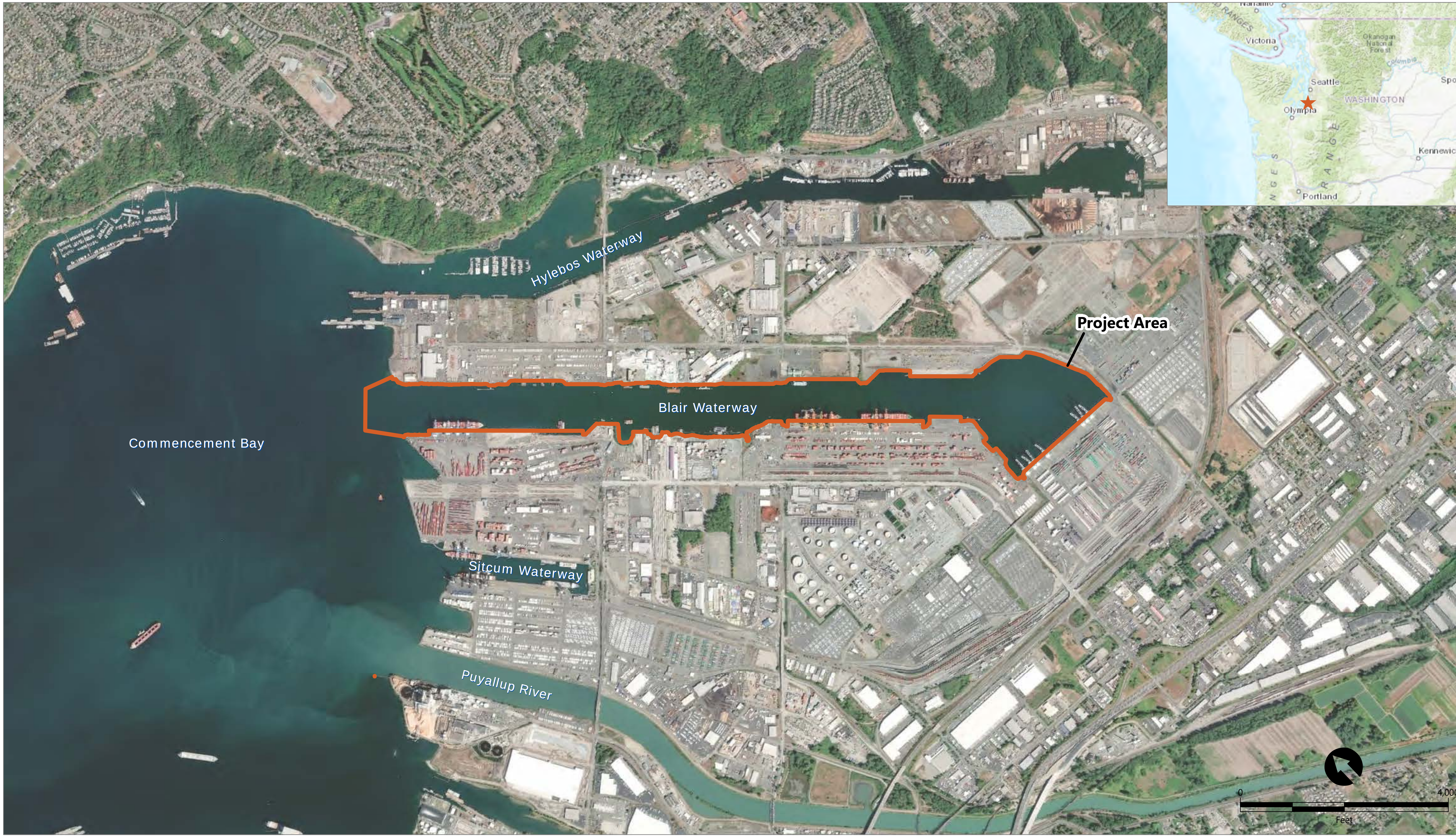
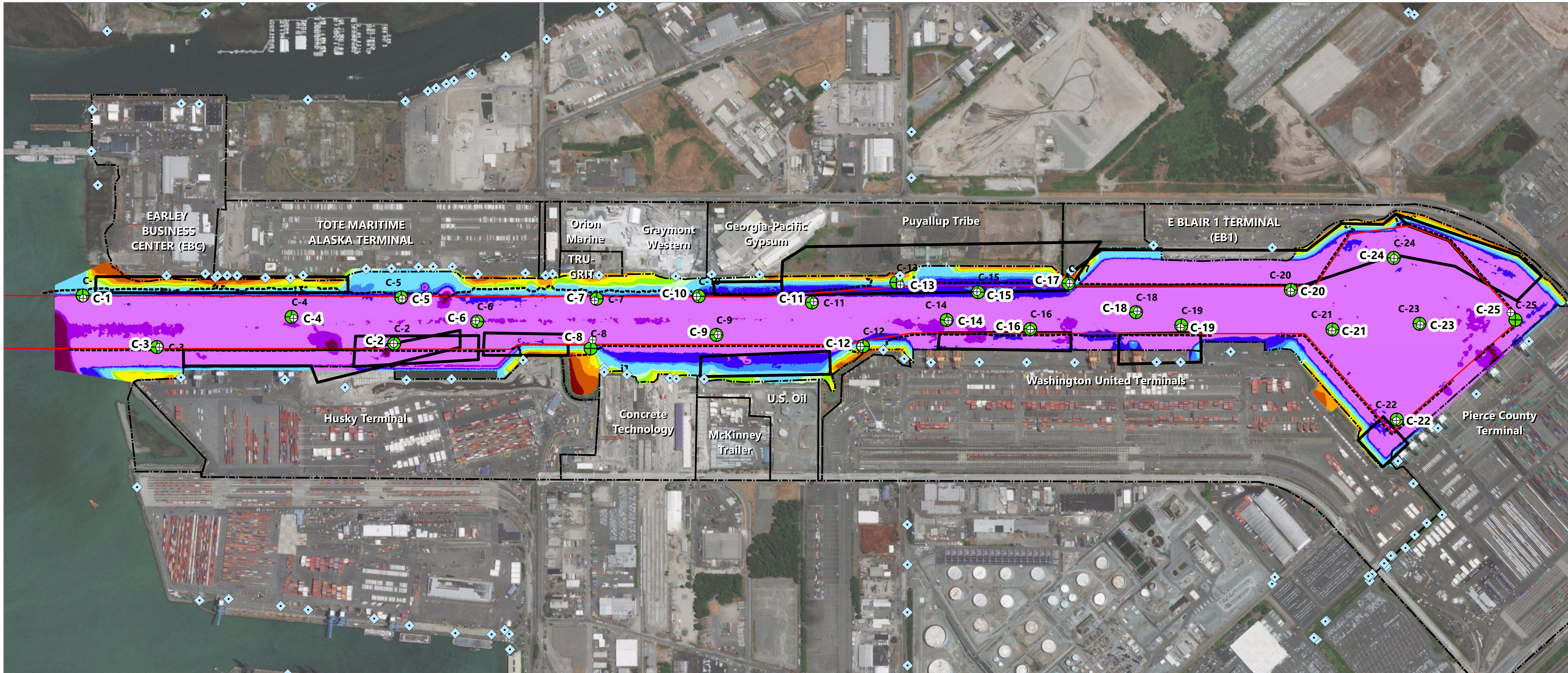


Figure 1
Site Map and Study Area

Tacoma Harbor Deepening Study



LEGEND:

- Outfall
- Actual Sampling Location
- Proposed Sampling Location
- Proposed Navigation Channel Boundary
- Property Boundary
- Historical Dredged Material Characterization Area
- Approximate 2H:1V Daylight Limits

MLLW Elevation (Feet)

- < -58
- -58 - -55
- -55 - -50
- -50 - -45
- -45 - -40
- -40 - -25
- -25 - -20
- -20 - -15
- -15 - -10
- -10 - -5
- -5 - 0
- 0 - 20

NOTES:
1. Bathymetry from November 2018.

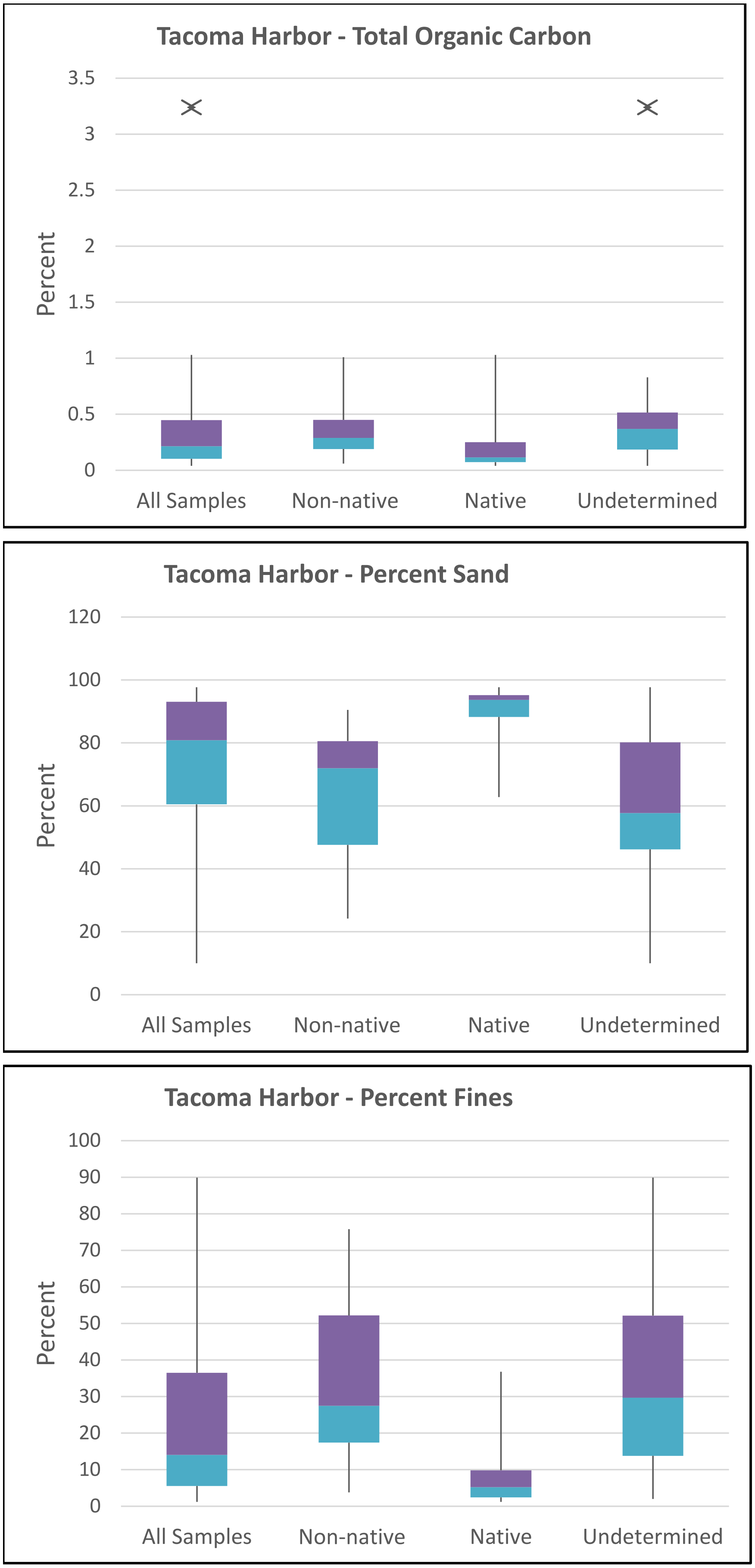
0 2,000
Feet

Figure 2

Proposed and Actual Sampling Locations

Tacoma Harbor Deepening Study

Figure 3. Boxplots of conventionals results from Tacoma Harbor Deepening Study



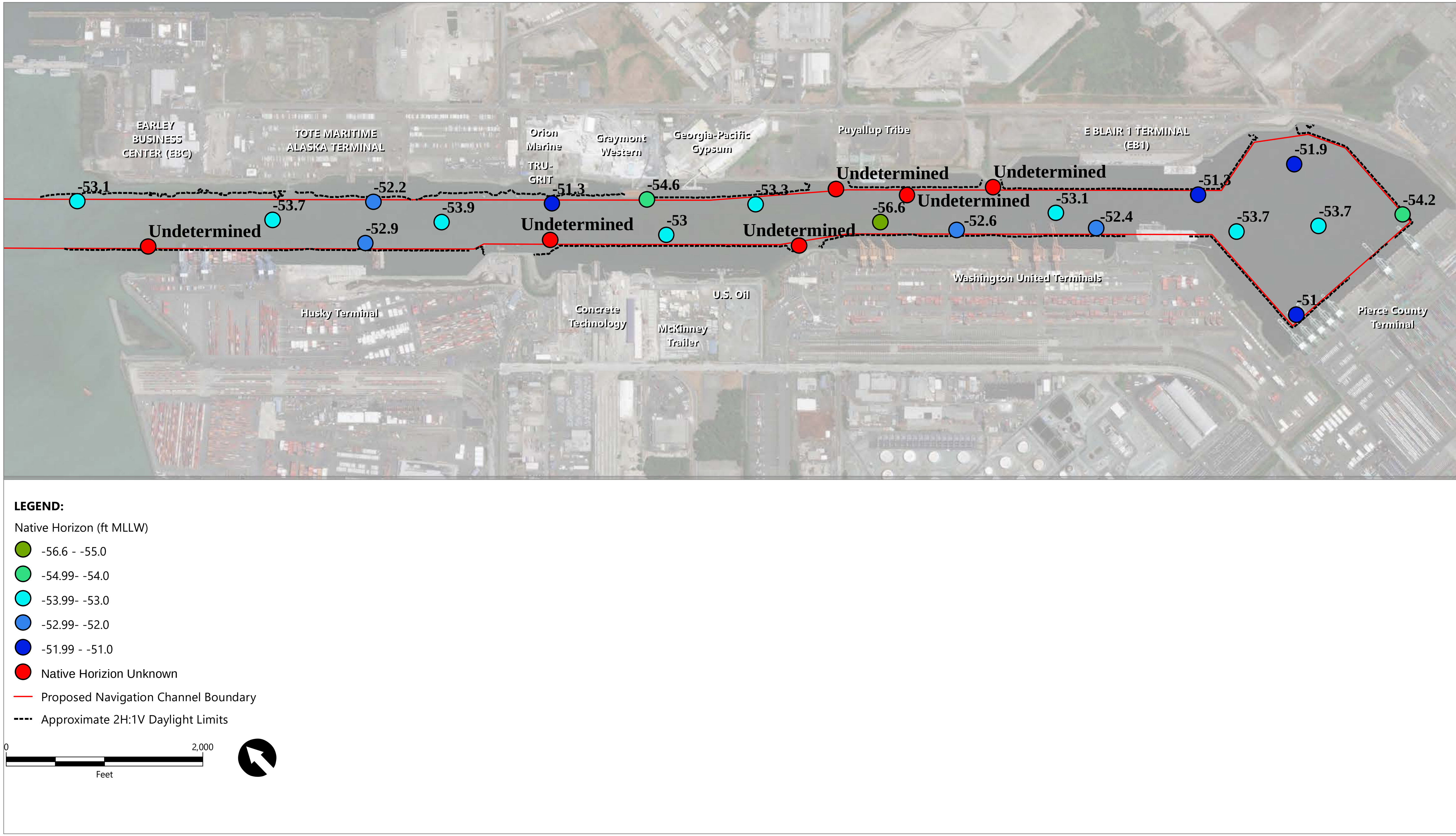
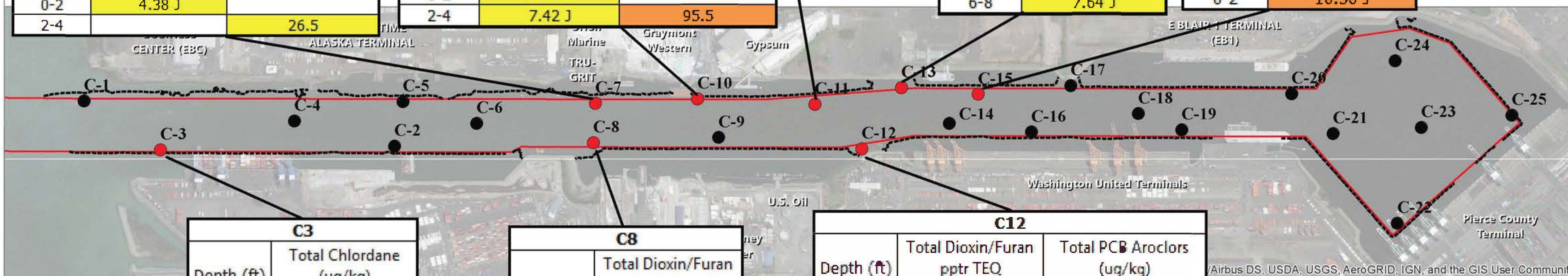


Figure 4
Depth of Native Horizon (ft MLLW)
Tacoma Harbor Deepening Study



C7

Depth (ft)	Total Dioxin/Furan pptr TEQ	Hexachlorobutadiene (ug/kg)
0-2	4.38 J	
2-4		26.5

C10

Depth (ft)	Total Dioxin/Furan pptr TEQ	TBT (ug/kg)
0-2	8.79 J	
2-4	7.42 J	95.5

C11

Depth (ft)	Total Dioxin/Furan pptr TEQ	Total Chlordane (ug/kg)
0-2	5.92 J	21.9 U

C13

Depth (ft)	Total Dioxin/Furan pptr TEQ
0-2	5.34 J
2-4	7.73 J
4-6	11.88 J
6-8	7.64 J

C15

Depth (ft)	Total Dioxin/Furan pptr TEQ
0-2	10.56 J

C3

Depth (ft)	Total Chlordane (ug/kg)
0-2.7	24.9 U

C8

Depth (ft)	Total Dioxin/Furan pptr TEQ
0-2	5.00 J

C12

Depth (ft)	Total Dioxin/Furan pptr TEQ	Total PCB Aroclors (ug/kg)
0-2	56.21 J	173.3 J
2-4	54.47 J	
4-6	17.74 J	

LEGEND:

- Suitable
- Unsuitable
- Proposed Navigation Channel Boundary
- Approximate 2H:1V Daylight Limits

NOTES:
1. Bathymetry from November 2018.

(yellow)	Detected concentration is greater than DMMP SL screening level
(orange)	Detected concentration is greater than DMMP bioaccumulation trigger(BT)
(blue)	Non-detected concentration is above one or more identified screening levels

0 2,000
Feet

Figure 5
Summary of SL/BT Exceedances
Tacoma Harbor Deepening

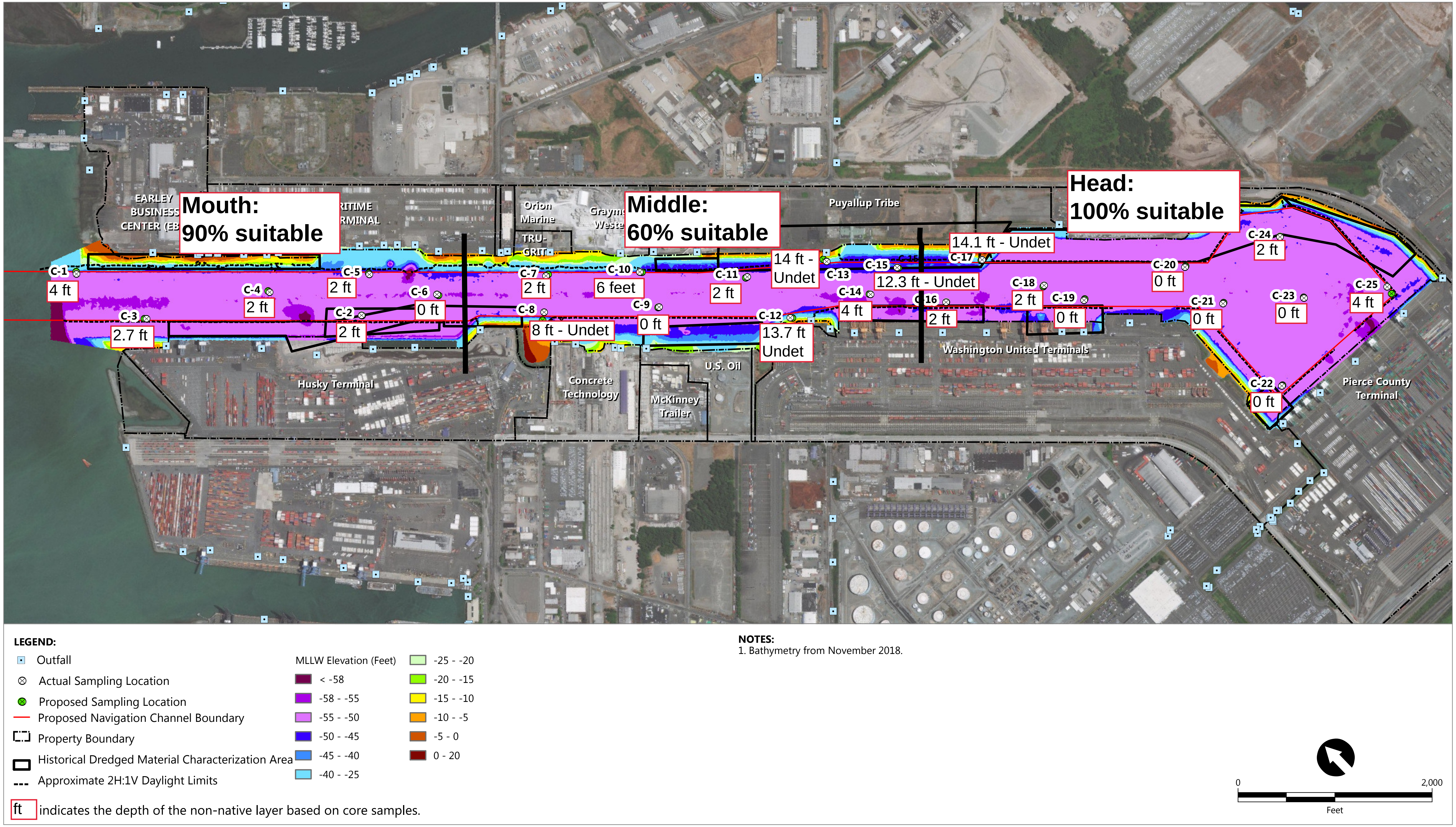
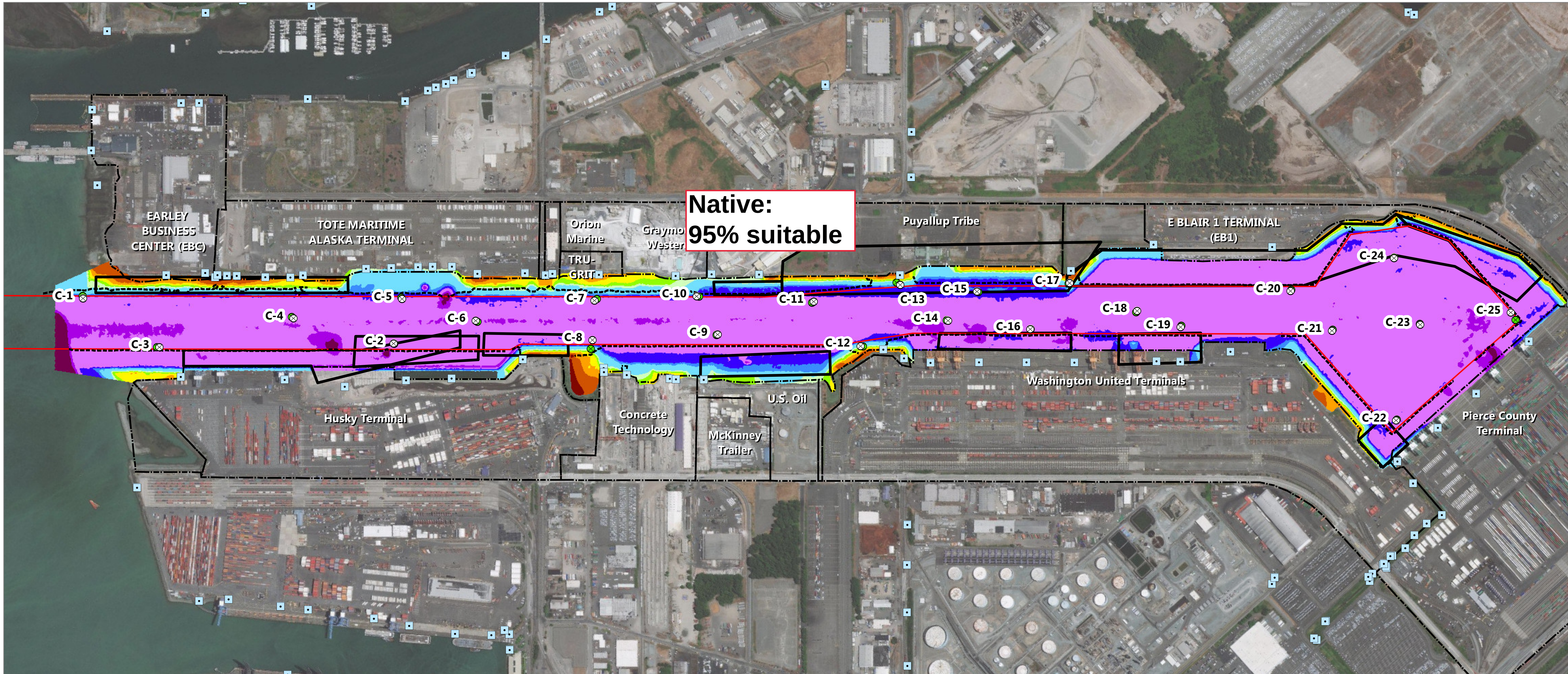


Figure 6

Probability of Suitability for Open-Water Disposal of Non-Native Material

Tacoma Harbor Deepening Study



LEGEND:

- Outfall
- Actual Sampling Location
- Proposed Sampling Location
- Proposed Navigation Channel Boundary
- Property Boundary
- Historical Dredged Material Characterization Area
- Approximate 2H:1V Daylight Limits

MLLW Elevation (Feet)

- < -58
- -58 - -55
- -55 - -50
- -50 - -45
- -45 - -40
- -40 - -25
- -25 - -20
- -20 - -15
- -15 - -10
- -10 - -5
- -5 - 0
- 0 - 20

NOTES:
1. Bathymetry from November 2018.
2. Native interval identified based on core lithology

0 2,000
Feet

Figure 7
Probability of Suitability for Open-Water Disposal for Native Material

Tacoma Harbor Deepening Study

Table 3
Sample Coordinates and Core Collection Data

Station	Date	Location[1] X Coordinate	Location[1] Y Coordinate	Measured Water Depth (feet)	Water Level (ft MLLW)[2]	Mudline Elevation (feet MLLW)	Drive Penetration (feet)	Collection Recovery Measurement (feet)	Recovery[3] (%)	Native Horizon Elevation (feet MLLW)
C-1	2/18/2019	1165157.4	715708.8	61.7	11.8	-49.9	13.5	13.1	97.0	-53.1
C-2	2/18/2019	1166970.1	713363.2	63.2	11.8	-51.4	11.0	9.7	88.2	-52.9
C-3	2/18/2019	1165354.3	714876.0	59.2	6.7	-52.5	12.0	11.9	99.2	Undetermined
C-4	2/18/2019	1166455.2	714192.3	61.5	7.8	-53.7	9.7	9.7	100.0	-53.7
C-5	2/20/2019	1167320.0	713610.6	58.5	7.0	-51.5	14.6	14.0	95.9	-52.2
C-6	2/18/2019	1167677.8	712979.4	65.6	11.7	-53.9	10.0	9.6	96.0	-53.9
C-7	2/20/2019	1168617.2	712335.3	59.2	8.8	-50.4	13.8	13.5	97.8	-51.3
C-8	2/21/2019	1168345.9	712082.2	55.8	3.8	-52.0	11.0	9.5	86.4	Undetermined
C-9	2/20/2019	1169230.3	711295.5	59.4	6.4	-53.0	9.7	9.5	97.9	-53.0
C-10	2/20/2019	1169339.5	711694.4	59.9	10.9	-49.0	13.5	13.4	99.3	-54.6
C-11	2/20/2019	1170100.3	710890.6	56.7	5.1	-51.6	13.9	13.0	93.5	-53.3
C-12	2/22/2019	1170124.7	710281.3	27.7	5.0	-22.7	14.7	14.7	100.0	Undetermined
C-13	2/22/2019	1170797.6	710436.2	48.4	9.4	-39.0	14.7	14.3	97.3	Undetermined
C-14	2/21/2019	1170888.7	709878.9	57.0	4.4	-52.6	9.6	9.2	95.8	-56.6
C-15	2/22/2019	1171275.8	709886.8	57.3	11.7	-45.6	14.7	12.6	85.7	Undetermined
C-16	2/22/2019	1171390.8	709280.6	62.2	11.6	-50.6	9.7	9.6	99.0	-52.6
C-17	2/22/2019	1171960.3	709337.6	31.2	9.5	-21.7	15.0	14.5	96.7	Undetermined
C-18	2/19/2019	1172236.9	708704.3	63.4	11.2	-52.2	9.0	7.1	78.9	-53.1
C-19	2/19/2019	1172424.4	708310.0	62.7	10.3	-52.4	9.6	8.0	83.3	-52.4
C-20	2/19/2019	1173409.8	707832.4	57.0	5.7	-51.3	13.8	13.6	98.6	-51.3
C-21	2/19/2019	1173431.1	707291.8	59.4	5.7	-53.7	9.6	8.6	89.6	-53.7
C-22	2/19/2019	1173278.7	706259.8	56.7	5.7	-51.0	13.2	13.0	98.5	-51.0
C-23	2/21/2019	1174069.4	706752.9	64.1	10.4	-53.7	8.5	7.5	88.2	-53.7
C-24	2/22/2019	1174329.1	707378.1	61.2	10.1	-51.1	9.7	9.3	95.9	-51.9
C-25	2/22/2019	1174764.8	706243.0	56.7	5.3	-51.4	9.7	9.6	99.0	-54.2

Notes

1. Coordinates are in North American Datum of 1983 Washington State Plane South, U.S. feet.

2. Water level obtained using real-time kinematic GPS.

3. Percent recovery calculated based on collection measurement.

MLLW: mean lower low water

Table 4

Core Sampling Intervals and Analysis

Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Round 1 Sampling Status[1]	Round 2 Analyses
C-1	C-1-A-190219	0 to 2	-49.9 to -51.9	Full Suite	
	C-1-B-190219	2 to 4	-51.9 to -53.9	Full Suite	
	C-1-C-190219	4 to 6	-53.9 to -55.9	Full Suite	
	C-1-D-190219	6 to 8	-55.9 to -57.9	Archive	
	C-1-E-190219	8 to 9.9	-57.9 to -59.8	Archive	
C-2	C-2-A-190219	0 to 2	-51.4 to -53.4	Full Suite	
	C-2-B-190219	2 to 4	-53.4 to -55.4	Full Suite	
	C-2-C-190219	4 to 6	-55.4 to -57.4	Archive	Conventionals and TBT
	C-2-D-190219	6 to 8.6	57.4 to -60.0	Archive	Conventionals and TBT
C-3	C-3-A-190218	0 to 2.7	-52.5 to -55.2	Full Suite	
	C-3-B-190218	2.7 to 5.8	-55.2 to -58.3	Full Suite	
	C-3-C-190218	5.8 to 7.5	-58.3 to -60.0	Archive	
	C-3-Z-190218	7.5 to 9.5	-60.0 to -62.0	Archive	
	C-3-Z2-190218	9.5 to 11.2	-62.0 to -63.7	Archive	
C-4	C-4-A-190218	0 to 2	-53.6 to -55.6	Full Suite	
	C-4-B-190218	2 to 4	-55.6 to -57.6	Full Suite	
	C-4-C-190218	4 to 6	-57.6 to -59.6	Archive	
	C-4-Z-190218	6 to 8.2	-59.6 to -61.8	Archive	
C-5	C-5-A-190221	0 to 2	-51.5 to -53.5	Full Suite	
	C-5-B-190221	2 to 4	-53.5 to -55.5	Full Suite	
	C-5-C-190221	4 to 6	-55.5 to -57.5	Archive	
	C-5-D-190221	6 to 8.5	-57.5 to -60.0	Archive	
	C-5-Z-190221	8.5 to 10.5	-60.0 to -62.0	Archive	
C-6	C-6-A-190219	0 to 2	-53.9 to -55.9	Full Suite	
	C-6-B-190219	2 to 4	-55.9 to -57.9	Full Suite	
	C-6-C-190219	4 to 6.1	-57.9 to -60.0	Archive	
	C-6-Z-190219	6.1 to 8.1	60.0 to -62.0	Archive	
C-7	C-7-A-190221	0 to 2	-50.4 to -52.4	Full Suite	
	C-7-B-190221	2 to 4	-52.4 to -54.4	Full Suite	
	C-7-C-190221	4 to 6	-54.4 to -56.4	Full Suite	
	C-7-D-190221	6 to 8	-56.4 to -58.4	Archive	

Table 4
Core Sampling Intervals and Analysis

Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Round 1 Sampling Status[1]	Round 2 Analyses
	C-7-E-190221	8 to 9.6	-58.4 to -60.0	Archive	
	C-7-Z-190221	9.6 to 11.6	-60.0 to -62.0	Archive	
C-8	C-8-A-190221	0 to 2	-52.0 to -54.0	Full Suite	
	C-8-B-190221	2 to 4	-54.0 to -56.0	Full Suite	
	C-8-C-190221	4 to 6	-56.0 to -58.0	Archive	
	C-8-D-190221	6 to 8	-58.0 to -60.0	Archive	
	C-8-Z-190221	8 to 8.3	-60.0 to -60.3	Archive	
C-9	C-9-A-190220	0 to 2	-53.0 to -55.0	Full Suite	
	C-9-B-190220	2 to 4	-55.0 to -57.0	Full Suite	
	C-9-C-190220	4 to 7	-57.0 to -60.0	Archive	
	C-9-Z-190220	7 to 9	-60.0 to -62.0	Archive	
C-10	C-10-A-190221	0 to 2	-49.0 to -51.0	Full Suite	
	C-10-B-190221	2 to 4	-51.0 to -53.0	Full Suite	
	C-10-C-190221	4 to 6	-53.0 to -55.0	Full Suite	
	C-10-D-190221	6 to 8	-55.0 to -57.0	Archive	
	C-10-E-190221	8 to 11	-57.0 to -60.0	Archive	
	C-10-Z-190221	11 to 13	-60.0 to -62.0	Archive	
C-11	C-11-A-190220	0 to 2	-51.6 to -53.6	Full Suite	
	C-11-B-190220	2 to 4	-53.6 to -55.6	Full Suite	
	C-11-C-190220	4 to 6.3	-55.6 to -57.9	Archive	
	C-11-D-190220	6.3 to 8.4	-57.9 to -60.0	Archive	
	C-11-Z-190220	8.4 to 10.4	-60.0 to -62.0	Archive	
C-12	C-12-A-190223	0 to 2	-22.7 to -24.7	Full Suite	
	C-12-B-190223	2 to 4	-24.7 to -26.7	Full Suite	
	C-12-C-190223	4 to 6	-26.7 to -28.7	Full Suite	
	C-12-D-190223	6 to 8	-28.7 to -30.7	Archive	conventionals and D/F
	C-12-E-190223	8 to 10	-30.7 to -32.7	Archive	conventionals and D/F
	C-12-F-190223	10 to 12	-32.7 to -34.7	Archive	
	C-12-G-190223	12 to 13.7	-34.7 to -36.4	Archive	
C-13	C-13-A-190223	0 to 2	-39.0 to -41	Full Suite	
	C-13-B-190223	2 to 4	-41.0 to -43.0	Full Suite	

Table 4
Core Sampling Intervals and Analysis

Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Round 1 Sampling Status[1]	Round 2 Analyses
	C-13-C-190223	4 to 6	-43.0 to -45.0	Full Suite	
	C-13-D-190223	6 to 8	-45.0 to -47.0	Archive	conventionals and D/F
	C-13-E-190223	8 to 10	-47.0 to -49.0	Archive	conventionals and D/F
	C-13-F-190223	10 to 12	-49.0 to -51.0	Archive	
	C-13-G-190223	12 to 14	-51.0 to -53.0	Archive	
C-14	C-14-A-190221	0 to 2	-52.6 to -54.6	Full Suite	
	C-14-B-190221	2 to 4	-54.6 to -56.6	Full Suite	
	C-14-C-190221	4 to 6	-56.6 to -58.6	Archive	
	C-14-C-190221	6 to 7.4	-58.6 to -60.0	Archive	
	C-14-Z-190221	7.4 to 7.6	-60.0 to -60.6	Archive	
C-15	C-15-A-190222	0 to 2	-45.6 to -47.6	Full Suite	
	C-15-B-190222	2 to 4	-47.6 to -49.6	Full Suite	
	C-15-C-190222	4 to 6	-49.6 to -51.6	Full Suite	
	C-15-D-190222	6 to 8	-51.6 to -53.6	Archive	
	C-15-E-190222	8 to 10	-53.6 to -55.6	Archive	
	C-15-F-190222	10 to 12.3	-55.6 to -57.9	Archive	
C-16	C-16-A-190223	0 to 2	-50.6 to -52.6	Full Suite	
	C-16-B-190223	2 to 4	-52.6 to -54.6	Full Suite	
	C-16-C-190223	4 to 6.5	-54.6 to -57.1	Archive	
C-17	C-17-A-190222	0 to 2	-19.7 to -21.7	Full Suite	
	C-17-B-190222	2 to 4	-21.7 to -23.7	Full Suite	
	C-17-C-190222	4 to 8	-23.7 to -25.7	Full Suite	
	C-17-D-190222	8 to 10	-25.7 to -27.7	Archive	
	C-17-E-190222	10 to 12	-27.7 to -29.7	Archive	
	C-17-F-190222	12 to 14.1	-29.7 to -31.8	Archive	
C-18	C-18-A1-190220	0 to 2.3	-52.2 to -54.5	Full Suite	
	C-18-B1-190220	3.9 to 6.3	-54.5 to -56.9	Full Suite	
C-19	C-19-A-190220	0 to 2	-52.4 to -54.4	Full Suite	
	C-19-B-190220	2 to 4	-54.4 to -56.4	Full Suite	
	C-19-C-190220	4 to 6	-56.4 to -58.4	Archive	
	C-19-D-190220	6 to 7.9	-58.4 to -60.3	Archive	

Table 4
Core Sampling Intervals and Analysis

Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Round 1 Sampling Status[1]	Round 2 Analyses
C-20	C-20-A-190219	0 to 2	-51.3 to -53.3	Full Suite	
	C-20-B-190219	2 to 4	-53.3 to -55.3	Full Suite	
	C-20-C-190219	4 to 6	-55.3 to -57.3	Archive	
	C-20-D-190219	6 to 8.7	-57.3 to -60.0	Archive	
	C-20-Z-190219	8.7 to 10.6	-60.0 to -61.9	Archive	
C-21	C-21-A-190219	0 to 2	-53.7 to -55.7	Full Suite	
	C-21-B-190219	2 to 4	-55.7 to -57.7	Full Suite	
	C-21-C-190219	4 to 6.3	-57.7 to -60.0	Archive	
	C-21-Z-190219	6.3 to 8.3	-60.0 to -62.0	Archive	
C-22	C-22-A-190219	0 to 2	-51.0 to -53.0	Full Suite	
	C-22-B-190219	2 to 4	-53.0 to -55.0	Full Suite	
	C-22-C-190219	4 to 6	-55.0 to -57.0	Archive	
	C-22-D-190219	6 to 9	-57.0 to -60.0	Archive	
	C-22-Z-190219	9 to 11	-60.0 to -62.0	Archive	
C-23	C-23-A1-190222	0 to 2	-53.7 to -55.7	Full Suite	
	C-23-B1-190222	2 to 4	-55.7 to -57.7	Full Suite	
C-24	C-24-A-190223	0 to 2	-51.1 to -53.1	Full Suite	
	C-24-B-190223	2 to 4	-53.1 to -55.1	Full Suite	
	C-24-C-190223	4 to 6.6	-55.1 to -57.7	Archive	
C-25	C-25-A-190222	0 to 2	-51.4 to -53.4	Full Suite	
	C-25-B-190222	2 to 4	-53.4 to -55.4	Full Suite	
	C-25-C-190222	4 to 6	-55.4 to -57.4	Archive	
	C-25-D-190222	6 to 8.6	-57.4 to -60.0	Archive	
	C-25-Z-190222	8.6 to 9.3	-60.0 to -60.7	Archive	

Notes:

1. The full suite of testing parameters include semivolatile organic compounds, polycyclic aromatic hydrocarbons, pesticides, polychlorinated biphenyls, metals, sulfide, ammonia, total organic carbon, grain size, total volatile solids, and total solids, dioxins and furans, and tributytin.

MLLW: mean lower low water

Table 5
Sample Results Summary - Conventionals and Physical Tests

Sample ID / Depth / Analyte	Method	C-1-A-190219 0 - 2 ft	C-1-B-190219 2 - 4 ft	C-1-C-190219 4 - 6 ft	C-2-A-190219 0 - 2 ft	C-2-B-190219 2 - 4 ft	C-2-C-190219 4 - 6 ft	C-2-D-190219 6 - 8.6 ft	C-3-A-190218 0 - 2.7 ft	C-3-B-190218 2.7 - 5.8 ft	C-4-A-190218 0 - 2 ft
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	SM4500NH3H	**2.09**	**0.81**	**0.68**	**2.64**	**2.24**	--	--	**3.01**	**8.74**	**0.63**
Sulfide	SM4500S2D	**388**	**104**	**93.3**	**117**	**1.89**	--	--	**529**	**115**	**29.6**
Conventional Parameters (%)											
Total organic carbon	SW9060A	**0.71**	**0.21**	**0.09**	**0.37**	**0.26**	**1.03**	**0.45**	**0.49**	**0.27**	**0.15**
Total solids	SM2540G	**71.88**	**80.16**	**78.63**	**74.57**	**78.53**	**73.42**	**80.56**	**68.43**	**77.92**	**78.72**
Total volatile solids	PSEP-TVS	**2.4**	**1.34**	**1.23**	**1.88**	**1.45**	--	--	**2.1**	**1.56**	**1.35**
Grain Size (%)											
Gravel	PSEP-PS	**0**	**0.3**	**0**	**0.5**	**0.1**	**0.4**	**0.5**	**0**	**0.1**	**0.1**
Sand, very coarse	PSEP-PS	**0.2**	**0.6**	**0.7**	**0.5**	**0.9**	**0.7**	**0.9**	**0.7**	**0.1**	**0.2**
Sand, coarse	PSEP-PS	**3.1**	**9.1**	**8.9**	**7**	**12.9**	**2.9**	**6.2**	**3.2**	**0.2**	**3.3**
Sand, medium	PSEP-PS	**12.5**	**33.4**	**38.9**	**28.6**	**38.4**	**17.6**	**32.3**	**8.3**	**1**	**25**
Sand, fine	PSEP-PS	**13.6**	**25.1**	**31.1**	**24.8**	**18.7**	**36.8**	**38.7**	**15.8**	**26.5**	**46**
Sand, very fine	PSEP-PS	**12.5**	**12.4**	**10.4**	**11.1**	**5.1**	**20.7**	**9.4**	**16**	**42.4**	**16**
Total Sand	PSEP-PS	**41.9**	**80.6**	**90**	**72**	**76**	**78.7**	**87.5**	**44**	**70.2**	**90.5**
Silt, coarse	PSEP-PS	**12.9**	**5.3**	**3.7**	**7.3**	**6.1**	**9.3**	**3.8**	**11.2**	**8**	**4.3**
Silt, medium	PSEP-PS	**14.3**	**4.6**	**1.8**	**6**	**6.7**	**4.5**	**2.5**	**12.9**	**8.6**	**1.3**
Silt, fine	PSEP-PS	**11**	**3.3**	**1.4**	**4.8**	**4.5**	**2.3**	**1.7**	**11.1**	**3.3**	**1**
Silt, very fine	PSEP-PS	**5.6**	**1.6**	**0.7**	**2.6**	**2.5**	**1.4**	**1.1**	**4.7**	**2.4**	**0.5**
Clay, coarse	PSEP-PS	**4.2**	**1.2**	**0.6**	**1.8**	**1.3**	**0.9**	**0.8**	**4.6**	**2**	**0.5**
Clay, medium	PSEP-PS	**3**	**0.9**	**0.4**	**1.5**	**0.8**	**0.7**	**0.5**	**3.6**	**1.6**	**0.4**
Clay, fine	PSEP-PS	**6.9**	**2.2**	**1.3**	**3.5**	**2**	**1.8**	**1.5**	**7.8**	**3.8**	**1.4**
Total Fines	PSEP-PS	**57.9**	**19.1**	**9.9**	**27.5**	**23.9**	**20.9**	**11.9**	**55.9**	**29.7**	**9.4**

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 5
Sample Results Summary - Conventionals and Physical Tests

Analyte / Sample ID / Depth	C-4-B-190218 2 - 4 ft	C-5-A-190221 0 - 2 ft	C-5-B-190221 2 - 4 ft	C-6-A-190219 0 - 2 ft	C-6-B-190219 2 - 4 ft	C-7-A-190221 0 - 2 ft	C-7-B-190221 2 - 4 ft	C-7-C-190221 4 - 6 ft	C-8-A-190221 0 - 2 ft	C-8-B-190221 2 - 4 ft	C-9-A-190220 0 - 2 ft
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	0.5 U	**3.9**	**14.8**	0.41 U	**1.58**	**4.01**	**1.06**	**1.18**	**6.98**	**27.9**	**5.97**
Sulfide	**8.33**	**32.9**	**6.35**	**13.5**	1.11 U	**258**	**7.28**	0.887 U	**153**	**4.52**	0.984 U
Conventional Parameters (%)											
Total organic carbon	**0.12**	**0.28**	**0.74 J**	**0.22**	**0.71**	**0.55**	**0.44**	**0.2**	**0.54**	**0.39**	**0.11**
Total solids	**79.07**	**80.52**	**74.08**	**90.85**	**77.91**	**60.4**	**79.72**	**81.42**	**74.91**	**74.88**	**84.21**
Total volatile solids	**1.07**	**3.39**	**2.45**	**1.36**	**2.26**	**1.33**	**1.57**	**1.28**	**1.95**	**2.13**	**0.92**
Grain Size (%)											
Gravel	**0.3**	**0.1**	**0.5**	**1.1**	**0.5**	**0.4**	**0.3**	**0.2**	**3.6**	**0**	**0.1**
Sand, very coarse	**0.3**	**0.7**	**2.2**	**1**	**0.9**	**0.4**	**0.9**	**0.4**	**0.6**	**0.2**	**0.5**
Sand, coarse	**5.2**	**8.4**	**14.2**	**16.9**	**4.5**	**2.5**	**4.4**	**2.9**	**2**	**0.3**	**8.4**
Sand, medium	**34.2**	**28.9**	**19.1**	**51**	**34.4**	**21.9**	**36.5**	**26.4**	**7**	**0.4**	**35.9**
Sand, fine	**45.5**	**26.2**	**18.7**	**21.5**	**42.8**	**28**	**44.9**	**49.2**	**14.8**	**1.4**	**33**
Sand, very fine	**10.3**	**11.5**	**16.6**	**3.7**	**11.3**	**11.3**	**6.9**	**13.9**	**18.7**	**8.4**	**9.3**
Total Sand	**95.5**	**75.7**	**70.8**	**94.1**	**93.9**	**64.1**	**93.6**	**92.8**	**43.1**	**10.7**	**87.1**
Silt, coarse	4.1 U	**8.5**	**9.6**	**1.4**	**1.1**	**7.9**	**1.5**	**3.1**	**16.3**	**17.7**	**3.8**
Silt, medium	4.1 U	**5.4**	**8**	**1**	**1.2**	**8.4**	**1.1**	**1.1**	**11.7**	**24.6**	**3**
Silt, fine	4.1 U	**3.4**	**3.8**	**0.7**	**1**	**6.3**	**0.8**	**0.6**	**8.1**	**17.4**	**2.3**
Silt, very fine	4.1 U	**2.1**	**2**	**0.4**	**0.5**	**3.9**	**0.6**	**0.3**	**5**	**10.4**	**1.1**
Clay, coarse	4.1 U	**1.4**	**1.4**	**0.4**	**0.2**	**2.8**	**0.5**	**0.4**	**3.5**	**5.8**	**0.5**
Clay, medium	4.1 U	**0.9**	**1**	**0.3**	**0.3**	**1.8**	**0.3**	**0.2**	**2.4**	**4.1**	**0.4**
Clay, fine	4.1 U	**2.5**	**2.7**	**0.7**	**1.2**	**4.6**	**1.4**	**1.2**	**6.4**	**9.3**	**1.5**
Total Fines	4.1 U	**24.2**	**28.5**	**4.9**	**5.5**	**35.7**	**6.2**	**6.9**	**53.4**	**89.3**	**12.6**

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 5
Sample Results Summary - Conventionals and Physical Tests

Sample ID Depth Analyte	C-9-B-190220 2 - 4 ft	C-10-A-190221 0 - 2 ft	C-10-B-190221 2 - 4 ft	C-10-C-190221 4 - 6 ft	C-11-A-190220 0 - 2 ft	C-11-B-190220 2 - 4 ft	C-12-A-190223 0 - 2 ft	C-12-B-190223 2 - 4 ft	C-12-C-190223 4 - 6 ft	C-12-D-190223 6 - 8 ft	C-12-E-190223 8 - 10 ft
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	**36.4**	**8.44**	**8.05**	**11.9**	**4.27**	**0.95**	**3.31**	**4.36**	**12**	--	--
Sulfide	1.03 U	**627**	**592**	0.989 U	**605**	1.12 U	**57.1**	**104**	**113**	--	--
Conventional Parameters (%)											
Total organic carbon	**0.19**	**1.01**	**0.45**	**0.19**	**0.86**	**0.14**	**0.61 J**	**0.37 J**	**0.75 J**	**0.1**	**0.21**
Total solids	**78.65**	**66.64**	**73.29**	**99.27**	**68.52**	**80.63**	**72.61**	**74.39**	**75.94**	**82.52**	**81.81**
Total volatile solids	**1.34**	**2.88**	**1.92**	**1.67**	**2.45**	**1.06**	**2.13**	**2.08**	**1.86**	--	--
Grain Size (%)											
Gravel	**0.2**	**0.7**	**0.1**	**0.2**	**0.2**	**0.3**	**3.5**	**2.9**	**0.6**	**2.8**	**13.7**
Sand, very coarse	**0.3**	**0.2**	**0.2**	**0.5**	**0.4**	**0.3**	**2.5**	**1.8**	**0.5**	**4**	**13.9**
Sand, coarse	**2.7**	**0.9**	**2.1**	**6.5**	**2.5**	**3.9**	**14.5**	**8.5**	**3.5**	**34**	**26.5**
Sand, medium	**9.2**	**5**	**7.2**	**19.8**	**12.5**	**35.6**	**16.9**	**14.2**	**10.5**	**29.5**	**15.9**
Sand, fine	**22**	**12.9**	**15.5**	**20.1**	**20.1**	**43.9**	**13.1**	**17**	**18.8**	**11.8**	**10.6**
Sand, very fine	**28.6**	**12.9**	**19.7**	**12.8**	**12.1**	**9.4**	**10.7**	**12.9**	**15.1**	**4.6**	**8.8**
Total Sand	**62.8**	**31.9**	**44.7**	**59.7**	**47.6**	**93.1**	**57.7**	**54.4**	**48.4**	**83.9**	**75.7**
Silt, coarse	**9.3**	**13.8**	**14.3**	**9.7**	**10.7**	**2**	**9.7**	**9.2**	**10.5**	**3.2**	**3.5**
Silt, medium	**9.2**	**14.5**	**13.5**	**8.9**	**14.2**	**1.1**	**8.2**	**9.9**	**13.3**	**2.7**	**1.7**
Silt, fine	**7.6**	**13.4**	**9.9**	**7.1**	**11.9**	**0.7**	**6.2**	**7.4**	**8.7**	**2.2**	**1.5**
Silt, very fine	**3.5**	**7.5**	**5.1**	**4.1**	**5.8**	**0.6**	**3.9**	**4.6**	**5.5**	**1.5**	**1.2**
Clay, coarse	**2.4**	**5.7**	**3.7**	**3**	**3**	**0.4**	**2.9**	**3.3**	**3.6**	**1.1**	**0.9**
Clay, medium	**1.5**	**3.4**	**2.1**	**1.9**	**1.7**	**0.3**	**2.5**	**2.6**	**2.9**	**0.8**	**0.7**
Clay, fine	**3.3**	**9.2**	**6.7**	**5.5**	**4.9**	**1.5**	**5.4**	**5.7**	**6.4**	**1.8**	**1.1**
Total Fines	**36.8**	**67.5**	**55.3**	**40.2**	**52.2**	**6.6**	**38.8**	**42.7**	**50.9**	**13.3**	**10.6**

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 5
Sample Results Summary - Conventionals and Physical Tests

Analyte / Sample ID / Depth	C-13-A-190223 0 - 2 ft	C-13-B-190223 2 - 4 ft	C-13-C-190223 4 - 6 ft	C-13-D-190223 6 - 8 ft	C-13-E-190223 8 - 10 ft	C-14-A-190221 0 - 2 ft	C-14-B-190221 2 - 4 ft	C-15-A-190222 0 - 2 ft	C-15-B-190222 2 - 4 ft	C-15-C-190222 4 - 6 ft	C-16-A-190223 0 - 2 ft
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	4.85	19.3	23.8	--	--	8.62	20.3	2.33	2.08	2.4	2.82
Sulfide	402	339	5.5	--	--	11.4	1.1 U	224	1.12 U	1.07 U	203
Conventional Parameters (%)											
Total organic carbon	0.59 J	0.39 J	0.18 J	0.19	0.04	0.09	0.15	0.25 J	0.1 J	0.17 J	0.25 J
Total solids	77.45	74.72	83.95	84.57	85.03	86.15	84.18	75.49	82.44	83.22	94.31
Total volatile solids	1.73	1.92	1.12	--	--	0.88	1.27	1.69	1.08	1.23	18.98
Grain Size (%)											
Gravel	24.4	0.9	4.4	7.9	0.2	10.8	1.2	4.3	6.5	1.1	1.4
Sand, very coarse	3.6	1.5	3.8	4	1.7	6.9	3.8	3	5.9	3.5	1.8
Sand, coarse	10.1	8.6	16.1	18.5	18.5	25.9	16.9	14.2	21.2	19.6	13.3
Sand, medium	19.6	18.8	33.2	35.9	56.2	34.3	34.1	31.2	37.9	38.7	40.7
Sand, fine	14.8	15.4	20	14.9	19.9	15.3	23.5	22.3	16.9	20.9	18.7
Sand, very fine	6.5	12.5	8.1	3.4	1.4	2.9	6.9	8.5	4.7	5.8	5.7
Total Sand	54.6	56.8	81.2	76.7	97.7	85.3	85.2	79.2	86.6	88.5	80.2
Silt, coarse	4.2	9.7	4.7	1.6	2 U	0.7	4.6	3.2	2.3	2.8	3.8
Silt, medium	4.3	9	2.6	3.6	2 U	0.5	2.5	3.6	1.1	1.9	3.4
Silt, fine	4.5	7.2	2.1	3.3	2 U	0.6	1.8	4.1	0.8	1.4	4.1
Silt, very fine	2	4.2	1.5	2.4	2 U	0.5	1.3	1.4	0.8	1.1	1.9
Clay, coarse	1.7	3.6	0.9	1.4	2 U	0.5	1	0.9	0.4	0.9	1.3
Clay, medium	1.5	2.7	0.7	1	2 U	0.3	0.8	0.8	0.4	0.6	1.2
Clay, fine	2.9	5.8	1.8	2	2 U	0.7	1.8	2.3	1.2	1.7	2.6
Total Fines	21.1	42.2	14.3	15.3	2 U	3.8	13.8	16.3	7	10.4	18.3

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 5
Sample Results Summary - Conventionals and Physical Tests

Sample ID Depth Analyte	C-16-B-190223 2 - 4 ft	C-17-A-190222 0 - 2 ft	C-17-B-190222 2 - 4 ft	C-17-C-190222 4 - 8 ft	C-18-A1-190220 0 - 2.3 ft	C-18-B1-190220 3.9 - 6.3 ft	C-19-A-190220 0 - 2 ft	C-19-B-190220 2 - 4 ft	C-20-A-190219 0 - 2 ft	C-20-B-190219 2 - 4 ft	C-21-A-190219 0 - 2 ft
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	**1.8**	**9.64**	**24.6**	**21.8**	**1.73**	**0.88**	**0.41**	**0.62**	**3.61**	**3.17**	0.44 U
Sulfide	1.11 U	**491**	1.73 U	1.07 U	**98.7**	0.97 U	1.01 U	**4.57**	**27.1**	1.01 U	**7.09**
Conventional Parameters (%)											
Total organic carbon	**0.05 J**	**0.83 J**	**3.24 J**	**0.39 J**	**0.29 J**	**0.13 J**	**0.09**	**0.1**	**0.08**	**0.04**	**0.49**
Total solids	**82.56**	**66.23**	**52.51**	**72.42**	**79.18**	**89.34**	**96.68**	**84.76**	**83.46**	**88.17**	**86.32**
Total volatile solids	**0.98**	**3.54**	**9.48**	**6.55**	**1.34**	**1.55**	**0.85**	**1.11**	**0.96**	**0.96**	**1.72**
Grain Size (%)											
Gravel	**1.5**	**0**	**0.2**	**0**	**1.1**	**3.1**	**2.1**	**2.5**	**1.1**	**4.7**	**1.1**
Sand, very coarse	**4.1**	**0.8**	**3.1**	**0.1**	**3.7**	**9.1**	**8.8**	**7**	**7.2**	**9.7**	**4.1**
Sand, coarse	**20.2**	**1.3**	**1.7**	**0.4**	**21.6**	**33.5**	**40.9**	**25.7**	**31**	**46.7**	**17.2**
Sand, medium	**55.6**	**2.1**	**1.7**	**1.5**	**36.5**	**44.3**	**33.7**	**33.7**	**32.6**	**31.8**	**43.2**
Sand, fine	**14.1**	**2.5**	**2.4**	**5.6**	**14.9**	**7.3**	**10.4**	**17.7**	**15.4**	**5.5**	**31.1**
Sand, very fine	**1.6**	**3.3**	**5.2**	**21.7**	**4.8**	**0.6**	**1.6**	**3.6**	**6.1**	**0.5**	**2.1**
Total Sand	**95.6**	**10**	**14.1**	**29.3**	**81.5**	**94.8**	**95.4**	**87.7**	**92.3**	**94.2**	**97.7**
Silt, coarse	2.8 U	**5.5**	**6.8**	**20.2**	**3.8**	2 U	2.4 U	**2.3**	**2.5**	1.2 U	1.3 U
Silt, medium	2.8 U	**12.9**	**13.7**	**18.6**	**3.7**	2 U	2.4 U	**2.5**	**1.2**	1.2 U	1.3 U
Silt, fine	2.8 U	**18.7**	**18.5**	**11.3**	**3**	2 U	2.4 U	**1.8**	**0.8**	1.2 U	1.3 U
Silt, very fine	2.8 U	**19.4**	**17**	**7.2**	**2.3**	2 U	2.4 U	**0.9**	**0.5**	1.2 U	1.3 U
Clay, coarse	2.8 U	**13.6**	**10.9**	**4.5**	**1.4**	2 U	2.4 U	**0.5**	**0.4**	1.2 U	1.3 U
Clay, medium	2.8 U	**7.6**	**6.9**	**2.8**	**1.2**	2 U	2.4 U	**0.3**	**0.3**	1.2 U	1.3 U
Clay, fine	2.8 U	**12.2**	**12**	**6**	**2**	2 U	2.4 U	**1.4**	**1**	1.2 U	1.3 U
Total Fines	2.8 U	**89.9**	**85.8**	**70.6**	**17.4**	2 U	2.4 U	**9.7**	**6.7**	1.2 U	1.3 U

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 5
Sample Results Summary - Conventionals and Physical Tests

Sample ID / Depth / Analyte	C-21-B-190219	C-22-A-190219	C-22-B-190219	C-23-A1-190222	C-23-B1-190222	C-24-A-190223	C-24-B-190223	C-25-A-190222	C-25-B-190222
Depth	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Conventional Parameters (mg/kg)									
Ammonia as nitrogen	0.45 U	**1.95**	**2.19**	0.41 U	0.38 U	**1.68**	**1.79**	**36.7**	**41.9**
Sulfide	1.19 U	1.01 U	1.07 U	1.01 U	1.07 U	**1.76**	1 U	1.31 U	1.17 U
Conventional Parameters (%)									
Total organic carbon	**0.11**	**0.07**	**0.04**	**0.07**	**0.04**	**0.06 J**	**0.04 J**	**0.29 J**	**0.44 J**
Total solids	**87**	**91.38**	**90.92**	**91.48**	**90.58**	**84.92**	**90.11**	**77.35**	**75.07**
Total volatile solids	**1.1**	**0.83**	**0.93**	**1.01**	**0.83**	**1.05**	**0.98**	**1.66**	**2.67**
Grain Size (%)									
Gravel	**0.4**	**0.4**	**0.4**	**2.6**	**4.1**	**15.3**	**4.5**	**0.1**	**0.5**
Sand, very coarse	**4.2**	**2.2**	**2.4**	**11.4**	**13.8**	**13.7**	**18.3**	**0.4**	**0.5**
Sand, coarse	**17.3**	**19.9**	**22.9**	**42.4**	**48.7**	**26.9**	**33**	**2**	**2.8**
Sand, medium	**43.5**	**45.3**	**47.6**	**32.9**	**26.9**	**26.7**	**34.2**	**5.3**	**31.1**
Sand, fine	**30.5**	**25.3**	**22.5**	**5.4**	**3.7**	**9.5**	**7.9**	**6.9**	**24.2**
Sand, very fine	**1.6**	**2.6**	**2.1**	**0.8**	**0.6**	**2.4**	**0.6**	**9.6**	**5.9**
Total Sand	**97.1**	**95.3**	**97.5**	**92.9**	**93.7**	**79.2**	**94**	**24.2**	**64.5**
Silt, coarse	2.5 U	**1.4**	2 U	**0.9**	2.1 U	**1.1**	1.4 U	**19.7**	**6.2**
Silt, medium	2.5 U	**0.9**	2 U	**0.6**	2.1 U	**1**	1.4 U	**25.3**	**12.2**
Silt, fine	2.5 U	**0.8**	2 U	**0.9**	2.1 U	**0.9**	1.4 U	**13.8**	**6.9**
Silt, very fine	2.5 U	**0.3**	2 U	**0.7**	2.1 U	**0.7**	1.4 U	**6.4**	**3.6**
Clay, coarse	2.5 U	**0.2**	2 U	**0.5**	2.1 U	**0.5**	1.4 U	**3.1**	**1.9**
Clay, medium	2.5 U	**0.1**	2 U	**0.2**	2.1 U	**0.4**	1.4 U	**2.2**	**1.4**
Clay, fine	2.5 U	**0.6**	2 U	**0.5**	2.1 U	**1.1**	1.4 U	**5.3**	**2.9**
Total Fines	2.5 U	**4.3**	2 U	**4.3**	2.1 U	**5.7**	1.4 U	**75.8**	**35.1**

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	DMMP SL	DMMP BT	C-1-A-190219 0 - 2 ft	C-1-B-190219 2 - 4 ft	C-1-C-190219 4 - 6 ft	C-2-A-190219 0 - 2 ft	C-2-B-190219 2 - 4 ft	C-2-C-190219 4 - 6 ft	C-2-D-190219 6 - 8.6 ft
Metals (mg/kg)									
Antimony	150	--	0.28 UJ	0.23 UJ	0.23 UJ	0.25 UJ	0.24 UJ	--	--
Arsenic	57	507.1	**3.24**	**1.67**	**1.06**	**4.97**	**1.95**	--	--
Cadmium	5.1	--	**0.09 J**	0.11 U	0.12 U	**0.05 J**	**0.05 J**	--	--
Chromium	260	--	**14.7**	**11**	**9.49**	**12.5**	**12.7**	--	--
Copper	390	--	**26.7**	**13.7**	**10.3**	**18.3**	**16.6**	--	--
Lead	450	975	**6.01**	**2.33**	**1.33**	**3.46**	**2.15**	--	--
Mercury	0.41	1.5	**0.0423**	**0.025**	**0.0114 J**	**0.0249 J**	**0.0167 J**	--	--
Selenium	--	3	**0.97**	**0.72**	**0.69**	**0.95**	**1.11**	--	--
Silver	6.1	--	**0.12 J**	**0.06 J**	**0.03 J**	**0.08 J**	**0.05 J**	--	--
Zinc	410	--	**33.3**	**19.3**	**14.9**	**27**	**23.7**	--	--
Organometallic Compounds (µg/kg)									
Tributyltin (ion)	--	73	**0.913 J**	3.42 U	3.49 U	**7.35**	**17.3**	3.6 U	3.43 U
Semivolatile Organics (µg/kg)									
1,2,4-Trichlorobenzene	31	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
1,2-Dichlorobenzene	35	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
1,4-Dichlorobenzene	110	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
2,4-Dimethylphenol	29	--	24.9 UJ	24 UJ	24.1 UJ	24.4 UJ	24.3 UJ	--	--
2-Methylphenol (o-Cresol)	63	--	**3 J**	4.8 U	4.8 U	4.9 U	4.9 U	--	--
4-Methylphenol (p-Cresol)	670	--	**5**	4.8 U	4.8 U	**2.9 J**	4.9 U	--	--
Benzoic acid	650	--	**84.7 J**	95.9 UJ	96.3 UJ	97.5 UJ	97 UJ	--	--
Benzyl alcohol	57	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
bis(2-Ethylhexyl)phthalate	1300	--	49.8 U	47.9 U	48.2 U	48.8 U	48.5 U	--	--
Butylbenzyl phthalate	63	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Diethyl phthalate	200	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Dimethyl phthalate	71	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
Di-n-butyl phthalate	1400	--	**37.3**	**22.5**	**22.4**	**40.6**	**14.9 J**	--	--
Di-n-octyl phthalate	6200	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Hexachlorobenzene	22	168	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
Hexachlorobutadiene	11	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
n-Nitrosodiphenylamine	28	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
Pentachlorophenol	400	504	19.9 UJ	19.2 UJ	19.3 UJ	19.5 UJ	19.4 UJ	--	--
Phenol	420	--	13.5 U	4.8 U	4.8 U	7.8 U	4.9 U	--	--
Polycyclic Aromatic Hydrocarbons (µg/kg)									
2-Methylnaphthalene	670	--	**24.7**	**8.6 J**	19.3 U	19.5 U	**6.4 J**	--	--
Acenaphthene	500	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Acenaphthylene	560	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Anthracene	960	--	**14.8 J**	19.2 U	19.3 U	**7.7 J**	19.4 U	--	--
Benzo(a)anthracene	1300	--	**24.1**	**16.6 J**	19.3 U	**17.5 J**	**5.2 J**	--	--
Benzo(a)pyrene	1600	--	**20.3**	**16.7 J**	19.3 U	**16.3 J**	19.4 U	--	--
Benzo(b,j,k)fluoranthenes	--	--	**57.7**	**35.3 J**	38.5 U	**38.8 J**	38.8 U	--	--
Benzo(g,h,i)perylene	670	--	**14.6 J**	**8 J**	19.3 U	**10.1 J**	19.4 U	--	--
Chrysene	1400	--	**37.5**	**21.2**	19.3 U	**24**	**6.7 J**	--	--
Dibenzo(a,h)anthracene	230	--	**4.4 J**	**3.7 J**	4.8 U	**2.7 J**	4.9 U	--	--
Dibenzofuran	540	--	**8.7 J**	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Fluoranthene	1700	4600	**47.4**	**22**	19.3 U	**32.1**	**7.7 J**	--	--
Fluorene	540	--	**8.3 J**	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Indeno(1,2,3-c,d)pyrene	600	--	**13.4 J**	**7.4 J**	19.3 U	**8.3 J**	19.4 U	--	--
Naphthalene	2100	--	**21.5**	**8.7 J**	19.3 U	**11.7 J**	**5.3 J**	--	--
Phenanthrene	1500	--	**45.7**	**13.6 J**	19.3 U	**24.9**	**13 J**	--	--
Pyrene	2600	11980	**61.5**	**27.1**	19.3 U	**39.5**	**9.3 J**	--	--
Total Benzofluoranthenes (b,j,k) (U = 0)	3200	--	**57.7**	**35.3 J**	38.5 U	**38.8 J**	38.8 U	--	--
Total HPAH (DMMP) (U = 0)[1]	12000	--	**280.9 J**	**158 J**	38.5 U	**189.3 J**	**28.9 J**	--	--
Total LPAH (DMMP) (U = 0)[2]	5200	--	**90.3 J**	**22.3 J**	19.3 U	**44.3 J**	**18.3 J**	--	--
Total PAH (DMMP) (U = 0)	--	--	**371.2 J**	**180.3 J**	38.5 U	**233.6 J**	**47.2 J**	--	--
Pesticides (µg/kg)[3]									
4,4'-DDD (p,p'-DDD)	16	--	0.31 U	0.31 U	0.32 U	0.32 U	0.32 U	--	--
4,4'-DDE (p,p'-DDE)	9	--	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	--	--
4,4'-DDT (p,p'-DDT)	12	--	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	--	--
Aldrin	9.5	--	0.36 U	0.36 U	0.36 U	0.37 U	0.37 U	--	--
Chlordane, alpha- (Chlordane, cis-)	--	--	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	--	--
Chlordane, beta- (Chlordane, trans-)	--	--	2.04 U	0.97 U	0.32 U	0.33 U	0.32 U	--	--
Dieldrin	1.9	--	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	--	--
Heptachlor	1.5	--	0.05 U	0.04 U	0.05 U	0.05 U	0.05 U	--	--
Nonachlor, cis-	--	--	0.2 U	0.2 U	0.21 U	0.21 U	0.21 U	--	--
Nonachlor, trans-	--	--	0.22 U	0.22 U	0.22 U	0.23 U	0.23 U	--	--
Oxychlordane	--	--	0.12 U	0.12 U	0.13 U	0.13 U	0.13 U	--	--
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	--	50	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	--	--
Total DMMP Chlordane (U = 0)[5]	2.8	37	2.04 U	0.97 U	0.32 U	0.33 U	0.32 U	--	--
PCB Aroclors (µg/kg)									
Aroclor 1016	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1221	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1232	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1242	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1248	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1254	--	--	**3 J**	3.9 U	4 U	**2 J**	4 U	--	--
Aroclor 1260	--	--	**2.1 J**	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1262	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1268	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Total DMMP PCB Aroclors (U = 0)	130	--	**5.1 J**	3.9 U	4 U	**2 J**	4 U	--	--
PCB Aroclors (mg/kg-OC)[6]									
Total DMMP PCB Aroclors (U = 0)	--	38	**0.72 J**	1.86 U	4.44 U	**0.54 J**	1.54 U	--	--

Notes:

- Detected concentration is greater than DMMP SL screening level
- Detected concentration is greater than DMMP BT screening level
- Non-detected concentration is above one or more identified screening levels
- TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	C-3-A-190218 0 - 2.7 ft	C-3-B-190218 2.7 - 5.8 ft	C-4-A-190218 0 - 2 ft	C-4-B-190218 2 - 4 ft	C-5-A-190221 0 - 2 ft	C-5-B-190221 2 - 4 ft	C-6-A-190219 0 - 2 ft	C-6-B-190219 2 - 4 ft
Metals (mg/kg)								
Antimony	0.29 UJ	0.25 UJ	0.25 UJ	0.24 UJ	0.23 UJ	0.25 UJ	0.21 UJ	0.26 UJ
Arsenic	**3.7**	**1.77**	**1.12**	**1.01**	**1.59**	**1.63**	**1.14**	**1.41**
Cadmium	**0.06 J**	0.12 U	0.12 U	0.12 U	**0.04 J**	**0.05 J**	**0.12**	0.13 U
Chromium	**12.3**	**10.9**	**11.8**	**10.8**	**11.3**	**12.7**	**9.11**	**11.1**
Copper	**25.5**	**14.9**	**11.9**	**10.8**	**14.4**	**16.9**	**10.3**	**15.6**
Lead	**6.26**	**1.55**	**1.26**	**1.21**	**2.25**	**1.86**	**1.42**	**1.46**
Mercury	**0.0599 J**	0.0231 UJ	0.026 UJ	0.0254 UJ	0.0269 U	0.0227 U	0.0241 U	**0.00982 J**
Selenium	**0.93**	**0.81**	0.61 U	**0.77**	**0.79**	**0.76**	**0.77**	**0.74**
Silver	**0.12 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.06 J**	**0.06 J**	**0.04 J**	**0.06 J**
Zinc	**34.4**	**19.9**	**20**	**19.4**	**21.1**	**24**	**17.9**	**18.8**
Organometallic Compounds (µg/kg)								
Tributyltin (ion)	**2.16 J**	3.54 UJ	3.49 UJ	3.79 UJ	**0.768 J**	3.48 U	**1.05 J**	**0.477 J**
Semivolatile Organics (µg/kg)								
1,2,4-Trichlorobenzene	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
1,2-Dichlorobenzene	4.8 U	4.9 U	4.9 U	4.7 U	5 U	**0.9 J**	5 U	4.9 U
1,4-Dichlorobenzene	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
2,4-Dimethylphenol	24.1 UJ	24.6 UJ	24.3 UJ	23.6 UJ	24.9 U	24.4 U	24.8 UJ	24.6 UJ
2-Methylphenol (o-Cresol)	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
4-Methylphenol (p-Cresol)	**5.4**	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
Benzoic acid	**85.1 J**	**15.8 J**	**16.8 J**	94.3 UJ	**21.2 J**	**56.2 J**	99.1 UJ	**37.8 J**
Benzyl alcohol	**13.4 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
bis(2-Ethylhexyl)phthalate	**29.5 J**	49.2 U	48.6 U	47.1 U	49.8 U	48.9 U	49.5 U	49.2 U
Butylbenzyl phthalate	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Diethyl phthalate	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Dimethyl phthalate	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
Di-n-butyl phthalate	**118**	**69.7**	**96.1**	**108**	19.9 U	23.3 U	**43.4**	**56.1**
Di-n-octyl phthalate	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Hexachlorobenzene	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
Hexachlorobutadiene	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
n-Nitrosodiphenylamine	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
Pentachlorophenol	19.3 UJ	19.7 UJ	19.4 UJ	18.9 UJ	**5.4 J**	**5.5 J**	19.8 UJ	19.7 UJ
Phenol	**30**	6.1 U	5.6 U	4.7 U	6.4 U	8.1 U	5 U	6.4 U
Polycyclic Aromatic Hydrocarbons (µg/kg)								
2-Methylnaphthalene	**18.4 J**	**8 J**	19.4 U	18.9 U	19.9 U	**17.2 J**	19.8 U	**21.3**
Acenaphthene	**7 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Acenaphthylene	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Anthracene	**13.9 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Benzo(a)anthracene	**20.7**	19.7 U	19.4 U	18.9 U	**7.4 J**	**5.2 J**	19.8 U	19.7 U
Benzo(a)pyrene	**26.8**	19.7 U	19.4 U	18.9 U	**8.5 J**	19.5 U	19.8 U	19.7 U
Benzo(b,j,k)fluoranthenes	**75.9**	39.4 U	38.9 U	37.7 U	**26.9 J**	39.1 U	39.6 U	39.3 U
Benzo(g,h,i)perylene	**20.1**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Chrysene	**34.4**	**5.3 J**	19.4 U	18.9 U	**11.7 J**	**7.1 J**	19.8 U	**7.4 J**
Dibenzo(a,h)anthracene	**7.6**	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
Dibenzofuran	**12 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	**5.4 J**
Fluoranthene	**38.3**	19.7 U	19.4 U	18.9 U	**11.9 J**	19.5 U	19.8 U	19.7 U
Fluorene	**11 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Indeno(1,2,3-c,d)pyrene	**16.7 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Naphthalene	**31**	19.7 U	19.4 U	18.9 U	19.9 U	**7.9 J**	19.8 U	**11.1 J**
Phenanthrene	**36.9**	**13 J**	**5.9 J**	18.9 U	**12.9 J**	**19.1 J**	19.8 U	**23.7**
Pyrene	**63.5**	19.7 U	19.4 U	18.9 U	**15.9 J**	19.5 U	**6.3 J**	19.7 U
Total Benzofluoranthenes (b,j,k) (U = 0)	**75.9**	39.4 U	38.9 U	37.7 U	**26.9 J**	39.1 U	39.6 U	39.3 U
Total HPAH (DMMP) (U = 0)[1]	**304 J**	**5.3 J**	38.9 U	37.7 U	**82.3 J**	**12.3 J**	**6.3 J**	**7.4 J**
Total LPAH (DMMP) (U = 0)[2]	**99.8 J**	**13 J**	**5.9 J**	18.9 U	**12.9 J**	**27 J**	19.8 U	**34.8 J**
Total PAH (DMMP) (U = 0)	**403.8 J**	**18.3 J**	**5.9 J**	37.7 U	**95.2 J**	**39.3 J**	**6.3 J**	**42.2 J**
Pesticides (µg/kg)[3]								
4,4'-DDD (p,p'-DDD)	1.59 U	0.32 U	1.58 UJ	1.54 U	0.32 U	0.32 U	0.32 U	0.32 U
4,4'-DDE (p,p'-DDE)	0.67 U	0.13 U	0.67 U	0.65 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	1.62 U	0.32 U	1.6 UJ	1.57 U	0.32 U	0.32 UJ	0.32 U	0.32 U
Aldrin	1.84 U	0.37 U	1.82 U	1.78 U	0.37 U	0.37 U	0.37 U	0.37 U
Chlordane, alpha- (Chlordane, cis-)	0.55 U	0.11 U	0.55 U	0.54 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	24.9 U	0.33 U	1.61 U	1.58 U	0.33 U	0.33 U	0.32 U	0.33 U
Dieldrin	0.57 U	0.11 U	0.57 U	0.55 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.23 U	0.05 U	0.23 U	0.22 U	0.05 U	0.05 U	0.05 U	0.05 U
Nonachlor, cis-	1.04 U	0.21 U	1.04 UJ	1.01 U	0.21 U	0.21 U	0.21 U	0.21 U
Nonachlor, trans-	1.13 U	0.23 U	1.13 UJ	1.1 U	0.23 U	0.23 U	0.23 U	0.23 U
Oxychlordane	0.64 U	0.13 U	0.63 UJ	0.62 U	0.13 U	0.13 U	0.13 U	0.13 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	1.62 U	0.32 U	1.6 UJ	1.57 U	0.32 U	0.32 UJ	0.32 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	24.9 U	0.33 U	1.61 UJ	1.58 U	0.33 U	0.33 U	0.32 U	0.33 U
PCB Aroclors (µg/kg)								
Aroclor 1016	4 U	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1221	4 U	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1232	4 U	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1242	4 U	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1248	4 U	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1254	4 U	4 U	4 U	3.9 U	3.8 U	4 U	**1.9 J**	4 U
Aroclor 1260	**3.8 J**	4 U	4 U	3.9 U	**0.8 J**	4 U	3.9 U	4 U
Aroclor 1262	4 UJ	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1268	4 UJ	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Total DMMP PCB Aroclors (U = 0)	**3.8 J**	4 U	4 U	3.9 U	**0.8 J**	4 U	**1.9 J**	4 U
PCB Aroclors (mg/kg-OC)[6]								
Total DMMP PCB Aroclors (U = 0)	**0.78 J**	1.48 U	2.67 U	3.25 U	**0.29 J**	0.54 U	**0.86 J**	0.56 U

Notes:

Yellow	Detected concentration is greater than DMMP SL screening level
Orange	Detected concentration is greater than DMMP BT screening level
Blue	Non-detected concentration is above one or more identified screening levels
Gray	TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID	C-7-A-190221	C-7-B-190221	C-7-C-190221	C-8-A-190221	C-8-B-190221	C-9-A-190220	C-9-B-190220
Depth	0 - 2 ft	2 - 4 ft	4 - 6 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Analyte							
Metals (mg/kg)							
Antimony	0.32 UJ	0.23 UJ	0.24 UJ	0.26 UJ	0.25 UJ	0.23 UJ	0.24 UJ
Arsenic	**4.52**	**1.76**	**1.39**	**4.3**	**2.66**	**2.08**	**2.58**
Cadmium	**0.08 J**	0.12 U	0.12 U	**0.07 J**	**0.07 J**	0.11 U	**0.09 J**
Chromium	**16.3**	**8.75**	**9.6**	**13.6**	**16.8**	**11.3**	**11.8**
Copper	**25.2**	**10.1**	**9.06**	**24.4**	**28.3**	**10.7**	**14.4**
Lead	**6.14**	**1.11**	**1.06**	**5.97**	**3.39**	**1.25**	**1.61**
Mercury	**0.0278 J**	0.0266 U	0.0214 U	**0.0351 J**	**0.0183 J**	0.0217 U	**0.00517 J**
Selenium	**1.05**	**0.66**	**0.56 J**	**0.89**	**0.94**	**0.76**	**0.84**
Silver	**0.11 J**	**0.04 J**	**0.03 J**	**0.11 J**	**0.09 J**	**0.04 J**	**0.06 J**
Zinc	**37.2**	**16.4**	**16.7**	**34.1**	**32.1**	**18**	**19.7**
Organometallic Compounds (µg/kg)							
Tributyltin (ion)	**2.55 J**	3.45 U	3.76 U	**3.45 J**	3.65 U	3.85 UJ	3.79 UJ
Semivolatile Organics (µg/kg)							
1,2,4-Trichlorobenzene	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
1,2-Dichlorobenzene	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
1,4-Dichlorobenzene	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
2,4-Dimethylphenol	24.8 U	24.3 U	24.7 U	24.4 U	24.9 U	24.8 UJ	23.8 UJ
2-Methylphenol (o-Cresol)	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
4-Methylphenol (p-Cresol)	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
Benzoic acid	**26.5 J**	97.1 U	98.8 U	**37.1 J**	99.5 U	99.1 UJ	95.3 UJ
Benzyl alcohol	19.9 U	19.4 U	19.8 U	19.5 U	19.9 U	**10.1 J**	**9.7 J**
bis(2-Ethylhexyl)phthalate	**29.9 J**	48.6 U	49.4 U	48.8 U	49.8 U	49.5 U	47.7 U
Butylbenzyl phthalate	19.9 U	19.4 U	19.8 U	19.5 U	19.9 U	19.8 U	19.1 U
Diethyl phthalate	19.9 U	19.4 U	25.5 U	67 U	27.7 U	19.8 U	19.1 U
Dimethyl phthalate	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
Di-n-butyl phthalate	48.3 U	19.4 U	30.6 U	19.5 U	19.9 U	**23.4**	**40.5**
Di-n-octyl phthalate	19.9 U	19.4 U	19.8 U	19.5 U	19.9 U	19.8 U	19.1 U
Hexachlorobenzene	5 U	**3 J**	4.9 U	4.9 U	5 U	5 U	4.8 U
Hexachlorobutadiene	5 U	**26.5**	4.9 U	4.9 U	5 U	5 U	4.8 U
n-Nitrosodiphenylamine	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
Pentachlorophenol	19.9 UJ	19.4 UJ	19.8 UJ	19.5 UJ	19.9 UJ	19.8 UJ	19.1 UJ
Phenol	6.2 U	5.4 U	4.9 U	4.9 U	5 U	5 U	5.3 U
Polycyclic Aromatic Hydrocarbons (µg/kg)							
2-Methylnaphthalene	19.9 U	**7.8 J**	**9.8 J**	**35.1**	**9.8 J**	19.8 U	19.1 U
Acenaphthene	19.9 U	19.4 U	19.8 U	**7.7 J**	19.9 U	19.8 U	19.1 U
Acenaphthylene	19.9 U	19.4 U	19.8 U	**6.4 J**	19.9 U	19.8 U	19.1 U
Anthracene	**13.2 J**	19.4 U	19.8 U	**20.1**	19.9 U	19.8 U	19.1 U
Benzo(a)anthracene	**29.8**	19.4 U	19.8 U	**38.4**	**5.4 J**	19.8 U	19.1 U
Benzo(a)pyrene	**37.8**	19.4 U	19.8 U	**41.8**	19.9 U	19.8 U	19.1 U
Benzo(b,j,k)fluoranthenes	**121**	38.8 U	39.5 U	**98.7**	39.8 U	39.6 U	38.1 U
Benzo(g,h,i)perylene	**29.3**	19.4 U	19.8 U	**27.1**	19.9 U	19.8 U	19.1 U
Chrysene	**50.8**	19.4 U	19.8 U	**71.7**	**17.6 J**	19.8 U	19.1 U
Dibenzo(a,h)anthracene	**8.8**	4.9 U	4.9 U	**11.8**	5 U	5 U	4.8 U
Dibenzofuran	19.9 U	19.4 U	19.8 U	**12.3 J**	19.9 U	19.8 U	19.1 U
Fluoranthene	**47.3**	19.4 U	19.8 U	**64.5**	19.9 U	19.8 U	19.1 U
Fluorene	**5.8 J**	19.4 U	19.8 U	**10.3 J**	19.9 U	19.8 U	19.1 U
Indeno(1,2,3-c,d)pyrene	**27.7**	19.4 U	19.8 U	**25.1**	19.9 U	19.8 U	19.1 U
Naphthalene	**17 J**	19.4 U	**8.5 J**	**26**	19.9 U	19.8 U	19.1 U
Phenanthrene	**33.8**	**14.7 J**	19.8 U	**59.9**	**22.6**	19.8 U	**14.7 J**
Pyrene	**65.8**	19.4 U	19.8 U	**81.6**	19.9 U	19.8 U	19.1 U
Total Benzofluoranthenes (b,j,k) (U = 0)	**121**	38.8 U	39.5 U	**98.7**	39.8 U	39.6 U	38.1 U
Total HPAH (DMMP) (U = 0)[1]	**418.3**	38.8 U	39.5 U	**460.7**	**23 J**	39.6 U	38.1 U
Total LPAH (DMMP) (U = 0)[2]	**69.8 J**	**14.7 J**	**8.5 J**	**130.4 J**	**22.6**	19.8 U	**14.7 J**
Total PAH (DMMP) (U = 0)	**488.1 J**	**14.7 J**	**8.5 J**	**591.1 J**	**45.6 J**	39.6 U	**14.7 J**
Pesticides (µg/kg)[3]							
4,4'-DDD (p,p'-DDD)	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.31 U
4,4'-DDE (p,p'-DDE)	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
Aldrin	0.37 U	0.36 U	0.37 U	0.37 U	0.37 U	0.37 U	0.36 U
Chlordane, alpha- (Chlordane, cis-)	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	0.32 U	0.32 U	0.32 U	0.33 U	0.33 U	0.33 U	0.32 U
Dieldrin	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Nonachlor, cis-	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Nonachlor, trans-	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.22 U
Oxychlordane	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	0.32 U	0.32 U	0.32 U	0.33 U	0.33 U	0.33 U	0.32 U
PCB Aroclors (µg/kg)							
Aroclor 1016	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Aroclor 1221	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Aroclor 1232	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Aroclor 1242	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Aroclor 1248	**3.4 J**	4 U	4 U	**3.8 J**	3.9 U	4 U	3.9 U
Aroclor 1254	**3.9 J**	4 U	4 U	**5**	3.9 U	4 U	3.9 U
Aroclor 1260	**2.1 J**	4 U	4 U	**3 J**	3.9 U	4 U	3.9 U
Aroclor 1262	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Aroclor 1268	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Total DMMP PCB Aroclors (U = 0)	**9.4 J**	4 U	4 U	**11.8 J**	3.9 U	4 U	3.9 U
PCB Aroclors (mg/kg-OC)[6]							
Total DMMP PCB Aroclors (U = 0)	**1.71 J**	0.91 U	2 U	**2.19 J**	1 U	3.64 U	2.05 U

Notes:

Detected concentration is greater than DMMP SL screening level

Detected concentration is greater than DMMP BT screening level

Non-detected concentration is above one or more identified screening levels

TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	C-10-A-190221 0 - 2 ft	C-10-B-190221 2 - 4 ft	C-10-C-190221 4 - 6 ft	C-11-A-190220 0 - 2 ft	C-11-B-190220 2 - 4 ft	C-12-A-190223 0 - 2 ft	C-12-B-190223 2 - 4 ft	C-12-C-190223 4 - 6 ft
Metals (mg/kg)								
Antimony	0.28 UJ	0.25 UJ	0.2 UJ	0.28 UJ	0.25 UJ	0.27 UJ	0.25 UJ	0.25 UJ
Arsenic	**5.95**	**3.4**	**1.88**	**4.8**	**1.3**	**6.8**	**5.07**	**5.07**
Cadmium	**0.13 J**	**0.12 J**	**0.1**	**0.09 J**	0.12 U	**0.14**	**0.13**	**0.14**
Chromium	**15.6**	**11.3**	**8.23**	**14.3**	**10.7**	**16.3**	**16.2**	**16.7**
Copper	**31.8**	**19.1**	**11.8**	**27.3**	**11.1**	**29.2**	**23.8**	**24.7**
Lead	**8.1**	**4.2**	**1.46**	**6.34**	**1.33**	**14.8**	**6.32**	**5.11**
Mercury	**0.0428 J**	**0.0271 J**	**0.00691 J**	**0.0352**	0.0241 U	**0.0703**	**0.0607**	**0.0549**
Selenium	**1**	**0.74**	**0.61**	**1.04**	**0.61 J**	**0.79**	**1.03**	**0.73**
Silver	**0.16 J**	**0.09 J**	**0.04 J**	**0.13 J**	**0.04 J**	**0.14 J**	**0.09 J**	**0.09 J**
Zinc	**43.4**	**25.5**	**15.8**	**36.7**	**18.7**	**43.7**	**30.4**	**29.8**
Organometallic Compounds (µg/kg)								
Tributyltin (ion)	**5.67**	**95.5**	3.81 U	**2.8 J**	3.79 UJ	**13.4**	**0.525 J**	3.65 U
Semivolatile Organics (µg/kg)								
1,2,4-Trichlorobenzene	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	4.8 U	5 U	5 U
1,2-Dichlorobenzene	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	**6.1**	5 U	5 U
1,4-Dichlorobenzene	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	**3.7 J**	5 U	5 U
2,4-Dimethylphenol	**3.4 J**	23.8 U	24 U	**3.1 J**	23.5 UJ	**10.6 J**	**2.8 J**	24.9 U
2-Methylphenol (o-Cresol)	4.9 U	4.8 U	4.8 U	**2.2 J**	4.7 U	4.8 U	5 U	5 U
4-Methylphenol (p-Cresol)	**6.4**	**2.7 J**	4.8 U	**6.8**	4.7 U	**14.4**	**5.1**	**2.8 J**
Benzoic acid	**146**	**43.3 J**	96 U	**93.3 J**	94 UJ	**228 J**	**77 J**	**46.1 J**
Benzyl alcohol	19.7 U	19.1 U	19.2 U	**17.9 J**	18.8 U	19 U	19.8 U	19.9 U
bis(2-Ethylhexyl)phthalate	**56.7**	**32.8 J**	48 U	**30.2 J**	47 U	**106**	**32.9 J**	49.8 U
Butylbenzyl phthalate	19.7 U	19.1 U	19.2 U	19 U	18.8 U	19 U	19.8 U	19.9 U
Diethyl phthalate	19.7 U	19.1 U	24.5 U	--	18.8 U	19 U	38.2 U	19.9 U
Dimethyl phthalate	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	**3.1 J**	5 U	5 U
Di-n-butyl phthalate	41.4 U	20.6 U	30.4 U	**72.2**	**17.7 J**	19 U	**6 J**	19.9 U
Di-n-octyl phthalate	19.7 U	19.1 U	19.2 U	19 U	18.8 U	19 U	19.8 U	19.9 U
Hexachlorobenzene	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	4.8 U	5 U	5 U
Hexachlorobutadiene	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	4.8 U	5 U	5 U
n-Nitrosodiphenylamine	**3.4 J**	4.8 U	4.8 U	4.7 U	4.7 U	4.8 U	5 U	5 U
Pentachlorophenol	**9.3 J**	19.1 UJ	19.2 UJ	**4.1 J**	18.8 UJ	**11.2 J**	**10.1 J**	19.9 UJ
Phenol	15 U	9.7 U	4.8 U	**20.3**	4.7 U	53 U	23.1 U	17.5 U
Polycyclic Aromatic Hydrocarbons (µg/kg)								
2-Methylnaphthalene	**28.6**	**10.6 J**	19.2 U	**17.7 J**	18.8 U	**21.5**	19.8 U	19.9 U
Acenaphthene	**7.5 J**	19.1 U	19.2 U	19 U	18.8 U	**21.1**	**8.2 J**	19.9 U
Acenaphthylene	**11 J**	19.1 U	19.2 U	19 U	18.8 U	**10.9 J**	19.8 U	19.9 U
Anthracene	**28.7**	**16.1 J**	19.2 U	**18.6 J**	18.8 U	**26.6 J**	**14.4 J**	**8.5 J**
Benzo(a)anthracene	**56.2**	**33.6**	19.2 U	**42.5**	18.8 U	**25.1**	**13.1 J**	**8 J**
Benzo(a)pyrene	**67.2**	**45.7**	19.2 U	**46.1**	18.8 U	**40.3**	**18.8 J**	**9.7 J**
Benzo(b,j,k)fluoranthenes	**205**	**115**	38.4 U	**118**	37.6 U	**114**	**49.2**	**22.5 J**
Benzo(g,h,i)perylene	**48.5**	**30.3**	19.2 U	**33.1**	18.8 U	**30.8**	**17.2 J**	**9.7 J**
Chrysene	**82.7**	**53.7**	19.2 U	**61.4**	18.8 U	**51.1**	**23.4**	**11.8 J**
Dibenzo(a,h)anthracene	**18.8**	**12.4**	4.8 U	**9.2**	4.7 U	**11**	**6**	**2.7 J**
Dibenzofuran	**16.6 J**	**7.2 J**	19.2 U	**9 J**	18.8 U	**23.9**	**9.6 J**	19.9 U
Fluoranthene	**110**	**52**	19.2 U	**52.1**	18.8 U	**90.9**	**36**	**18.5 J**
Fluorene	**15.7 J**	**7.3 J**	19.2 U	**8 J**	18.8 U	**28**	**12.5 J**	19.9 U
Indeno(1,2,3-c,d)pyrene	**43.9**	**28.7**	19.2 U	**29.5**	18.8 U	**25.4**	**14.6 J**	**7.3 J**
Naphthalene	**27.7**	**15.9 J**	19.2 U	**20.1**	18.8 U	**60.2**	**27.9**	**16.9 J**
Phenanthrene	**53.3**	**43**	**7.7 J**	**39.2**	18.8 U	**78.3**	**38.5**	**24.2**
Pyrene	**174**	**79.1**	**6.6 J**	**76**	18.8 U	**215**	**71.1**	**40.1**
Total Benzofluoranthenes (b,j,k) (U = 0)	**205**	**115**	38.4 U	**118**	37.6 U	**114**	**49.2**	**22.5 J**
Total HPAH (DMMP) (U = 0)[1]	**806.3**	**450.5**	**6.6 J**	**467.9**	37.6 U	**603.6**	**249.4 J**	**130.3 J**
Total LPAH (DMMP) (U = 0)[2]	**143.9 J**	**82.3 J**	**7.7 J**	**85.9 J**	18.8 U	**225.1 J**	**101.5 J**	**49.6 J**
Total PAH (DMMP) (U = 0)	**950.2 J**	**532.8 J**	**14.3 J**	**553.8 J**	37.6 U	**828.7 J**	**350.9 J**	**179.9 J**
Pesticides (µg/kg)[3]								
4,4'-DDD (p,p'-DDD)	1.59 U	0.32 U	0.32 U	0.32 U	0.31 U	0.32 U	0.31 U	1.93 U
4,4'-DDE (p,p'-DDE)	0.67 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	1.61 U	0.32 U	0.32 U	0.32 U	0.31 U	3.96 U	3.39 U	2.42 U
Aldrin	1.83 U	0.37 U	0.36 U	0.37 U	0.35 U	0.37 U	0.36 U	0.36 U
Chlordane, alpha- (Chlordane, cis-)	0.55 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	1.62 U	0.32 U	0.32 U	14.9 U	0.31 U	0.32 U	0.32 U	0.32 U
Dieldrin	0.57 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.23 U	0.05 U	0.05 U	1.49 U	0.04 U	0.05 U	0.04 U	0.04 U
Nonachlor, cis-	1.04 U	0.21 U	0.21 U	0.21 U	0.2 U	0.21 U	0.2 U	0.2 U
Nonachlor, trans-	1.13 U	0.23 U	0.22 U	0.23 U	0.22 U	0.23 U	0.22 U	0.22 U
Oxychlordane	0.64 U	0.13 U	0.13 U	21.9 U	0.12 U	0.13 U	0.12 U	0.12 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	1.61 U	0.32 U	0.32 U	0.32 U	0.31 U	3.96 U	3.39 U	2.42 U
Total DMMP Chlordane (U = 0)[5]	1.62 U	0.32 U	0.32 U	21.9 U	0.31 U	0.32 U	0.32 U	0.32 U
PCB Aroclors (µg/kg)								
Aroclor 1016	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	3.9 U	3.8 U
Aroclor 1221	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	3.9 U	3.8 U
Aroclor 1232	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	3.9 U	3.8 U
Aroclor 1242	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	3.9 U	3.8 U
Aroclor 1248	**5.8**	**4.1**	3.9 U	4 U	3.8 U	**52.7**	**44.9**	**11**
Aroclor 1254	**9**	**5 J**	3.9 U	**3.4 J**	3.8 U	**94.3 J**	**33.5 J**	**7.8**
Aroclor 1260	**5.5 J**	**2.1 J**	3.9 U	**2.6 J**	3.8 U	**26.3 J**	**11.7 J**	**5.7 J**
Aroclor 1262	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 UJ	3.9 UJ	3.8 UJ
Aroclor 1268	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 UJ	3.9 UJ	3.8 UJ
Total DMMP PCB Aroclors (U = 0)	**20.3 J**	**11.2 J**	3.9 U	**6 J**	3.8 U	**173.3 J**	**90.1 J**	**24.5 J**
PCB Aroclors (mg/kg-OC)[6]								
Total DMMP PCB Aroclors (U = 0)	**2.01 J**	**2.49 J**	2.05 U	**0.70 J**	2.71 U	**28.41 J**	**24.35 J**	**3.27 J**

Notes:

Detected concentration is greater than DMMP SL screening level

Detected concentration is greater than DMMP BT screening level

Non-detected concentration is above one or more identified screening levels

TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6
Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID Depth Analyte	C-13-A-190223 0 - 2 ft	C-13-B-190223 2 - 4 ft	C-13-C-190223 4 - 6 ft	C-14-A-190221 0 - 2 ft	C-14-B-190221 2 - 4 ft	C-15-A-190222 0 - 2 ft	C-15-B-190222 2 - 4 ft	C-15-C-190222 4 - 6 ft
Metals (mg/kg)								
Antimony	0.24 UJ	0.25 UJ	0.22 UJ	0.23 UJ	0.23 UJ	0.25 UJ	0.22 UJ	0.22 UJ
Arsenic	**6.08**	**6.67**	**3.88**	**4.18**	**5.08**	**6.4**	**2.74**	**4.28**
Cadmium	**0.11 J**	**0.11 J**	**0.05 J**	0.11 U	**0.06 J**	**0.05 J**	0.11 U	**0.04 J**
Chromium	**13**	**13.5**	**12**	**11.3**	**13**	**12.4**	**9.38**	**11.5**
Copper	**66.1**	**22.7**	**14.1**	**12.3**	**14.6**	**21.3**	**11.5**	**14.3**
Lead	**4.5**	**5.04**	**1.67**	**1.54**	**1.8**	**5.36**	**1.36**	**1.74**
Mercury	**0.0252**	**0.0381**	**0.011 J**	0.0216 U	0.0216 U	**0.027 J**	**0.0142 J**	**0.0148 J**
Selenium	**0.77**	**0.89**	**0.73**	**0.95**	**0.78**	**0.77**	**0.62**	**0.66**
Silver	**0.08 J**	**0.11 J**	**0.05 J**	**0.04 J**	**0.05 J**	**0.09 J**	**0.04 J**	**0.05 J**
Zinc	**43.1**	**34.2**	**22.2**	**21.7**	**22.2**	**30**	**18**	**22.5**
Organometallic Compounds (μg/kg)								
Tributyltin (ion)	**1.68 J**	**3.69**	3.81 U	3.74 U	3.82 U	**1.99 J**	3.77 U	3.84 U
Semivolatile Organics (μg/kg)								
1,2,4-Trichlorobenzene	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
1,2-Dichlorobenzene	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
1,4-Dichlorobenzene	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 UJ	5 UJ	5 UJ
2,4-Dimethylphenol	24.5 U	24.8 U	24.5 U	24.3 U	24.7 U	23.6 UJ	24.8 UJ	24.8 UJ
2-Methylphenol (o-Cresol)	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
4-Methylphenol (p-Cresol)	4.9 U	**3.1 J**	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Benzoic acid	**71.1 J**	**76.3 J**	**22.3 J**	97.1 U	98.6 U	**79.4 J**	99 U	99 UJ
Benzyl alcohol	19.6 U	**3.4 J**	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
bis(2-Ethylhexyl)phthalate	**30.4 J**	**41.7 J**	49 U	**54.7**	49.3 U	**61.8**	49.5 U	49.5 U
Butylbenzyl phthalate	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	**7.8 J**	19.8 U	19.8 U
Diethyl phthalate	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	31.9 U
Dimethyl phthalate	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Di-n-butyl phthalate	19.6 U	19.9 U	19.6 U	34.4 U	39.9 U	121 U	81.4 U	38.6 U
Di-n-octyl phthalate	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Hexachlorobenzene	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Hexachlorobutadiene	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
n-Nitrosodiphenylamine	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Pentachlorophenol	19.6 UJ	19.9 UJ	19.6 UJ	19.4 UJ	**7.7 J**	18.9 UJ	19.8 UJ	19.8 UJ
Phenol	23.7 U	31.6 U	8.2 U	4.9 U	4.9 U	13.7 U	5.9 U	7 U
Polycyclic Aromatic Hydrocarbons (μg/kg)								
2-Methylnaphthalene	**7.1 J**	**7 J**	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Acenaphthene	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Acenaphthylene	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Anthracene	**6.9 J**	**10.6 J**	19.6 UJ	19.4 U	19.7 U	**6.1 J**	19.8 UJ	19.8 UJ
Benzo(a)anthracene	**17.1 J**	**19.2 J**	19.6 U	19.4 U	19.7 U	**10.2 J**	19.8 U	19.8 U
Benzo(a)pyrene	**23.1**	**29.4**	19.6 U	19.4 U	19.7 U	**18.9**	19.8 U	19.8 U
Benzo(b,j,k)fluoranthenes	**62.9**	**85.1**	39.2 U	38.8 U	39.4 U	**54.5**	39.6 U	39.6 U
Benzo(g,h,i)perylene	**20.8**	**26.9**	19.6 U	19.4 U	19.7 U	**10.9 J**	19.8 U	19.8 U
Chrysene	**27.8**	**32.4**	19.6 U	19.4 U	19.7 U	**17 J**	19.8 U	19.8 U
Dibenzo(a,h)anthracene	**6.6**	**8.6**	4.9 U	4.9 U	4.9 U	**4.8**	5 U	5 U
Dibenzofuran	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Fluoranthene	**25.5**	**25.2**	19.6 U	19.4 U	19.7 U	**16.5 J**	19.8 U	19.8 U
Fluorene	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Indeno(1,2,3-c,d)pyrene	**15.9 J**	**21.9**	19.6 U	19.4 U	19.7 U	**10.6 J**	19.8 U	19.8 U
Naphthalene	**7.9 J**	**9 J**	19.6 U	19.4 U	19.7 U	**8.9 J**	19.8 UJ	19.8 UJ
Phenanthrene	**16.3 J**	**21.4**	**5.8 J**	19.4 U	19.7 U	**15.8 J**	**6.1 J**	19.8 U
Pyrene	**48.8**	**68.5**	19.6 U	19.4 U	19.7 U	**27.5**	19.8 U	19.8 U
Total Benzofluoranthenes (b,j,k) (U = 0)	**62.9**	**85.1**	39.2 U	38.8 U	39.4 U	**54.5**	39.6 U	39.6 U
Total HPAH (DMMP) (U = 0)[1]	**248.5 J**	**317.2 J**	39.2 U	38.8 U	39.4 U	**170.9 J**	39.6 U	39.6 U
Total LPAH (DMMP) (U = 0)[2]	**31.1 J**	**41 J**	**5.8 J**	19.4 U	19.7 U	**30.8 J**	**6.1 J**	19.8 UJ
Total PAH (DMMP) (U = 0)	**279.6 J**	**358.2 J**	**5.8 J**	38.8 U	39.4 U	**201.7 J**	**6.1 J**	39.6 UJ
Pesticides (μg/kg)[3]								
4,4'-DDD (p,p'-DDD)	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U	0.31 U	0.32 U	0.32 U
4,4'-DDE (p,p'-DDE)	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.31 U	0.32 U	0.32 U
Aldrin	0.37 U	0.36 U	0.36 U	0.37 U	0.37 U	0.35 U	0.37 U	0.37 U
Chlordane, alpha- (Chlordane, cis-)	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	0.32 U	1.94 U	0.32 U	0.32 U	0.33 U	0.31 U	0.32 U	0.32 U
Dieldrin	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.04 U	0.05 U	0.05 U
Nonachlor, cis-	0.21 U	0.2 U	0.21 U	0.21 U	0.21 U	0.2 U	0.21 U	0.21 U
Nonachlor, trans-	0.23 U	0.22 U	0.23 U	0.23 U	0.23 U	0.22 U	0.23 U	0.23 U
Oxychlordane	0.13 U	0.12 U	0.13 U	0.13 U	0.13 U	0.12 U	0.13 U	0.13 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.31 U	0.32 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	0.32 U	1.94 U	0.32 U	0.32 U	0.33 U	0.31 U	0.32 U	0.32 U
PCB Aroclors (μg/kg)								
Aroclor 1016	4 U	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Aroclor 1221	4 U	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Aroclor 1232	4 U	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Aroclor 1242	4 U	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Aroclor 1248	**6.5**	**8**	**3.7 J**	3.9 U	4 U	**8.2**	4 U	4 U
Aroclor 1254	**3.3 J**	**5.9**	3.9 U	3.9 U	4 U	**8.1 J**	4 U	4 U
Aroclor 1260	**1.9 J**	**9.2 J**	3.9 U	3.9 U	4 U	**3.1 J**	4 U	4 U
Aroclor 1262	4 UJ	3.9 UJ	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Aroclor 1268	4 UJ	3.9 UJ	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Total DMMP PCB Aroclors (U = 0)	**11.7 J**	**23.1 J**	**3.7 J**	3.9 U	4 U	**19.4 J**	4 U	4 U
PCB Aroclors (mg/kg-OC)[6]								
Total DMMP PCB Aroclors (U = 0)	**1.98 J**	**5.92 J**	**2.06 J**	4.33 U	2.67 U	**7.76 J**	4 U	2.35 U

Notes:

(yellow)	Detected concentration is greater than DMMP SL screening level
(orange)	Detected concentration is greater than DMMP BT screening level
(blue)	Non-detected concentration is above one or more identified screening levels
(gray)	TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

μg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6
Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID Depth Analyte	C-16-A-190223 0 - 2 ft	C-16-B-190223 2 - 4 ft	C-17-A-190222 0 - 2 ft	C-17-B-190222 2 - 4 ft	C-17-C-190222 4 - 8 ft	C-18-A1-190220 0 - 2.3 ft	C-18-B1-190220 3.9 - 6.3 ft
Metals (mg/kg)							
Antimony	0.2 UJ	0.23 UJ	0.28 UJ	0.37 UJ	0.25 UJ	0.24 U	0.22 U
Arsenic	**3.82**	**2.21**	**3.74**	**3.44**	**2.15**	**3.2**	**3.89**
Cadmium	**0.07 J**	0.11 U	**0.05 J**	**0.21**	**0.04 J**	**0.05 J**	0.11 U
Chromium	**10.2**	**10.6**	**16.3**	**16.4**	**14.4**	**11.5**	**10.1**
Copper	**14.9**	**10.5**	**32.6**	**30.7**	**21.2**	**16.1**	**13**
Lead	**2.82**	**1.29**	**3.94**	**3.12**	**2.07**	**2.81**	**1.51**
Mercury	**0.0195 J**	**0.00813 J**	**0.0296**	**0.0373**	**0.0201 J**	0.0291 U	0.021 U
Selenium	**0.67**	**0.69**	**1.11**	**1.22**	**0.98**	**0.7**	**0.88**
Silver	**0.08 J**	**0.04 J**	**0.1 J**	**0.1 J**	**0.07 J**	**0.05 J**	**0.04 J**
Zinc	**22.5**	**19.7**	**30.4**	**25.3**	**23.9**	**25.6**	**29.6**
Organometallic Compounds (µg/kg)							
Tributyltin (ion)	**15.8**	**0.895 J**	3.61 U	3.84 U	3.69 U	**2.31 J**	3.64 UJ
Semivolatile Organics (µg/kg)							
1,2,4-Trichlorobenzene	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
1,2-Dichlorobenzene	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
1,4-Dichlorobenzene	4.8 U	4.9 U	5 UJ	4.9 UJ	4.8 UJ	4.8 U	4.7 U
2,4-Dimethylphenol	23.9 U	24.6 U	24.8 UJ	**2.6 J**	23.9 UJ	24.2 U	23.6 U
2-Methylphenol (o-Cresol)	4.8 U	4.9 U	**2.7 J**	**3.1 J**	4.8 U	4.8 U	4.7 U
4-Methylphenol (p-Cresol)	4.8 U	4.9 U	**4.7 J**	**7.6**	**2 J**	**3.1 J**	4.7 U
Benzoic acid	**68.4 J**	98.6 UJ	**310**	**164**	**32.9 J**	**214 J**	**60.2 J**
Benzyl alcohol	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
bis(2-Ethylhexyl)phthalate	47.8 U	49.3 U	49.7 U	48.7 U	**29.6 J**	48.4 U	47.2 U
Butylbenzyl phthalate	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Diethyl phthalate	23.2 U	19.7 U	19.9 U	19.5 U	24.6 U	**7.2 J**	**9.2 J**
Dimethyl phthalate	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
Di-n-butyl phthalate	19.1 U	19.7 U	97.9 U	99.9 U	91.1 U	19.4 U	18.9 U
Di-n-octyl phthalate	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Hexachlorobenzene	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
Hexachlorobutadiene	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
n-Nitrosodiphenylamine	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
Pentachlorophenol	19.1 UJ	19.7 UJ	**4.5 J**	19.5 UJ	19.2 UJ	19.4 UJ	18.9 UJ
Phenol	18.3 U	8.1 U	**41**	**34.7**	7.3 U	**38.7**	13.4 U
Polycyclic Aromatic Hydrocarbons (µg/kg)							
2-Methylnaphthalene	19.1 U	19.7 U	**11.7 J**	**7.1 J**	**6.2 J**	19.4 U	**7.5 J**
Acenaphthene	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Acenaphthylene	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Anthracene	**8.8 J**	19.7 UJ	19.9 UJ	19.5 UJ	19.2 UJ	**5.9 J**	18.9 U
Benzo(a)anthracene	**11.9 J**	19.7 U	**6.5 J**	19.5 U	19.2 U	**9 J**	18.9 U
Benzo(a)pyrene	**10.8 J**	19.7 U	19.9 U	19.5 U	19.2 U	**16.4 J**	18.9 U
Benzo(b,j,k)fluoranthenes	38.2 U	39.4 U	**22.7 J**	39 U	38.3 U	**42.2**	37.8 U
Benzo(g,h,i)perylene	**7.7 J**	19.7 U	19.9 U	19.5 U	19.2 U	**9.7 J**	18.9 U
Chrysene	**28.8**	19.7 U	**14.7 J**	**8.8 J**	**5.9 J**	**18.2 J**	18.9 U
Dibenzo(a,h)anthracene	**2.7 J**	4.9 U	**2.6 J**	4.9 U	4.8 U	**3.8 J**	4.7 U
Dibenzofuran	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Fluoranthene	**12.3 J**	19.7 U	**8 J**	19.5 U	**4.9 J**	**13.9 J**	18.9 U
Fluorene	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Indeno(1,2,3-c,d)pyrene	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	**8.2 J**	18.9 U
Naphthalene	19.1 U	19.7 U	**6.3 J**	**6.8 J**	**8.1 J**	**7.9 J**	**5.4 J**
Phenanthrene	**15.8 J**	19.7 U	**25.2**	**13.7 J**	**14.6 J**	**11.9 J**	**6.3 J**
Pyrene	**23.5**	19.7 U	**21.3**	19.5 U	**6.2 J**	**48.3**	18.9 U
Total Benzofluoranthenes (b,j,k) (U = 0)	38.2 U	39.4 U	**22.7 J**	39 U	38.3 U	**42.2**	37.8 U
Total HPAH (DMMP) (U = 0)[1]	**97.7 J**	39.4 U	**75.8 J**	**8.8 J**	**17 J**	**169.7 J**	37.8 U
Total LPAH (DMMP) (U = 0)[2]	**24.6 J**	19.7 UJ	**31.5 J**	**20.5 J**	**22.7 J**	**25.7 J**	**11.7 J**
Total PAH (DMMP) (U = 0)	**122.3 J**	39.4 UJ	**107.3 J**	**29.3 J**	**39.7 J**	**195.4 J**	**11.7 J**
Pesticides (µg/kg)[3]							
4,4'-DDD (p,p'-DDD)	0.31 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
4,4'-DDE (p,p'-DDE)	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
Aldrin	0.36 U	0.37 U	0.37 U	0.37 U	0.36 U	0.36 U	0.37 U
Chlordane, alpha- (Chlordane, cis-)	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	0.32 U	0.33 U	0.33 U	0.33 U	0.32 U	0.99 U	0.32 U
Dieldrin	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Nonachlor, cis-	0.2 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Nonachlor, trans-	0.22 U	0.23 U	0.23 U	0.23 U	0.22 U	0.22 U	0.23 U
Oxychlordane	0.12 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	0.32 U	0.33 U	0.33 U	0.33 U	0.32 U	0.99 U	0.32 U
PCB Aroclors (µg/kg)							
Aroclor 1016	4 U	4 U	4 U	4 U	4 U	3.9 U	4 U
Aroclor 1221	4 U	4 U	4 U	4 U	4 U	3.9 U	4 U
Aroclor 1232	4 U	4 U	4 U	4 U	4 U	3.9 U	4 U
Aroclor 1242	4 U	4 U	4 U	4 U	4 U	3.9 U	4 U
Aroclor 1248	**2 J**	4 U	**2.5 J**	4 U	4 U	3.9 U	4 U
Aroclor 1254	**2.2 J**	4 U	**2.4 J**	4 U	4 U	3.9 U	4 U
Aroclor 1260	**1.1 J**	4 U	**1.1 J**	4 U	4 U	3.9 UJ	4 U
Aroclor 1262	4 U	4 U	4 U	4 U	4 U	3.9 UJ	4 U
Aroclor 1268	4 U	4 U	4 U	4 U	4 U	3.9 UJ	4 U
Total DMMP PCB Aroclors (U = 0)	**5.3 J**	4 U	**6 J**	4 U	4 U	3.9 UJ	4 U
PCB Aroclors (mg/kg-OC)[6]							
Total DMMP PCB Aroclors (U = 0)	**2.12 J**	8 U	**0.72 J**	0.12 U	1.03 U	1.34 UJ	3.08 U

Notes:

(yellow)	Detected concentration is greater than DMMP SL screening level
(orange)	Detected concentration is greater than DMMP BT screening level
(blue)	Non-detected concentration is above one or more identified screening levels
(grey)	TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID Depth Analyte	C-19-A-190220 0 - 2 ft	C-19-B-190220 2 - 4 ft	C-20-A-190219 0 - 2 ft	C-20-B-190219 2 - 4 ft	C-21-A-190219 0 - 2 ft	C-21-B-190219 2 - 4 ft	C-22-A-190219 0 - 2 ft	C-22-B-190219 2 - 4 ft
Metals (mg/kg)								
Antimony	0.19 UJ	0.23 UJ	0.23 UJ	0.21 UJ	0.23 UJ	0.21 UJ	0.2 UJ	0.2 UJ
Arsenic	**1.89**	**2.53**	**1.28**	**1.1**	**4.41**	**2.26**	**1.59**	**1.31**
Cadmium	0.1 U	0.12 U	**0.05 J**	**0.03 J**	0.11 U	**0.05 J**	0.1 U	0.1 U
Chromium	**9.73**	**10.3**	**9.69**	**10.4**	**7.99**	**8.59**	**11.3**	**9.53**
Copper	**12.7**	**15.2**	**13.9**	**14**	**14.9**	**14.9**	**12.7**	**10.9**
Lead	**1.54**	**1.84**	**1.41**	**1.5**	**1.43**	**1.49**	**1.36**	**1.41**
Mercury	0.0187 U	0.0204 U	**0.00698 J**	**0.00973 J**	**0.0112 J**	**0.0134 J**	**0.00859 J**	**0.00788 J**
Selenium	**0.62**	**0.77**	**0.51 J**	**0.82**	**0.82**	**0.82**	**0.72**	**0.84**
Silver	**0.04 J**	**0.05 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.03 J**	**0.03 J**	**0.03 J**
Zinc	**20.9**	**21.3**	**18.7**	**20.1**	**18**	**20.1**	**19.2**	**17.6**
Organometallic Compounds (µg/kg)								
Tributyltin (ion)	**0.417 J**	**1.07 J**	3.79 U	3.76 U	3.63 U	3.76 U	3.53 U	3.57 U
Semivolatile Organics (µg/kg)								
1,2,4-Trichlorobenzene	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
1,2-Dichlorobenzene	4.9 U	4.9 U	5 U	**0.8 J**	4.8 U	4.8 U	4.9 U	4.9 U
1,4-Dichlorobenzene	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
2,4-Dimethylphenol	24.4 UJ	24.6 UJ	24.8 UJ	24.3 UJ	23.9 UJ	24.2 UJ	24.7 UJ	24.7 UJ
2-Methylphenol (o-Cresol)	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
4-Methylphenol (p-Cresol)	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Benzoic acid	97.7 UJ	**19.6 J**	99.1 UJ	97.1 UJ	95.7 UJ	96.7 UJ	98.7 UJ	98.6 UJ
Benzyl alcohol	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
bis(2-Ethylhexyl)phthalate	48.9 U	49.2 U	49.5 U	48.6 U	47.9 U	48.3 U	49.4 U	49.3 U
Butylbenzyl phthalate	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Diethyl phthalate	19.5 U	19.7 U	35.8 U	28.9 U	19.1 U	19.3 U	19.7 U	21.9 U
Dimethyl phthalate	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Di-n-butyl phthalate	**161**	**133**	**36.8**	**22.6**	**17.2 J**	**39.8**	**18.8 J**	19.7 U
Di-n-octyl phthalate	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Hexachlorobenzene	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Hexachlorobutadiene	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
n-Nitrosodiphenylamine	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Pentachlorophenol	19.5 UJ	19.7 UJ	19.8 UJ	19.4 UJ	19.1 UJ	19.3 UJ	19.7 UJ	19.7 UJ
Phenol	4.9 U	5.3 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Polycyclic Aromatic Hydrocarbons (µg/kg)								
2-Methylnaphthalene	19.5 U	19.7 U	19.8 U	19.4 U	**7.3 J**	19.3 U	19.7 U	19.7 U
Acenaphthene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Acenaphthylene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Anthracene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Benzo(a)anthracene	19.5 U	19.7 U	19.8 U	19.4 U	**7 J**	19.3 U	19.7 U	19.7 U
Benzo(a)pyrene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Benzo(b,j,k)fluoranthenes	39.1 U	39.3 U	39.6 U	38.9 U	38.3 U	38.7 U	39.5 U	39.5 U
Benzo(g,h,i)perylene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Chrysene	19.5 U	19.7 U	19.8 U	19.4 U	**14.3 J**	19.3 U	19.7 U	19.7 U
Dibenzo(a,h)anthracene	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Dibenzofuran	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Fluoranthene	19.5 U	19.7 U	19.8 U	19.4 U	**5.8 J**	19.3 U	19.7 U	19.7 U
Fluorene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Indeno(1,2,3-c,d)pyrene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Naphthalene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Phenanthrene	19.5 U	19.7 U	19.8 U	19.4 U	**38.1**	19.3 U	19.7 U	19.7 U
Pyrene	19.5 U	**5.5 J**	**5.9 J**	19.4 U	**8.1 J**	19.3 U	19.7 U	19.7 U
Total Benzofluoranthenes (b,j,k) (U = 0)	39.1 U	39.3 U	39.6 U	38.9 U	38.3 U	38.7 U	39.5 U	39.5 U
Total HPAH (DMMP) (U = 0)[1]	39.1 U	**5.5 J**	**5.9 J**	38.9 U	**35.2 J**	38.7 U	39.5 U	39.5 U
Total LPAH (DMMP) (U = 0)[2]	19.5 U	19.7 U	19.8 U	19.4 U	**38.1**	19.3 U	19.7 U	19.7 U
Total PAH (DMMP) (U = 0)	39.1 U	**5.5 J**	**5.9 J**	38.9 U	**73.3 J**	38.7 U	39.5 U	39.5 U
Pesticides (µg/kg)[3]								
4,4'-DDD (p,p'-DDD)	0.31 U	0.31 U	0.3 U	0.31 U	0.31 U	0.31 U	0.31 U	0.32 U
4,4'-DDE (p,p'-DDE)	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	0.31 U	0.32 U	0.31 U	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U
Aldrin	0.36 U	0.36 U	0.35 U	0.36 U	0.35 U	0.36 U	0.36 U	0.36 U
Chlordane, alpha- (Chlordane, cis-)	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	0.32 U	0.32 U	0.31 U	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U
Dieldrin	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.04 U	0.05 U	0.04 U	0.05 U	0.04 U	0.05 U	0.05 U	0.05 U
Nonachlor, cis-	0.2 U	0.21 U	0.2 U	0.21 U	0.2 U	0.2 U	0.21 U	0.21 U
Nonachlor, trans-	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U
Oxychlordane	0.12 U	0.12 U	0.12 U	0.13 U	0.12 U	0.12 U	0.13 U	0.13 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	0.31 U	0.32 U	0.31 U	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	0.32 U	0.32 U	0.31 U	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U
PCB Aroclors (µg/kg)								
Aroclor 1016	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1221	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1232	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1242	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1248	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1254	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1260	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1262	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1268	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Total DMMP PCB Aroclors (U = 0)	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
PCB Aroclors (mg/kg-OC)[6]								
Total DMMP PCB Aroclors (U = 0)	4.22 U	3.9 U	4.75 U	9.75 U	0.78 U	3.55 U	5.57 U	10 U

Notes:

Detected concentration is greater than DMMP SL screening level

Detected concentration is greater than DMMP BT screening level

Non-detected concentration is above one or more identified screening levels

TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	C-23-A1-190222 0 - 2 ft	C-23-B1-190222 2 - 4 ft	C-24-A-190223 0 - 2 ft	C-24-B-190223 2 - 4 ft	C-25-A-190222 0 - 2 ft	C-25-B-190222 2 - 4 ft
Metals (mg/kg)						
Antimony	0.21 UJ	0.21 UJ	0.22 UJ	0.21 UJ	0.24 UJ	0.24 UJ
Arsenic	**2.41**	**2**	**1.99**	**1.16**	**2.79**	**2.59**
Cadmium	**0.04 J**	**0.04 J**	0.11 U	0.1 U	**0.05 J**	0.12 U
Chromium	**10.1**	**9.02**	**11.3**	**9.86**	**15.5**	**13.2**
Copper	**15.1**	**12.8**	**13.4**	**11.2**	**27.7**	**19.4**
Lead	**1.84**	**1.45**	**1.64**	**1.6**	**2.42**	**1.79**
Mercury	0.0232 U	**0.0101 J**	**0.0112 J**	**0.00818 J**	**0.0219 J**	**0.0191 J**
Selenium	**0.66**	**0.84**	**0.62**	**0.64**	**0.85**	**0.73**
Silver	**0.04 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.07 J**	**0.05 J**
Zinc	**23.8**	**21.2**	**23**	**22.4**	**73.9**	**20.1**
Organometallic Compounds (µg/kg)						
Tributyltin (ion)	3.51 U	3.46 U	3.78 U	3.53 U	3.6 U	3.77 U
Semivolatile Organics (µg/kg)						
1,2,4-Trichlorobenzene	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
1,2-Dichlorobenzene	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
1,4-Dichlorobenzene	5 UJ	4.9 UJ	4.9 U	4.9 U	4.9 UJ	4.8 UJ
2,4-Dimethylphenol	24.9 UJ	24.6 UJ	24.5 U	24.7 U	24.7 UJ	24.2 UJ
2-Methylphenol (o-Cresol)	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
4-Methylphenol (p-Cresol)	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Benzoic acid	**15.4 J**	98.6 U	**43.9 J**	**25.5 J**	**33.6 J**	**84.3 J**
Benzyl alcohol	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
bis(2-Ethylhexyl)phthalate	49.9 U	49.3 U	49.1 U	49.4 U	**30.4 J**	**31.4 J**
Butylbenzyl phthalate	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Diethyl phthalate	30.9 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Dimethyl phthalate	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Di-n-butyl phthalate	87.1 U	142 U	19.6 U	19.8 U	140 U	171 U
Di-n-octyl phthalate	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Hexachlorobenzene	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Hexachlorobutadiene	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
n-Nitrosodiphenylamine	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Pentachlorophenol	20 UJ	19.7 UJ	19.6 UJ	19.8 UJ	19.8 UJ	19.3 UJ
Phenol	6.8 U	6.5 U	10 U	7.9 U	14.8 U	19.5 U
Polycyclic Aromatic Hydrocarbons (µg/kg)						
2-Methylnaphthalene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	**17.9 J**
Acenaphthene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Acenaphthylene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Anthracene	20 UJ	19.7 UJ	19.6 UJ	19.8 UJ	19.8 UJ	19.3 UJ
Benzo(a)anthracene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Benzo(a)pyrene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Benzo(b,j,k)fluoranthenes	39.9 U	39.4 U	39.3 U	39.6 U	39.5 U	38.7 U
Benzo(g,h,i)perylene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Chrysene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Dibenzo(a,h)anthracene	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Dibenzofuran	20 U	19.7 U	19.6 U	19.8 U	19.8 U	**5.9 J**
Fluoranthene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Fluorene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Indeno(1,2,3-c,d)pyrene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Naphthalene	20 UJ	19.7 UJ	19.6 U	19.8 U	19.8 UJ	**5.8 J**
Phenanthrene	20 U	19.7 U	19.6 U	19.8 U	**6.7 J**	**15 J**
Pyrene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Total Benzofluoranthenes (b,j,k) (U = 0)	39.9 U	39.4 U	39.3 U	39.6 U	39.5 U	38.7 U
Total HPAH (DMMP) (U = 0)[1]	39.9 U	39.4 U	39.3 U	39.6 U	39.5 U	38.7 U
Total LPAH (DMMP) (U = 0)[2]	20 UJ	19.7 UJ	19.6 UJ	19.8 UJ	**6.7 J**	**20.8 J**
Total PAH (DMMP) (U = 0)	39.9 UJ	39.4 UJ	39.3 UJ	39.6 UJ	**6.7 J**	**20.8 J**
Pesticides (µg/kg)[3]						
4,4'-DDD (p,p'-DDD)	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U
4,4'-DDE (p,p'-DDE)	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	0.32 U	0.31 U	0.32 U	0.32 U	0.31 U	0.32 U
Aldrin	0.36 U	0.36 U	0.36 U	0.36 U	0.35 U	0.36 U
Chlordane, alpha- (Chlordane, cis-)	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	0.32 U	0.31 U	0.32 U	0.32 U	0.31 U	0.32 U
Dieldrin	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.05 U	0.04 U	0.05 U	0.05 U	0.04 U	0.05 U
Nonachlor, cis-	0.2 U	0.2 U	0.21 U	0.21 U	0.2 U	0.2 U
Nonachlor, trans-	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U
Oxychlordane	0.12 U	0.12 U	0.13 U	0.13 U	0.12 U	0.12 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	0.32 U	0.31 U	0.32 U	0.32 U	0.31 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	0.32 U	0.31 U	0.32 U	0.32 U	0.31 U	0.32 U
PCB Aroclors (µg/kg)						
Aroclor 1016	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1221	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1232	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1242	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1248	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1254	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1260	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1262	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1268	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Total DMMP PCB Aroclors (U = 0)	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
PCB Aroclors (mg/kg-OC)[6]						
Total DMMP PCB Aroclors (U = 0)	5.57 U	9.75 U	6.5 U	10 U	1.31 U	0.89 U

Notes:

(yellow)	Detected concentration is greater than DMMP SL screening level
(orange)	Detected concentration is greater than DMMP BT screening level
(blue)	Non-detected concentration is above one or more identified screening levels
(grey)	TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 7
Summary of Dioxin/Furan Results

Sample ID	C-1-A-190219	C-1-B-190219	C-1-C-190219	C-2-A-190219	C-2-B-190219	C-3-A-190218	C-3-B-190218	C-4-A-190218	C-4-B-190218	C-5-A-190221	C-5-B-190221
Depth	0 - 2 ft	2 - 4 ft	4 - 6 ft	0 - 2 ft	2 - 4 ft	0 - 2.7 ft	2.7 - 5.8 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Analyte											
Dioxin Furans (ng/kg)											
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**1.87 J**	**0.51 J**	**0.08 J**	**1.23 J**	**0.26 J**	**2.53 J**	**0.08 J**	0.05 UJ	0.05 UJ	**0.59 J**	**0.67 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**1.78 J**	**0.32 J**	**0.03 J**	**0.96 J**	**0.19 J**	**2.42 J**	**0.02 J**	0.05 UJ	0.05 UJ	**0.36 J**	**0.01 J**

Sample ID	C-6-A-190219	C-6-B-190219	C-7-A-190221	C-7-B-190221	C-7-C-190221	C-8-A-190221	C-8-B-190221	C-9-A-190220	C-9-B-190220	C-10-A-190221	C-10-B-190221
Depth	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	4 - 6 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Analyte											
Dioxin Furans (ng/kg)											
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**0.74 J**	**0.05 J**	**4.38 J**	**0.53 J**	**0.68 J**	**5.00 J**	**0.60 J**	**0.06 J**	**0.06 J**	**8.79 J**	**7.42 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**0.57 J**	**5.60E-04 J**	**4.21 J**	**0.02 J**	**2.97E-05 J**	**4.88 J**	**0.07 J**	**0.01 J**	**2.88E-03 J**	**8.40 J**	**7.29 J**

Sample ID	C-10-C-190221	C-11-A-190220	C-11-B-190220	C-12-A-190223	C-12-B-190223	C-12-C-190223	C-12-D-190223	C-12-E-190223	C-13-A-190223	C-13-B-190223	C-13-C-190223
Depth	4 - 6 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	4 - 6 ft	6 - 8 ft	8 - 10 ft	0 - 2 ft	2 - 4 ft	4 - 6 ft
Analyte											
Dioxin Furans (ng/kg)											
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**0.61 J**	**5.92 J**	**0.18 J**	**56.21 J**	**54.47 J**	**17.74 J**	**0.63 J**	**0.07 J**	**5.34 J**	**7.73 J**	**11.88 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**0.42 J**	**5.76 J**	**0.09 J**	**56.21 J**	**54.01 J**	**17.55 J**	**0.51 J**	**2.76E-03 J**	**5.06 J**	**7.55 J**	**11.73 J**

Notes:

Detected concentration is greater than DMMP SL screening level (4 ng/kg TEQ)

Detected concentration is greater than DMMP BT screening level (10 ng/kg TEQ)

Bold: Detected result

*: EMPC value reported by laboratory; treated as non-detect (U) in the TEQ calculation

BT: Bioaccumulation Trigger

D/F: dioxins/furans

DMMP: Dredged Material Management Program

J: Estimated value

ML: Maximum Level

ng/kg: nanogram per kilogram

SL: Screening Level

TEF: toxic equivalence factor

TEQ: toxic equivalent

U: Compound analyzed, but not detected above detection limit

Table 7

Summary of Dioxin/Furan Results

Analyte	C-13-D-190223	C-13-E-190223	C-14-A-190221	C-14-B-190221	C-15-A-190222	C-15-B-190222	C-15-C-190222	C-16-A-190223	C-16-B-190223	C-17-A-190222	C-17-B-190222
Depth	6 - 8 ft	8 - 10 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	4 - 6 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Dioxin Furans (ng/kg)											
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**7.64 J**	**0.07 J**	**0.68 J**	**0.56 J**	**10.56 J**	**0.15 J**	**0.07 J**	**2.75 J**	**0.18 J**	**1.86 J**	**0.19 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**7.29 J**	**0.01 J**	**6.68E-03 J**	**0.07 J**	**9.37 J**	**0.08 J**	**0.01 J**	**2.66 J**	**0.11 J**	**1.81 J**	**0.11 J**

Analyte	C-17-C-190222	C-18-A1-190220	C-18-B1-190220	C-19-A-190220	C-19-B-190220	C-20-A-190219	C-20-B-190219	C-21-A-190219	C-21-B-190219	C-22-A-190219	C-22-B-190219
Depth	4 - 8 ft	0 - 2.3 ft	3.9 - 6.3 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Dioxin Furans (ng/kg)											
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**0.10 J**	**2.99 J**	**0.08 J**	**0.27 J**	**0.39 J**	**0.50 J**	**0.04 J**	**0.08 J**	**0.06 J**	**0.15 J**	**0.13 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**0.02 J**	**2.93 J**	**0.03 J**	**0.14 J**	**0.27 J**	**0.42 J**	**4.80E-04 J**	**0.02 J**	**0.02 J**	**0.09 J**	**0.06 J**

Analyte	C-23-A1-190222	C-23-B1-190222	C-24-A-190223	C-24-B-190223	C-25-A-190222	C-25-B-190222
Depth	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Dioxin Furans (ng/kg)						
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**0.35 J**	**0.08 J**	**0.63 J**	**0.05 J**	**0.07 J**	**0.07 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**0.27 J**	**0.01 J**	**0.48 J**	**5.5E-03 J**	**0.02 J**	**0.01 J**

Notes:

Detected concentration is greater than DMMP SL screening level (4 ng/kg TEQ)

Detected concentration is greater than DMMP BT screening level (10 ng/kg TEQ)

Bold: Detected result

*: EMPC value reported by laboratory; treated as non-detect (U) in the TEQ calculation

BT: Bioaccumulation Trigger

D/F: dioxins/furans

DMMP: Dredged Material Management Program

J: Estimated value

ML: Maximum Level

ng/kg: nanogram per kilogram

SL: Screening Level

TEF: toxic equivalence factor

TEQ: toxic equivalent

U: Compound analyzed, but not detected above detection limit

Table 8
Suitability Probabilities for Open-Water Disposal of Non-Native Material

Area	Station	sediment category	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Analyses[1]	Detected SL/BT Exceedance	Dioxins/furans above 4/10 pptr TEQ	Suitable/Unsuitable	Suitability Probablility	Average suitability probability	Rounded Suitability Probability
Mouth	C-1	surf	A	0 to 2	-49.9 to -51.9	Full Suite	no	no	suitable	100	92.86	**90**
	C-1	surf	B	2 to 4	-51.9 to -53.9	Full Suite	no	no	suitable	100		
	C-2	surf	A	0 to 2	-51.4 to -53.4	Full Suite	no	no	suitable	100		
	C-3	undetermined	A	0 to 2.7	-52.5 to -55.2	Full Suite	Total Chlordane non-detect	no	possibly suitable	50		
	C-3	undetermined	B	2.7 to 5.8	-55.2 to -58.3	Full Suite	no	no	suitable	100		
	C-4	surf	A	0 to 2	-53.6 to -55.6	Full Suite	no	no	suitable	100		
	C-5	surf	A	0 to 2	-51.5 to -53.5	Full Suite	no	no	suitable	100		
Middle	C-7	surf	A	0 to 2	-50.4 to -52.4	Full Suite	no	4.38	likely suitable	75	63.63636364	**60**
	C-8	undetermined	A	0 to 2	-52.0 to -54.0	Full Suite	no	5.00	likely suitable	75		
	C-8	undetermined	B	2 to 4	-54.0 to -56.0	Full Suite	no	no	suitable	100		
	C-10	surf	A	0 to 2	-49.0 to -51.0	Full Suite	no	8.79	likely suitable	75		
	C-10	surf	B	2 to 4	-51.0 to -53.0	Full Suite	Tributyltin	7.42	unsuitable	0		
	C-10	surf	C	4 to 6	-53.0 to -55.0	Full Suite	no	no	suitable	100		
	C-11	surf	A	0 to 2	-51.6 to -53.6	Full Suite	Total Chlordane non-detect	5.92	possibly suitable	50		
	C-12	undetermined	A	0 to 2	-22.7 to -24.7	Full Suite	Total PCB Aroclors	56.2	unsuitable	0		
	C-12	undetermined	B	2 to 4	-24.7 to -26.7	Full Suite	no	54.5	unsuitable	0		
	C-12	undetermined	C	4 to 6	-26.7 to -28.7	Full Suite	no	17.7	unsuitable	0		
	C-12	undetermined	D	6 to 8	-28.7 to -30.7	D/F	no	no	suitable	100		
	C-12	undetermined	E	8 to 10	-30.7 to -32.7	D/F	no	no	suitable	100		
	C-13	undetermined	A	0 to 2	-39.0 to -41	Full Suite	no	5.34	likely suitable	75		
	C-13	undetermined	B	2 to 4	-41.0 to -43.0	Full Suite	no	7.73	likely suitbble	75		
	C-13	undetermined	C	4 to 6	-43.0 to -45.0	Full Suite	no	11.88	unsuitable	0		
	C-13	undetermined	D	6 to 8	-45.0 to -47.0	D/F	no	7.64	likely suitable	75		
	C-13	undetermined	E	8 to 10	-47.0 to -49.0	D/F	no	no	suitable	100		
	C-14	surf	A	0 to 2	-52.6 to -54.6	Full Suite	no	no	suitable	100		
	C-14	surf	B	2 to 4	-54.6 to -56.6	Full Suite	no	no	suitable	100		
	C-15	undetermined	A	0 to 2	-45.6 to -47.6	Full Suite	no	10.6	unsuitable	0		
	C-15	undetermined	B	2 to 4	-47.6 to -49.6	Full Suite	no	no	suitable	100		
	C-15	undetermined	C	4 to 6	-49.6 to -51.6	Full Suite	no	no	suitable	100		
Head	C-16	surf	A	0 to 2	-50.6 to -52.6	Full Suite	no	no	suitable	100	100	**100**
	C-17	undetermined	A	0 to 2	-19.7 to -21.7	Full Suite	no	no	suitable	100		
	C-17	undetermined	B	2 to 4	-21.7 to -23.7	Full Suite	no	no	suitable	100		
	C-17	undetermined	C	4 to 8	-23.7 to -25.7	Full Suite	no	no	suitable	100		
	C-18	surf	A	0 to 2.3	-52.2 to -54.5	Full Suite	no	no	suitable	100		
	C-24	surf	A	0 to 2	-51.1 to -53.1	Full Suite	no	no	suitable	100		
	C-25	surf	A	0 to 2	-51.4 to -53.4	Full Suite	no	no	suitable	100		
	C-25	surf	B	2 to 4	-53.4 to -55.4	Full Suite	no	no	suitable	100		

Legend

	Probability of being suitable during full characterization
suitable	100
likely suitable	75
possibly suitable	50
unsuitable	0

above SL, BT or dioxin above 4 pptr TEQ

dioxin above 10 pptr TEQ

all less than SLs/BTs

Table 9
Suitability Probabilities for Open-Water Disposal of Native Material

Station		Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Analyses[1]	Detected SL/BT Exceedance	Dioxins/furans above 4 pptr TEQ	Suitable/Unsuitable	Suitability Probablility	Average suitability probability	Rounded Suitability Probability
C-1	native	C	4 to 6	-53.9 to -55.9	Full Suite	no	no	suitable	100	98.07692308	95
C-2	native	B	2 to 4	-53.4 to -55.4	Full Suite	no	no	suitable	100		
C-2	native	C	4 to 6	-55.4 to -57.4	TBT	no	no	suitable	100		
C-2	native	D	6 to 8.6	57.4 to -60.0	TBT	no	no	suitable	100		
C-4	native	B	2 to 4	-55.6 to -57.6	Full Suite	no	no	suitable	100		
C-5	native	B	2 to 4	-53.5 to -55.5	Full Suite	no	no	suitable	100		
C-6	native	A	0 to 2	-53.9 to -55.9	Full Suite	no	no	suitable	100		
C-6	native	B	2 to 4	-55.9 to -57.9	Full Suite	no	no	suitable	100		
C-7	native	B	2 to 4	-52.4 to -54.4	Full Suite	Hexachlorobutadiene	no	possibly suitable	50		
C-7	native	C	4 to 6	-54.4 to -56.4	Full Suite	no	no	suitable	100		
C-9	native	A	0 to 2	-53.0 to -55.0	Full Suite	no	no	suitable	100		
C-9	native	B	2 to 4	-55.0 to -57.0	Full Suite	no	no	suitable	100		
C-11	native	B	2 to 4	-53.6 to -55.6	Full Suite	no	no	suitable	100		
C-16	native	B	2 to 4	-52.6 to -54.6	Full Suite	no	no	suitable	100		
C-18	native	B	3.9 to 6.3	-54.5 to -56.9	Full Suite	no	no	suitable	100		
C-19	native	A	0 to 2	-52.4 to -54.4	Full Suite	no	no	suitable	100		
C-19	native	B	2 to 4	-54.4 to -56.4	Full Suite	no	no	suitable	100		
C-20	native	A	0 to 2	-51.3 to -53.3	Full Suite	no	no	suitable	100		
C-20	native	B	2 to 4	-53.3 to -55.3	Full Suite	no	no	suitable	100		
C-21	native	A	0 to 2	-53.7 to -55.7	Full Suite	no	no	suitable	100		
C-21	native	B	2 to 4	-55.7 to -57.7	Full Suite	no	no	suitable	100		
C-22	native	A	0 to 2	-51.0 to -53.0	Full Suite	no	no	suitable	100		
C-22	native	B	2 to 4	-53.0 to -55.0	Full Suite	no	no	suitable	100		
C-23	native	A	0 to 2	-53.7 to -55.7	Full Suite	no	no	suitable	100		
C-23	native	B	2 to 4	-55.7 to -57.7	Full Suite	no	no	suitable	100		
C-24	native	B	2 to 4	-53.1 to -55.1	Full Suite	no	no	suitable	100		

Legend

	Probability of being suitable during full characterization
suitable	100
likely suitable	75
possibly suitable	50
unsuitable	0

above SL, BT or dioxin above 4 pptr TEQ

dioxin above 10 pptr TEQ

all less than SLs/BTs

Table 10
SMS Comparison for Samples with TOC above 0.5%

Sample ID		C-1-A-190219	C-5-B-190221	C-6-B-190219	C-7-A-190221	C-8-A-190221	C-10-A-190221	C-11-A-190220	C-12-A-190223	C-12-C-190223	C-13-A-190223	C-17-A-190222	C-17-B-190222
Sample Date		2/19/2019	2/21/2019	2/19/2019	2/21/2019	2/21/2019	2/21/2019	2/20/2019	2/23/2019	2/23/2019	2/23/2019	2/22/2019	2/22/2019
Depth		0 - 2 ft	2 - 4 ft	2 - 4 ft	0 - 2 ft	0 - 2 ft	0 - 2 ft	0 - 2 ft	0 - 2 ft	4 - 6 ft	0 - 2 ft	0 - 2 ft	2 - 4 ft
Analyte	SQS	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ
Conventional Parameters (%)													
Total organic carbon		0.71	0.74	0.71	0.55	0.54	1.01	0.86	0.61	0.75	0.59	0.83	3.24
Metals (mg/kg)													
Arsenic	57	3.24	1.63	1.41	4.52	4.3	5.95	4.8	6.8	5.07	6.08	3.74	3.44
Cadmium	5.1	0.09 J	0.05 J	0.13 U	0.08 J	0.07 J	0.13 J	0.09 J	0.14	0.14	0.11 J	0.05 J	0.21
Chromium	260	14.7	12.7	11.1	16.3	13.6	15.6	14.3	16.3	16.7	13	16.3	16.4
Copper	390	26.7	16.9	15.6	25.2	24.4	31.8	27.3	29.2	24.7	66.1	32.6	30.7
Lead	450	6.01	1.86	1.46	6.14	5.97	8.1	6.34	14.8	5.11	4.5	3.94	3.12
Mercury	0.41	0.0423	0.0227 U	0.00982 J	0.0278 J	0.0351 J	0.0428 J	0.0352	0.0703	0.0549	0.0252	0.0296	0.0373
Silver	6.1	0.12 J	0.06 J	0.06 J	0.11 J	0.11 J	0.16 J	0.13 J	0.14 J	0.09 J	0.08 J	0.1 J	0.1 J
Zinc	410	33.3	24	18.8	37.2	34.1	43.4	36.7	43.7	29.8	43.1	30.4	25.3
Semivolatile Organics (ug/kg)													
Benzoic acid	650	84.7 J	56.2 J	37.8 J	26.5 J	37.1 J	146	93.3 J	228 J	46.1 J	71.1 J	310	164
Benzyl alcohol	57	19.9 U	19.5 U	19.7 U	19.9 U	19.5 U	19.7 U	17.9 J	19 U	19.9 U	19.6 U	19.9 U	19.5 U
2,4-Dimethylphenol	29	24.9 UJ	24.4 U	24.6 UJ	24.8 U	24.4 U	3.4 J	3.1 J	10.6 J	24.9 U	24.5 U	24.8 UJ	2.6 J
2-Methylphenol (o-Cresol)	63	3 J	4.9 U	4.9 U	5 U	4.9 U	4.9 U	2.2 J	4.8 U	5 U	4.9 U	2.7 J	3.1 J
4-Methylphenol (p-Cresol)	670	5	4.9 U	4.9 U	5 U	4.9 U	6.4	6.8	14.4	2.8 J	4.9 U	4.7 J	7.6
Pentachlorophenol	360	19.9 UJ	5.5 J	19.7 UJ	19.9 UJ	19.5 UJ	9.3 J	4.1 J	11.2 J	19.9 UJ	19.6 UJ	4.5 J	19.5 UJ
Phenol	420	13.5 U	8.1 U	6.4 U	6.2 U	4.9 U	15 U	20.3	53 U	17.5 U	23.7 U	41	34.7
Semivolatile Organics (mg/kg OC)													
1,2,4-Trichlorobenzene	0.81	0.38 U	0.35 U	0.37 U	0.49 U	0.48 U	0.26 U	0.29 U	0.41 U	0.36 U	0.44 U	0.33 U	0.08 U
1,2-Dichlorobenzene	2.3	0.70 U	0.13 J	0.69 U	0.70 U	0.69 U	0.69 U	0.66 U	0.86	0.70 U	0.69 U	0.70 U	0.69 U
1,4-Dichlorobenzene	3.1	0.70 U	0.69 U	0.69 U	0.70 U	0.69 U	0.69 U	0.66 U	0.52 J	0.70 U	0.69 U	0.70 UJ	0.69 UJ
Hexachlorobenzene	0.38	0.10 U	0.09 U	0.10 U	0.13 U	0.13 U	0.07 U	0.08 U	0.11 U	0.09 U	0.12 U	0.08 U	0.02 U
bis(2-Ethylhexyl)phthalate	47	7.01 U	6.89 U	6.93 U	4.21 J	6.87 U	7.99	4.25 J	14.93	7.01 U	4.28 J	7.00 U	6.86 U
Butylbenzyl phthalate	4.9	2.80 U	2.75 U	2.77 U	2.80 U	2.75 U	2.77 U	2.68 U	2.68 U	2.80 U	2.76 U	2.80 U	2.75 U
Diethyl phthalate	61	2.80 U	2.75 U	2.77 U	2.80 U	9.44 U	2.77 U	--	2.68 U	2.80 U	2.76 U	2.80 U	2.75 U
Dimethyl phthalate	53	0.70 U	0.69 U	0.69 U	0.70 U	0.69 U	0.69 U	0.66 U	0.44 J	0.70 U	0.69 U	0.70 U	0.69 U
Di-n-butyl phthalate	220	5.25	3.28 U	7.90	6.80 U	2.75 U	5.83 U	10.17	2.68 U	2.80 U	2.76 U	13.79 U	14.07 U
Di-n-octyl phthalate	58	2.80 U	2.75 U	2.77 U	2.80 U	2.75 U	2.77 U	2.68 U	2.68 U	2.80 U	2.76 U	2.80 U	2.75 U
Hexachlorobutadiene	3.9	0.70 U	0.66 U	0.69 U	0.91 U	0.91 U	0.49 U	0.55 U	0.79 U	0.67 U	0.83 U	0.60 U	0.15 U
Dibenzofuran	15	1.23 J	2.75 U	0.76 J	2.80 U	1.73 J	2.34 J	1.27 J	3.37	2.80 U	2.76 U	2.80 U	2.75 U
n-Nitrosodiphenylamine	11	0.70 U	0.69 U	0.69 U	0.70 U	0.69 U	0.48 J	0.66 U	0.68 U	0.70 U	0.69 U	0.70 U	0.69 U
Polycyclic Aromatic Hydrocarbons (mg/kg OC)													
2-Methylnaphthalene	38	3.48	2.42 J	3.00	2.80 U	4.94	4.03	2.49 J	3.03	2.80 U	1.00 J	1.65 J	1.00 J
Acenaphthene	16	2.80 U	2.75 U	2.77 U	2.80 U	1.08 J	1.06 J	2.68 U	2.97	2.80 U	2.76 U	2.80 U	2.75 U
Acenaphthylene	66	2.80 U	2.75 U	2.77 U	2.80 U	0.90 J	1.55 J	2.68 U	1.54 J	2.80 U	2.76 U	2.80 U	2.75 U
Anthracene	220	2.08 J	2.75 U	2.77 U	1.86 J	2.83	4.04	2.62 J	3.75 J	1.20 J	0.97 J	2.80 UJ	2.75 UJ
Benzo(a)anthracene	110	3.39	0.73 J	2.77 U	4.20	5.41	7.92	5.99	3.54	1.13 J	2.41 J	0.92 J	2.75 U
Benzo(a)pyrene	99	2.86	2.75 U	2.77 U	5.32	5.89	9.46	6.49	5.68	1.37 J	3.25	2.80 U	2.75 U
Benzo(b,j,k)fluoranthenes	230	8.13	5.51 U	5.54 U	17.04	13.90	28.87	16.62	16.06	3.17 J	8.86	3.20 J	5.49 U
Benzo(g,h,i)perylene	31	2.06 J	2.75 U	2.77 U	4.13	3.82	6.83	4.66	4.34	1.37 J	2.93	2.80 U	2.75 U
Chrysene	110	5.28	1.00 J	1.04 J	7.15	10.10	11.65	8.65	7.20	1.66 J	3.92	2.07 J	1.24 J
Dibenzo(a,h)anthracene	12	0.62 J	0.69 U	0.69 U	1.24	1.66	2.65	1.30	1.55	0.38 J	0.93	0.37 J	0.69 U
Fluoranthene	160	6.68	2.75 U	2.77 U	6.66	9.08	15.49	7.34	12.80	2.61 J	3.59	1.13 J	2.75 U
Fluorene	23	1.17 J	2.75 U	2.77 U	0.82 J	1.45 J	2.21 J	1.13 J	3.94	2.80 U	2.76 U	2.80 U	2.75 U
Indeno(1,2,3-c,d)pyrene	34	1.89 J	2.75 U	2.77 U	3.90	3.54	6.18	4.15	3.58	1.03 J	2.24 J	2.80 U	2.75 U
Naphthalene	99	3.03	1.11 J	1.56 J	2.39 J	3.66	3.90	2.83	8.48	2.38 J	1.11 J	0.89 J	0.96 J
Phenanthrene	100	6.44	2.69 J	3.34	4.76	8.44	7.51	5.52	11.03	3.41	2.30 J	3.55	1.93 J
Pyrene	1000	8.66	2.75 U	2.77 U	9.27	11.49	24.51	10.70	30.28	5.65	6.87	3.00	2.75 U
PCB Aroclors (mg/kg-OC)[6]													
Total DMMP PCB Aroclors (U = 0)	12	0.72 J	0.54 U	0.56 U	1.71 J	2.19 J	2.01 J	0.7 J	28.41 J	3.27 J	1.98 J	0.72 J	0.12 U

non-detect reported at MDL
non-detect exceedance
detected exceedance

Table 11
SMS Comparison for Samples with TOC less than 0.5%

Sample ID Depth Analyte	SQS	C-1-B-190219 2 - 4 ft	C-1-C-190219 4 - 6 ft	C-2-A-190219 0 - 2 ft	C-2-B-190219 2 - 4 ft	C-3-A-190218 0 - 2.7 ft	C-3-B-190218 2.7 - 5.8 ft	C-4-A-190218 0 - 2 ft	C-4-B-190218 2 - 4 ft	C-5-A-190221 0 - 2 ft	C-6-A-190219 0 - 2 ft	C-7-B-190221 2 - 4 ft	C-7-C-190221 4 - 6 ft	C-8-B-190221 2 - 4 ft
Conventional Parameters (%)														
Total organic carbon		**0.21**	**0.09**	**0.37**	**0.26**	**0.49**	**0.27**	**0.15**	**0.12**	**0.28**	**0.22**	**0.44**	**0.2**	**0.39**
Metals (mg/kg)														
Arsenic	57	**1.67**	**1.06**	**4.97**	**1.95**	**3.7**	**1.77**	**1.12**	**1.01**	**1.59**	**1.14**	**1.76**	**1.39**	**2.66**
Cadmium	5.1	0.11 U	0.12 U	**0.05 J**	**0.05 J**	**0.06 J**	0.12 U	0.12 U	0.12 U	**0.04 J**	**0.12**	0.12 U	0.12 U	**0.07 J**
Chromium	260	**11**	**9.49**	**12.5**	**12.7**	**12.3**	**10.9**	**11.8**	**10.8**	**11.3**	**9.11**	**8.75**	**9.6**	**16.8**
Copper	390	**13.7**	**10.3**	**18.3**	**16.6**	**25.5**	**14.9**	**11.9**	**10.8**	**14.4**	**10.3**	**10.1**	**9.06**	**28.3**
Lead	450	**2.33**	**1.33**	**3.46**	**2.15**	**6.26**	**1.55**	**1.26**	**1.21**	**2.25**	**1.42**	**1.11**	**1.06**	**3.39**
Mercury	0.41	**0.025**	**0.0114 J**	**0.0249 J**	**0.0167 J**	**0.0599 J**	0.0231 UJ	0.026 UJ	0.0254 UJ	0.0269 U	0.0241 U	0.0266 U	0.0214 U	**0.0183 J**
Silver	6.1	**0.06 J**	**0.03 J**	**0.08 J**	**0.05 J**	**0.12 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.06 J**	**0.04 J**	**0.04 J**	**0.03 J**	**0.09 J**
Zinc	410	**19.3**	**14.9**	**27**	**23.7**	**34.4**	**19.9**	**20**	**19.4**	**21.1**	**17.9**	**16.4**	**16.7**	**32.1**
Semivolatile Organics (ug/kg)														
Benzoic acid	650	95.9 UJ	96.3 UJ	97.5 UJ	97 UJ	**85.1 J**	**15.8 J**	**16.8 J**	94.3 UJ	**21.2 J**	99.1 UJ	97.1 U	98.8 U	99.5 U
Benzyl alcohol	57	19.2 U	19.3 U	19.5 U	19.4 U	**13.4 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Hexachlorobutadiene	11	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	**26.5**	4.9 U	5 U
2,4-Dimethylphenol	29	24 UJ	24.1 UJ	24.4 UJ	24.3 UJ	24.1 UJ	24.6 UJ	24.3 UJ	23.6 UJ	24.9 U	24.8 UJ	24.3 U	24.7 U	24.9 U
2-Methylphenol (o-Cresol)	63	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
4-Methylphenol (p-Cresol)	670	4.8 U	4.8 U	**2.9 J**	4.9 U	**5.4**	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
Pentachlorophenol	360	19.2 UJ	19.3 UJ	19.5 UJ	19.4 UJ	19.3 UJ	19.7 UJ	19.4 UJ	18.9 UJ	**5.4 J**	19.8 UJ	19.4 UJ	19.8 UJ	19.9 UJ
Phenol	420	4.8 U	4.8 U	7.8 U	4.9 U	**30**	6.1 U	5.6 U	4.7 U	6.4 U	5 U	5.4 U	4.9 U	5 U
Semivolatile Organics (ug/kg)														
1,2,4-Trichlorobenzene	31	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
1,2-Dichlorobenzene	35	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
1,4-Dichlorobenzene	110	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
Hexachlorobenzene	22	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	**3 J**	4.9 U	5 U
bis(2-Ethylhexyl)phthalate	1300	47.9 U	48.2 U	48.8 U	48.5 U	**29.5 J**	49.2 U	48.6 U	47.1 U	49.8 U	49.5 U	48.6 U	49.4 U	49.8 U
Butylbenzyl phthalate	63	19.2 U	19.3 U	19.5 U	19.4 U	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Diethyl phthalate	200	19.2 U	19.3 U	19.5 U	19.4 U	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	25.5 U	27.7 U
Dimethyl phthalate	71	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
Di-n-butyl phthalate	1400	**22.5**	**22.4**	**40.6**	**14.9 J**	**118**	**69.7**	**96.1**	**108**	19.9 U	**43.4**	19.4 U	30.6 U	19.9 U
Di-n-octyl phthalate	6200	19.2 U	19.3 U	19.5 U	19.4 U	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Dibenzofuran	540	19.2 U	19.3 U	19.5 U	19.4 U	**12 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
n-Nitrosodiphenylamine	28	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
Polycyclic Aromatic Hydrocarbons (ug/kg)														
2-Methylnaphthalene	670	**8.6 J**	19.3 U	19.5 U	**6.4 J**	**18.4 J**	**8 J**	19.4 U	18.9 U	19.9 U	19.8 U	**7.8 J**	**9.8 J**	**9.8 J**
Acenaphthene	500	19.2 U	19.3 U	19.5 U	19.4 U	**7 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Acenaphthylene	1300	19.2 U	19.3 U	19.5 U	19.4 U	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Anthracene	960	19.2 U	19.3 U	**7.7 J**	19.4 U	**13.9 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Benzo(a)anthracene	1300	**16.6 J**	19.3 U	**17.5 J**	**5.2 J**	**20.7**	19.7 U	19.4 U	18.9 U	**7.4 J**	19.8 U	19.4 U	19.8 U	**5.4 J**
Benzo(a)pyrene	1600	**16.7 J**	19.3 U	**16.3 J**	19.4 U	**26.8**	19.7 U	19.4 U	18.9 U	**8.5 J**	19.8 U	19.4 U	19.8 U	19.9 U
Benzo(b,j,k)fluoranthenes	3200	**35.3 J**	38.5 U	**38.8 J**	38.8 U	**75.9**	39.4 U	38.9 U	37.7 U	**26.9 J**	39.6 U	38.8 U	39.5 U	39.8 U
Benzo(g,h,i)perylene	670	**8 J**	19.3 U	**10.1 J**	19.4 U	**20.1**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Chrysene	1400	**21.2**	19.3 U	**24**	**6.7 J**	**34.4**	**5.3 J**	19.4 U	18.9 U	**11.7 J**	19.8 U	19.4 U	19.8 U	**17.6 J**
Dibenzo(a,h)anthracene	230	**3.7 J**	4.8 U	**2.7 J**	4.9 U	**7.6**	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
Fluoranthene	1700	**22**	19.3 U	**32.1**	**7.7 J**	**38.3**	19.7 U	19.4 U	18.9 U	**11.9 J**	19.8 U	19.4 U	19.8 U	19.9 U
Fluorene	540	19.2 U	19.3 U	19.5 U	19.4 U	**11 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Indeno(1,2,3-c,d)pyrene	600	**7.4 J**	19.3 U	**8.3 J**	19.4 U	**16.7 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Naphthalene	2100	**8.7 J**	19.3 U	**11.7 J**	**5.3 J**	**31**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	**8.5 J**	19.9 U
Phenanthrene	1500	**13.6 J**	19.3 U	**24.9**	**13 J**	**36.9**	**13 J**	**5.9 J**	18.9 U	**12.9 J**	19.8 U	**14.7 J**	19.8 U	**22.6**
Pyrene	2600	**27.1**	19.3 U	**39.5**	**9.3 J**	**63.5**	19.7 U	19.4 U	18.9 U	**15.9 J**	**6.3 J**	19.4 U	19.8 U	19.9 U
PCB Aroclors (µg/kg)														
Total DMMP PCB Aroclors (U = 0)	130	3.9 U	4 U	**2 J**	4 U	**3.8 J**	4 U	4 U	3.9 U	**0.8 J**	**1.9 J**	4 U	4 U	3.9 U

non-detect exceedance
detected exceedance
AET-based SQS different from DMMP SL

Table 11

SMS Comparison for Samples with TOC less than 0.5%

Sample ID Depth Analyte	SQS	C-9-A-190220 0 - 2 ft	C-9-B-190220 2 - 4 ft	C-10-B-190221 2 - 4 ft	C-10-C-190221 4 - 6 ft	C-11-B-190220 2 - 4 ft	C-12-B-190223 2 - 4 ft	C-13-B-190223 2 - 4 ft	C-13-C-190223 4 - 6 ft	C-14-A-190221 0 - 2 ft	C-14-B-190221 2 - 4 ft	C-15-A-190222 0 - 2 ft	C-15-B-190222 2 - 4 ft	C-15-C-190222 4 - 6 ft
Conventional Parameters (%)														
Total organic carbon		**0.11**	**0.19**	**0.45**	**0.19**	**0.14**	**0.37**	**0.39**	**0.18**	**0.09**	**0.15**	**0.25**	**0.1**	**0.17**
Metals (mg/kg)														
Arsenic	57	**2.08**	**2.58**	**3.4**	**1.88**	**1.3**	**5.07**	**6.67**	**3.88**	**4.18**	**5.08**	**6.4**	**2.74**	**4.28**
Cadmium	5.1	0.11 U	**0.09 J**	**0.12 J**	**0.1**	0.12 U	**0.13**	**0.11 J**	**0.05 J**	0.11 U	**0.06 J**	**0.05 J**	0.11 U	**0.04 J**
Chromium	260	**11.3**	**11.8**	**11.3**	**8.23**	**10.7**	**16.2**	**13.5**	**12**	**11.3**	**13**	**12.4**	**9.38**	**11.5**
Copper	390	**10.7**	**14.4**	**19.1**	**11.8**	**11.1**	**23.8**	**22.7**	**14.1**	**12.3**	**14.6**	**21.3**	**11.5**	**14.3**
Lead	450	**1.25**	**1.61**	**4.2**	**1.46**	**1.33**	**6.32**	**5.04**	**1.67**	**1.54**	**1.8**	**5.36**	**1.36**	**1.74**
Mercury	0.41	0.0217 U	**0.00517 J**	**0.0271 J**	**0.00691 J**	0.0241 U	**0.0607**	**0.0381**	**0.011 J**	0.0216 U	0.0216 U	**0.027 J**	**0.0142 J**	**0.0148 J**
Silver	6.1	**0.04 J**	**0.06 J**	**0.09 J**	**0.04 J**	**0.04 J**	**0.09 J**	**0.11 J**	**0.05 J**	**0.04 J**	**0.05 J**	**0.09 J**	**0.04 J**	**0.05 J**
Zinc	410	**18**	**19.7**	**25.5**	**15.8**	**18.7**	**30.4**	**34.2**	**22.2**	**21.7**	**22.2**	**30**	**18**	**22.5**
Semivolatile Organics (ug/kg)														
Benzoic acid	650	99.1 UJ	95.3 UJ	**43.3 J**	96 U	94 UJ	**77 J**	**76.3 J**	**22.3 J**	97.1 U	98.6 U	**79.4 J**	99 U	99 UJ
Benzyl alcohol	57	**10.1 J**	**9.7 J**	19.1 U	19.2 U	18.8 U	19.8 U	**3.4 J**	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Hexachlorobutadiene	11	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
2,4-Dimethylphenol	29	24.8 UJ	23.8 UJ	23.8 U	24 U	23.5 UJ	**2.8 J**	24.8 U	24.5 U	24.3 U	24.7 U	23.6 UJ	24.8 UJ	24.8 UJ
2-Methylphenol (o-Cresol)	63	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
4-Methylphenol (p-Cresol)	670	5 U	4.8 U	**2.7 J**	4.8 U	4.7 U	**5.1**	**3.1 J**	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Pentachlorophenol	360	19.8 UJ	19.1 UJ	19.1 UJ	19.2 UJ	18.8 UJ	**10.1 J**	19.9 UJ	19.6 UJ	19.4 UJ	**7.7 J**	18.9 UJ	19.8 UJ	19.8 UJ
Phenol	420	5 U	5.3 U	9.7 U	4.8 U	4.7 U	23.1 U	31.6 U	8.2 U	4.9 U	4.9 U	13.7 U	5.9 U	7 U
Semivolatile Organics (ug/kg)														
1,2,4-Trichlorobenzene	31	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
1,2-Dichlorobenzene	35	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
1,4-Dichlorobenzene	110	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 UJ	5 UJ	5 UJ
Hexachlorobenzene	22	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
bis(2-Ethylhexyl)phthalate	1300	49.5 U	47.7 U	**32.8 J**	48 U	47 U	**32.9 J**	**41.7 J**	49 U	**54.7**	49.3 U	**61.8**	49.5 U	49.5 U
Butylbenzyl phthalate	63	19.8 U	19.1 U	19.1 U	19.2 U	18.8 U	19.8 U	19.9 U	19.6 U	19.4 U	19.7 U	**7.8 J**	19.8 U	19.8 U
Diethyl phthalate	200	19.8 U	19.1 U	19.1 U	24.5 U	18.8 U	38.2 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	31.9 U
Dimethyl phthalate	71	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Di-n-butyl phthalate	1400	**23.4**	**40.5**	20.6 U	30.4 U	**17.7 J**	**6 J**	19.9 U	19.6 U	34.4 U	39.9 U	121 U	81.4 U	38.6 U
Di-n-octyl phthalate	6200	19.8 U	19.1 U	19.1 U	19.2 U	18.8 U	19.8 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Dibenzofuran	540	19.8 U	19.1 U	**7.2 J**	19.2 U	18.8 U	**9.6 J**	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
n-Nitrosodiphenylamine	28	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Polycyclic Aromatic Hydrocarbons (ug/kg)														
2-Methylnaphthalene	670	19.8 U	19.1 U	**10.6 J**	19.2 U	18.8 U	19.8 U	**7 J**	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Acenaphthene	500	19.8 U	19.1 U	19.1 U	19.2 U	18.8 U	**8.2 J**	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Acenaphthylene	1300	19.8 U	19.1 U	19.1 U	19.2 U	18.8 U	19.8 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Anthracene	960	19.8 U	19.1 U	**16.1 J**	19.2 U	18.8 U	**14.4 J**	**10.6 J**	19.6 UJ	19.4 U	19.7 U	**6.1 J**	19.8 UJ	19.8 UJ
Benzo(a)anthracene	1300	19.8 U	19.1 U	**33.6**	19.2 U	18.8 U	**13.1 J**	**19.2 J**	19.6 U	19.4 U	19.7 U	**10.2 J**	19.8 U	19.8 U
Benzo(a)pyrene	1600	19.8 U	19.1 U	**45.7**	19.2 U	18.8 U	**18.8 J**	**29.4**	19.6 U	19.4 U	19.7 U	**18.9**	19.8 U	19.8 U
Benzo(b,j,k)fluoranthenes	3200	39.6 U	38.1 U	**115**	38.4 U	37.6 U	**49.2**	**85.1**	39.2 U	38.8 U	39.4 U	**54.5**	39.6 U	39.6 U
Benzo(g,h,i)perylene	670	19.8 U	19.1 U	**30.3**	19.2 U	18.8 U	**17.2 J**	**26.9**	19.6 U	19.4 U	19.7 U	**10.9 J**	19.8 U	19.8 U
Chrysene	1400	19.8 U	19.1 U	**53.7**	19.2 U	18.8 U	**23.4**	**32.4**	19.6 U	19.4 U	19.7 U	**17 J**	19.8 U	19.8 U
Dibenzo(a,h)anthracene	230	5 U	4.8 U	**12.4**	4.8 U	4.7 U	**6**	**8.6**	4.9 U	4.9 U	4.9 U	**4.8**	5 U	5 U
Fluoranthene	1700	19.8 U	19.1 U	**52**	19.2 U	18.8 U	**36**	**25.2**	19.6 U	19.4 U	19.7 U	**16.5 J**	19.8 U	19.8 U
Fluorene	540	19.8 U	19.1 U	**7.3 J**	19.2 U	18.8 U	**12.5 J**	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Indeno(1,2,3-c,d)pyrene	600	19.8 U	19.1 U	**28.7**	19.2 U	18.8 U	**14.6 J**	**21.9**	19.6 U	19.4 U	19.7 U	**10.6 J**	19.8 U	19.8 U
Naphthalene	2100	19.8 U	19.1 U	**15.9 J**	19.2 U	18.8 U	**27.9**	**9 J**	19.6 U	19.4 U	19.7 U	**8.9 J**	19.8 UJ	19.8 UJ
Phenanthrene	1500	19.8 U	**14.7 J**	**43**	**7.7 J**	18.8 U	**38.5**	**21.4**	**5.8 J**	19.4 U	19.7 U	**15.8 J**	**6.1 J**	19.8 U
Pyrene	2600	19.8 U	19.1 U	**79.1**	**6.6 J**	18.8 U	**71.1**	**68.5**	19.6 U	19.4 U	19.7 U	**27.5**	19.8 U	19.8 U
PCB Aroclors (µg/kg)														
Total DMMP PCB Aroclors (U = 0)	130	4 U	3.9 U	**11.2 J**	3.9 U	3.8 U	**90.1 J**	**23.1 J**	**3.7 J**	3.9 U	4 U	**19.4 J**	4 U	4 U

non-detect exceedance
detected exceedance
AET-based SQS different from DMMP SL

Table 11
SMS Comparison for Samples with TOC less than 0.5%

Analyte	SQS	C-16-A-190223 0 - 2 ft	C-16-B-190223 2 - 4 ft	C-17-C-190222 4 - 8 ft	C-18-A1-190220 0 - 2.3 ft	C-18-B1-190220 3.9 - 6.3 ft	C-19-A-190220 0 - 2 ft	C-19-B-190220 2 - 4 ft	C-20-A-190219 0 - 2 ft	C-20-B-190219 2 - 4 ft	C-21-A-190219 0 - 2 ft	C-21-B-190219 2 - 4 ft	C-22-A-190219 0 - 2 ft	C-22-B-190219 2 - 4 ft
Conventional Parameters (%)														
Total organic carbon		**0.25**	**0.05**	**0.39**	**0.29**	**0.13**	**0.09**	**0.1**	**0.08**	**0.04**	**0.49**	**0.11**	**0.07**	**0.04**
Metals (mg/kg)														
Arsenic	57	**3.82**	**2.21**	**2.15**	**3.2**	**3.89**	**1.89**	**2.53**	**1.28**	**1.1**	**4.41**	**2.26**	**1.59**	**1.31**
Cadmium	5.1	**0.07 J**	0.11 U	**0.04 J**	**0.05 J**	0.11 U	0.1 U	0.12 U	**0.05 J**	**0.03 J**	0.11 U	**0.05 J**	0.1 U	0.1 U
Chromium	260	**10.2**	**10.6**	**14.4**	**11.5**	**10.1**	**9.73**	**10.3**	**9.69**	**10.4**	**7.99**	**8.59**	**11.3**	**9.53**
Copper	390	**14.9**	**10.5**	**21.2**	**16.1**	**13**	**12.7**	**15.2**	**13.9**	**14**	**14.9**	**14.9**	**12.7**	**10.9**
Lead	450	**2.82**	**1.29**	**2.07**	**2.81**	**1.51**	**1.54**	**1.84**	**1.41**	**1.5**	**1.43**	**1.49**	**1.36**	**1.41**
Mercury	0.41	**0.0195 J**	**0.00813 J**	**0.0201 J**	0.0291 U	0.021 U	0.0187 U	0.0204 U	**0.00698 J**	**0.00973 J**	**0.0112 J**	**0.0134 J**	**0.00859 J**	**0.00788 J**
Silver	6.1	**0.08 J**	**0.04 J**	**0.07 J**	**0.05 J**	**0.04 J**	**0.04 J**	**0.05 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.03 J**	**0.03 J**	**0.03 J**
Zinc	410	**22.5**	**19.7**	**23.9**	**25.6**	**29.6**	**20.9**	**21.3**	**18.7**	**20.1**	**18**	**20.1**	**19.2**	**17.6**
Semivolatile Organics (ug/kg)														
Benzoic acid	650	**68.4 J**	98.6 UJ	**32.9 J**	**214 J**	**60.2 J**	97.7 UJ	**19.6 J**	99.1 UJ	97.1 UJ	95.7 UJ	96.7 UJ	98.7 UJ	98.6 UJ
Benzyl alcohol	57	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Hexachlorobutadiene	11	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
2,4-Dimethylphenol	29	23.9 U	24.6 U	23.9 UJ	24.2 U	23.6 U	24.4 UJ	24.6 UJ	24.8 UJ	24.3 UJ	23.9 UJ	24.2 UJ	24.7 UJ	24.7 UJ
2-Methylphenol (o-Cresol)	63	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
4-Methylphenol (p-Cresol)	670	4.8 U	4.9 U	**2 J**	**3.1 J**	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Pentachlorophenol	360	19.1 UJ	19.7 UJ	19.2 UJ	19.4 UJ	18.9 UJ	19.5 UJ	19.7 UJ	19.8 UJ	19.4 UJ	19.1 UJ	19.3 UJ	19.7 UJ	19.7 UJ
Phenol	420	18.3 U	8.1 U	7.3 U	**38.7**	13.4 U	4.9 U	5.3 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Semivolatile Organics (ug/kg)														
1,2,4-Trichlorobenzene	31	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
1,2-Dichlorobenzene	35	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	**0.8 J**	4.8 U	4.8 U	4.9 U	4.9 U
1,4-Dichlorobenzene	110	4.8 U	4.9 U	4.8 UJ	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Hexachlorobenzene	22	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
bis(2-Ethylhexyl)phthalate	1300	47.8 U	49.3 U	**29.6 J**	48.4 U	47.2 U	48.9 U	49.2 U	49.5 U	48.6 U	47.9 U	48.3 U	49.4 U	49.3 U
Butylbenzyl phthalate	63	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Diethyl phthalate	200	23.2 U	19.7 U	24.6 U	**7.2 J**	**9.2 J**	19.5 U	19.7 U	35.8 U	28.9 U	19.1 U	19.3 U	19.7 U	21.9 U
Dimethyl phthalate	71	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Di-n-butyl phthalate	1400	19.1 U	19.7 U	91.1 U	19.4 U	18.9 U	**161**	**133**	**36.8**	**22.6**	**17.2 J**	**39.8**	**18.8 J**	19.7 U
Di-n-octyl phthalate	6200	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Dibenzofuran	540	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
n-Nitrosodiphenylamine	28	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Polycyclic Aromatic Hydrocarbons (ug/kg)														
2-Methylnaphthalene	670	19.1 U	19.7 U	**6.2 J**	19.4 U	**7.5 J**	19.5 U	19.7 U	19.8 U	19.4 U	**7.3 J**	19.3 U	19.7 U	19.7 U
Acenaphthene	500	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Acenaphthylene	1300	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Anthracene	960	**8.8 J**	19.7 UJ	19.2 UJ	**5.9 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Benzo(a)anthracene	1300	**11.9 J**	19.7 U	19.2 U	**9 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	**7 J**	19.3 U	19.7 U	19.7 U
Benzo(a)pyrene	1600	**10.8 J**	19.7 U	19.2 U	**16.4 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Benzo(b,j,k)fluoranthenes	3200	38.2 U	39.4 U	38.3 U	**42.2**	37.8 U	39.1 U	39.3 U	39.6 U	38.9 U	38.3 U	38.7 U	39.5 U	39.5 U
Benzo(g,h,i)perylene	670	**7.7 J**	19.7 U	19.2 U	**9.7 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Chrysene	1400	**28.8**	19.7 U	**5.9 J**	**18.2 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	**14.3 J**	19.3 U	19.7 U	19.7 U
Dibenzo(a,h)anthracene	230	**2.7 J**	4.9 U	4.8 U	**3.8 J**	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Fluoranthene	1700	**12.3 J**	19.7 U	**4.9 J**	**13.9 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	**5.8 J**	19.3 U	19.7 U	19.7 U
Fluorene	540	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Indeno(1,2,3-c,d)pyrene	600	19.1 U	19.7 U	19.2 U	**8.2 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Naphthalene	2100	19.1 U	19.7 U	**8.1 J**	**7.9 J**	**5.4 J**	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Phenanthrene	1500	**15.8 J**	19.7 U	**14.6 J**	**11.9 J**	**6.3 J**	19.5 U	19.7 U	19.8 U	19.4 U	**38.1**	19.3 U	19.7 U	19.7 U
Pyrene	2600	**23.5**	19.7 U	**6.2 J**	**48.3**	18.9 U	19.5 U	**5.5 J**	**5.9 J**	19.4 U	**8.1 J**	19.3 U	19.7 U	19.7 U
PCB Aroclors (µg/kg)														
Total DMMP PCB Aroclors (U = 0)	130	**5.3 J**	4 U	4 U	3.9 UJ	4 U	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U

non-detect exceedance
detected exceedance
AET-based SQS different from DMMP SL

Table 11
SMS Comparison for Samples with TOC less than 0.5%

Analyte	SQS	C-23-A1-190222 0 - 2 ft	C-23-B1-190222 2 - 4 ft	C-24-A-190223 0 - 2 ft	C-24-B-190223 2 - 4 ft	C-25-A-190222 0 - 2 ft	C-25-B-190222 2 - 4 ft
Conventional Parameters (%)							
Total organic carbon		**0.07**	**0.04**	**0.06**	**0.04**	**0.29**	**0.44**
Metals (mg/kg)							
Arsenic	57	**2.41**	**2**	**1.99**	**1.16**	**2.79**	**2.59**
Cadmium	5.1	**0.04 J**	**0.04 J**	0.11 U	0.1 U	**0.05 J**	0.12 U
Chromium	260	**10.1**	**9.02**	**11.3**	**9.86**	**15.5**	**13.2**
Copper	390	**15.1**	**12.8**	**13.4**	**11.2**	**27.7**	**19.4**
Lead	450	**1.84**	**1.45**	**1.64**	**1.6**	**2.42**	**1.79**
Mercury	0.41	0.0232 U	**0.0101 J**	**0.0112 J**	**0.00818 J**	**0.0219 J**	**0.0191 J**
Silver	6.1	**0.04 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.07 J**	**0.05 J**
Zinc	410	**23.8**	**21.2**	**23**	**22.4**	**73.9**	**20.1**
Semivolatile Organics (ug/kg)							
Benzoic acid	650	**15.4 J**	98.6 U	**43.9 J**	**25.5 J**	**33.6 J**	**84.3 J**
Benzyl alcohol	57	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Hexachlorobutadiene	11	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
2,4-Dimethylphenol	29	24.9 UJ	24.6 UJ	24.5 U	24.7 U	24.7 UJ	24.2 UJ
2-Methylphenol (o-Cresol)	63	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
4-Methylphenol (p-Cresol)	670	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Pentachlorophenol	360	20 UJ	19.7 UJ	19.6 UJ	19.8 UJ	19.8 UJ	19.3 UJ
Phenol	420	6.8 U	6.5 U	10 U	7.9 U	14.8 U	19.5 U
Semivolatile Organics (ug/kg)							
1,2,4-Trichlorobenzene	31	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
1,2-Dichlorobenzene	35	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
1,4-Dichlorobenzene	110	5 UJ	4.9 UJ	4.9 U	4.9 U	4.9 UJ	4.8 UJ
Hexachlorobenzene	22	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
bis(2-Ethylhexyl)phthalate	1300	49.9 U	49.3 U	49.1 U	49.4 U	**30.4 J**	**31.4 J**
Butylbenzyl phthalate	63	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Diethyl phthalate	200	30.9 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Dimethyl phthalate	71	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Di-n-butyl phthalate	1400	87.1 U	142 U	19.6 U	19.8 U	140 U	171 U
Di-n-octyl phthalate	6200	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Dibenzofuran	540	20 U	19.7 U	19.6 U	19.8 U	19.8 U	**5.9 J**
n-Nitrosodiphenylamine	28	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Polycyclic Aromatic Hydrocarbons (ug/kg)							
2-Methylnaphthalene	670	20 U	19.7 U	19.6 U	19.8 U	19.8 U	**17.9 J**
Acenaphthene	500	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Acenaphthylene	1300	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Anthracene	960	20 UJ	19.7 UJ	19.6 UJ	19.8 UJ	19.8 UJ	19.3 UJ
Benzo(a)anthracene	1300	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Benzo(a)pyrene	1600	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Benzo(b,j,k)fluoranthenes	3200	39.9 U	39.4 U	39.3 U	39.6 U	39.5 U	38.7 U
Benzo(g,h,i)perylene	670	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Chrysene	1400	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Dibenzo(a,h)anthracene	230	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Fluoranthene	1700	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Fluorene	540	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Indeno(1,2,3-c,d)pyrene	600	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Naphthalene	2100	20 UJ	19.7 UJ	19.6 U	19.8 U	19.8 UJ	**5.8 J**
Phenanthrene	1500	20 U	19.7 U	19.6 U	19.8 U	**6.7 J**	**15 J**
Pyrene	2600	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
PCB Aroclors (µg/kg)							
Total DMMP PCB Aroclors (U = 0)	130	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U

non-detect exceedance
detected exceedance
AET-based SQS different from DMMP SL

Table 12
Probability of Suitability for Beneficial Use of Non-Native Material

Section	Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Detected SL/BT Exceedance	Dioxins/furans above 4/10 pptr TEQ	PAH above 2000 ug/kg	Beneficial Use Suitable/Unsuitable	Suitability Probablility	Average suitability probability	Rounded Suitability Probability
Mouth	C-1	A	0 to 2	-49.9 to -51.9	no	no	no	suitable	100	85.71	**85**
		B	2 to 4	-51.9 to -53.9	no	no	no	suitable	100		
	C-2	A	0 to 2	-51.4 to -53.4	no	no	no	suitable	100		
	C-3	A	0 to 2.7	-52.5 to -55.2	Total Chlordane non-detect	no	no	unsuitable	0		
		B	2.7 to 5.8	-55.2 to -58.3	no	no	no	suitable	100		
	C-4	A	0 to 2	-53.6 to -55.6	no	no	no	suitable	100		
	C-5	A	0 to 2	-51.5 to -53.5	no	no	no	suitable	100		
Middle	C-7	A	0 to 2	-50.4 to -52.4	no	4.38	no	unsuitable	0	40.91	**40**
	C-8	A	0 to 2	-52.0 to -54.0	no	5.00	no	unsuitable	0		
		B	2 to 4	-54.0 to -56.0	no	no	no	suitable	100		
	C-10	A	0 to 2	-49.0 to -51.0	no	8.79	no	unsuitable	0		
		B	2 to 4	-51.0 to -53.0	Tributyltin	7.42	no	unsuitable	0		
		C	4 to 6	-53.0 to -55.0	no	no	no	suitable	100		
	C-11	A	0 to 2	-51.6 to -53.6	Total Chlordane non-detect	5.92	no	unsuitable	0		
	C-12	A	0 to 2	-22.7 to -24.7	Total PCB Aroclors	56.2	no	unsuitable	0		
		B	2 to 4	-24.7 to -26.7	no	54.5	no	unsuitable	0		
		C	4 to 6	-26.7 to -28.7	no	17.7	no	unsuitable	0		
		D	6 to 8	-28.7 to -30.7	no	no	no	suitable	100		
		E	8 to 10	-30.7 to -32.7	no	no	no	suitable	100		
	C-13	A	0 to 2	-39.0 to -41	no	5.34	no	unsuitable	0		
		B	2 to 4	-41.0 to -43.0	no	7.73	no	unsuitable	0		
		C	4 to 6	-43.0 to -45.0	no	11.88	no	unsuitable	0		
		D	6 to 8	-45.0 to -47.0	no	7.64	no	unsuitable	0		
		E	8 to 10	-47.0 to -49.0	no	no	no	suitable	100		
	C-14	A	0 to 2	-52.6 to -54.6	no	no	no	suitable	100		
		B	2 to 4	-54.6 to -56.6	no	no	no	suitable	100		
	C-15	A	0 to 2	-45.6 to -47.6	no	10.6	no	unsuitable	0		
		B	2 to 4	-47.6 to -49.6	no	no	no	suitable	100		
		C	4 to 6	-49.6 to -51.6	no	no	no	suitable	100		
Head	C-16	A	0 to 2	-50.6 to -52.6	no	no	no	suitable	100	100	**100**
	C-17	A	0 to 2	-19.7 to -21.7	no	no	no	suitable	100		
		B	2 to 4	-21.7 to -23.7	no	no	no	suitable	100		
		C	4 to 8	-23.7 to -25.7	no	no	no	suitable	100		
	C-18	A	0 to 2.3	-52.2 to -54.5	no	no	no	suitable	100		
	C-24	A	0 to 2	-51.1 to -53.1	no	no	no	suitable	100		
	C-25	A	0 to 2	-51.4 to -53.4	no	no	no	suitable	100		
		B	2 to 4	-53.4 to -55.4	no	no	no	suitable	100		

above SL, BT or dioxin above 4 pptr TEQ
dioxin above 10 pptr TEQ
all less than SLs/BTs

Table 13
Native Material - Probability of Suitability for Beneficial Use

Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Detected SL/BT Exceedance	Dioxins/furans above 4 pptr TEQ	PAH above 2000 ug/kg	Beneficial Use Suitable/Unsuitable	Suitability Probablility	Average suitability probability	Rounded Suitability Probability
C-1	C	4 to 6	-53.9 to -55.9	no	no	no	suitable	100	96.15	95
C-2	B	2 to 4	-53.4 to -55.4	no	no	no	suitable	100		
	C	4 to 6	-55.4 to -57.4	no	no	no	suitable	100		
	D	6 to 8.6	57.4 to -60.0	no	no	no	suitable	100		
C-4	B	2 to 4	-55.6 to -57.6	no	no	no	suitable	100		
C-5	B	2 to 4	-53.5 to -55.5	no	no	no	suitable	100		
C-6	A	0 to 2	-53.9 to -55.9	no	no	no	suitable	100		
	B	2 to 4	-55.9 to -57.9	no	no	no	suitable	100		
C-7	B	2 to 4	-52.4 to -54.4	Hexachlorobutadiene	no	no	unsuitable	0		
	C	4 to 6	-54.4 to -56.4	no	no	no	suitable	100		
C-9	A	0 to 2	-53.0 to -55.0	no	no	no	suitable	100		
	B	2 to 4	-55.0 to -57.0	no	no	no	suitable	100		
C-11	B	2 to 4	-53.6 to -55.6	no	no	no	suitable	100		
C-16	B	2 to 4	-52.6 to -54.6	no	no	no	suitable	100		
C-18	B	3.9 to 6.3	-54.5 to -56.9	no	no	no	suitable	100		
C-19	A	0 to 2	-52.4 to -54.4	no	no	no	suitable	100		
	B	2 to 4	-54.4 to -56.4	no	no	no	suitable	100		
C-20	A	0 to 2	-51.3 to -53.3	no	no	no	suitable	100		
	B	2 to 4	-53.3 to -55.3	no	no	no	suitable	100		
C-21	A	0 to 2	-53.7 to -55.7	no	no	no	suitable	100		
	B	2 to 4	-55.7 to -57.7	no	no	no	suitable	100		
C-22	A	0 to 2	-51.0 to -53.0	no	no	no	suitable	100		
	B	2 to 4	-53.0 to -55.0	no	no	no	suitable	100		
C-23	A	0 to 2	-53.7 to -55.7	no	no	no	suitable	100		
	B	2 to 4	-55.7 to -57.7	no	no	no	suitable	100		
C-24	B	2 to 4	-53.1 to -55.1	no	no	no	suitable	100		

above SL, BT or dioxin above 4 pptr TEQ
dioxin above 10 pptr TEQ
all less than SLs/BTs

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Re: EPA Comments on USACE Draft Tacoma Harbor Feasibility Report/Environmental Assessment

Dear Ms. Koch:

Thank you for your letter dated February 14, 2020 regarding the U.S. Environmental Protection Agency's (EPA) review of the Tacoma Harbor Draft Feasibility Report/Environmental Assessment, December 2019. We appreciate your review of the draft report and subsequent comments. The U.S. Army Corps of Engineers (USACE) is committed to continued coordination and collaboration between our two agencies, specifically as it relates to the Tacoma Harbor and ongoing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial activities in the vicinity of Blair Waterway. Based on the coordination that has occurred between the EPA and USACE, we would like to provide responses and clarification to statements made in the letter specific to potential impacts on contaminated sites. Responses to other topics brought forth in the letter related to water quality, air quality, biological resources, and monitoring will be included in the Response to Public Comments appendix to the Final Feasibility Report.

As suggested in the comment letter, USACE is coordinating with EPA regarding the status of the Commencement Bay Superfund Site and findings discussed in the fifth Five Year Review. USACE received a copy of the fifth Five Year Review in April 2020. As noted in the Five Year Review, "the USACE also sampled the Blair Waterway in 2019 in anticipation of deepening the waterway. Dioxin/furans and hexachlorobutadiene were detected at concentrations greater than the [Dredge Material Management Program (DMMP)] requirements for open-water disposal within the nearshore areas of middle sections of the waterway. If this material is not removed under this program, additional data would be needed to determine whether the contamination is site-related, and action is warranted due to newly identified contamination." In a subsequent conversation on April 29, 2020 with EPA's Justine Barton and Kristine Koch, clarification was provided from EPA to indicate the intent of this statement was to acknowledge the presence of material unsuitable for open-water disposal per DMMP guidelines. If USACE did not proceed with the deepening of Blair Waterway, EPA would possibly independently pursue additional studies to characterize the material and determine a path forward for potential site action under CERCLA. Through the characterization conducted by USACE in 2019, EPA acknowledges that there are no site specific Remedial Action Levels (RALs) for Blair Waterway, however, none of the sediment concentrations exceed the lowest RALs for other waterways in the Commencement Bay Superfund Site. In an evaluation of those same sediment results collected by USACE in 2019, only a single sample had an exceedance of the hexachlorobutadiene Sediment Cleanup Level established for the sediment operable unit in the Commencement Bay Superfund Site.

EPA further stated during the April 29th coordination call that levels of contamination for unsuitable material were such that the USACE could easily manage it with the standard Best Management Practices currently identified in the draft Feasibility Report and used during typical navigation dredging projects with unsuitable material. Further, any concerns EPA has regarding unsuitable material at depth would be addressed through USACE adherence to DMMP anti-degradation requirements.

USACE will continue regular coordination and communication with EPA throughout the feasibility, design, and construction phases of the project. USACE will also be coordinating with Washington State Department of Ecology regarding the status of Model Toxics Control Act sites through these phases as well. It is the intent of USACE to ensure that the proposed deepening and widening of the federal navigation channel in the Blair Waterway is consistent with agreed upon remedies for relevant State and Federal contaminated site cleanup and monitoring. Further, USACE will continue to engage the DMMP agencies to ensure adherence to requirements related to management and disposal of dredged material.

Regarding comments related to monitoring at the open-water disposal site in Commencement Bay, the costs for bathymetric and physical monitoring will be included as a specific line item in the final cost estimate and clearly articulated in the text of the Final Feasibility Report. Disposal site monitoring costs will include multibeam bathymetric surveys and physical monitoring using sediment profile imaging prior to the start of the project and at the end of each dredge season. The USACE is currently estimating that dredging will occur over four open-water work windows.

Other text revisions and clarifications requested in the letter specific to contaminated sites and sediment management were made and will be included in the Final Feasibility Report.

In light of these responses and clarifications, USACE requests a written response from EPA acknowledging this information and concurrence, or additional clarification if warranted, by August 14, 2020. For clarifications or questions related to the technical aspects of this letter, please reach out to the Technical Point of Contact for Tacoma Harbor, Kristen Kerns at (206) 764-3473 or Kristen.Kerns@usace.army.mil. If you have any other questions or concerns, please contact me at (206) 764-6761 or Laura.A.Boerner@usace.army.mil.

Sincerely,

BOERNER.LAURA.A.1251907443 Digitally signed by BOERNER.LAURA.A.1251907443 Date: 2020.05.28 14:02:51 -07'00'

Laura A. Boerner, LG, LHG
Chief, Planning, Environmental, and
Cultural Resources Branch
Corps of Engineers, Seattle District

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
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SUPERFUND &
EMERGENCY
MANAGEMENT DIVISION

August 14, 2020

Laura A. Boerner, LG, LHG
Chief, Planning, Environmental, and Cultural Resources Branch
Corps of Engineers, Seattle District
P.O. Box 3755
Seattle, Washington 98124-3755

Re: EPA Comments on USACE Draft Tacoma Harbor Feasibility Report/Environmental Assessment

Dear Ms. Boerner:

We have received you letter dated May 28th and concur that your letter clearly articulates our April 29th conversation regarding contaminant concentrations and management of sediments in the Blair Waterway. Based on the relatively low contaminant concentrations, we agree that USACE could easily manage these sediments with the standard Best Management Practices currently identified in the draft Feasibility Report and used during typical navigation dredging projects with unsuitable material.

As a point of clarification, the February 14 letter was sent to you from the NEPA review group at EPA, which is separate from the Superfund and Emergency Management Group (SEMD). My office cannot speak to the monitoring at the open water disposal site as it is beyond our purview. We have shared your letter with them so that they are aware of your response. EPA will continue to coordinate with you on this project through that office. Please make sure that you send your other responses to that group rather than to SEMD.

If you have any further questions or concerns regarding this project, please contact Justine Barton, Water Division, at (206) 553-6051 or by email at barton.justine@epa.gov.

Sincerely,

Kristine Koch
Project Manager
SEMD Cleanup Section 3

cc: Justine Barton, EPA-WD via email
Kristen Kerns, USACE via email

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

Planning, Environmental, and Cultural Resources Branch

Mr. Brad Thompson
U.S. Fish and Wildlife Service
Washington Fish and Wildlife Office
510 Desmond Drive SE, Suite 102
Lacey, WA 98503

Dear Mr. Thompson:

The Seattle District, U.S. Army Corps of Engineers (Corps) proposes navigation improvements in the Federal Navigation Channel in the Blair Waterway of Tacoma Harbor, Pierce County, Washington. The proposed plan would involve deepening the entire 2.75 mile long Blair Waterway from -51 feet to -57 feet Mean Lower Low Water, and widening the existing navigation channel to improve navigation. The work will be accomplished via mechanical (clamshell bucket) dredging and is expected to take up to three years. Disposal of dredged material that meets open-water disposal guidelines (estimated volume of suitable material is 2,412,000 cubic yards [CY]), will occur at the Commencement Bay Dredged Material Management Program open-water disposal site and beneficial use of dredged material may also occur at the Saltchuk aquatic site, an approximately 64-acre site located northeast of the Blair Waterway. Sediment that does not meet open-water disposal guidelines (estimated at 392,000 CY) will be removed and placed at an appropriate upland disposal site.

Navigational challenges have been identified in the Blair Waterway of Tacoma Harbor and authorized depths do not meet the draft requirements of some of the current and projected future fleet of larger container ships. Operational inefficiencies created by inadequate channel depth result in economic inefficiencies that translate into costs for the national economy.

As required by Section 7(c) of the Endangered Species Act (ESA) of 1973 (16 U.S.C § 1531 et seq.), the Corps has prepared a Biological Assessment (BA, Encl) to assess the impacts of the project on listed species, including bull trout (*Salvelinus confluentus*) and marbled murrelet (*Brachyramphus marmoratus*). Based on the discussion on the accompanying BA, the Corps concludes that this project may affect but is not likely to adversely affect marbled murrelet and bull trout or their critical habitat.

The Corps wishes to initiate informal consultation pursuant to Section 7 of the ESA, as amended, and requests your concurrence with our determination of effect. If you have any questions or wish to discuss project details, please contact Ms. Katie Whitlock, the Environmental Coordinator for this project, at (206) 764-3576 or kaitlin.e.whitlock@usace.army.mil, or Mr. Fred Goetz, the Seattle District ESA Coordinator, at (206) 764-3515 or frederick.a.goetz@usace.army.mil. I may also be contacted at (206) 764-6761 or laura.a.boerner@usace.army.mil.

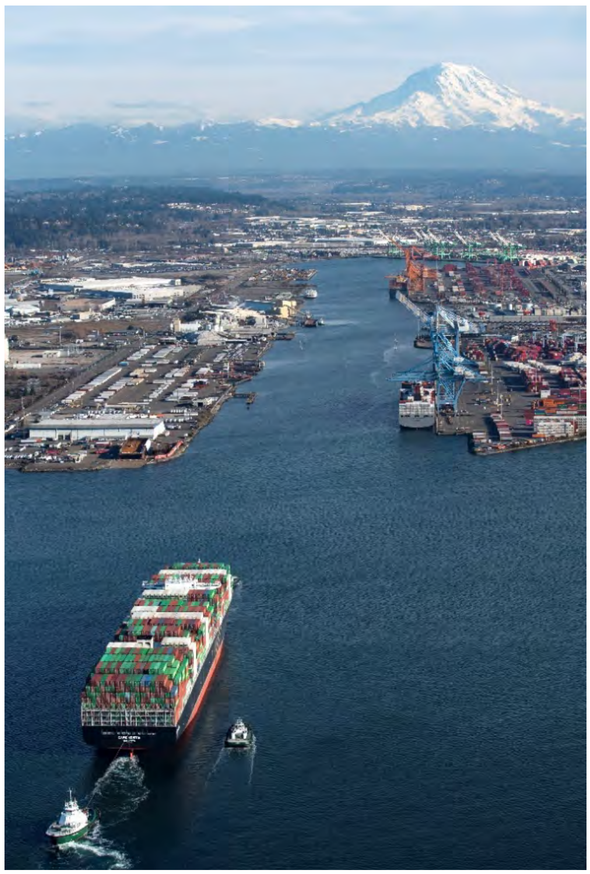
Sincerely,

Laura A. Boerner, LG, LHG
Chief, Planning, Environmental, and
Cultural Resources Branch

Enclosures

TACOMA HARBOR, WA
NAVIGATION IMPROVEMENT PROJECT
PIERCE COUNTY, WASHINGTON

BIOLOGICAL ASSESSMENT



JANUARY 2020

US Army Corps of Engineers®
Seattle District

Port of Tacoma

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1 Introduction

This Biological Assessment (BA) addresses the effects of the U.S. Army Corps of Engineers (Corps) proposal for navigation channel improvements in the Blair Waterway at Tacoma Harbor, Washington on species protected under the Endangered Species Act (ESA) of 1973. The federally authorized Tacoma Harbor navigation project, consisting of the Hylebos Waterway, Blair Waterway, two training walls at the mouth of the Puyallup River, and the Thea Foss Waterway, is located in Puget Sound's Commencement Bay at Tacoma, Washington. The Corps identified alternatives at Blair and Sitcum waterways during initial plan formulation; however, the Port of Tacoma subsequently requested to remove Sitcum Waterway from the study scope (Chapter 3 of the draft Feasibility Report/Environmental Assessment [FR/EA]; USACE 2019). The Blair Waterway provides approximately 2.75 miles of deep draft navigation accessible from Commencement Bay, Puget Sound, and the Pacific Ocean. For the proposed action, the Blair Waterway will be dredged with a clamshell dredge, dredged materials will be barged, and in-water disposal of suitable materials will occur at the Dredge Material Management Program (DMMP) open-water site in Commencement Bay. Material would be placed Saltchuk aquatic site, an approximately 64 acre site located northeast of the Blair waterway, if it is suitable for beneficial use of dredged material and based on ongoing habitat model evaluation, funding, and approval. Dredged material that does not meet DMMP standards for open-water disposal, or the standards set for Saltchuk beneficial reuse, will be taken to an appropriate upland disposal site.

Consultations with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS; jointly the Services) on disposal of dredged material at the DMMP open-water disposal sites in Puget Sound were conducted separately (USACE 2015a). Therefore, this BA evaluates only the dredging of the Blair Waterway, a range of slope stabilization measures, and any potential effects of material placement at Saltchuk and transporting material to a transloading facility for upland disposal. Species considered in this BA are only those ESA-listed species with potential to occur within a 3-mile radius of the project area in the Blair Waterway (Section 2, Figure 3).

This BA will serve as the consultation document addressing the deepening activities during Section 7 consultation with the Services per the requirements of the ESA. It evaluates potential effects of the project on Essential Fish Habitat (EFH) under Public Law 104-297 (the Sustainable Fisheries Act of 1996), which amended the Magnuson-Stevens Act. Effects to marine mammals protected under the Marine Mammal Protection Act (MMPA) of 1972 (16 U.S.C. §§ 1361-1407) appear in Section 7.

1.1 Authority

This study is authorized by Section 209, Rivers and Harbors Act of 1962, Public Law 87-874, stating:

> "The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to wind or tidal effects, to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its territorial possessions, which include the following named localities:…Puget Sound, Washington, and adjacent waters, including tributaries, in the interest of flood control, navigation, and other water uses and related land resources."

Section 209, Rivers and Harbors Act of 1962, Public Law 87-874 allows for the evaluation of alternatives for navigation improvement and consideration of ecosystem restoration in the form of beneficial use of dredge material at Tacoma Harbor including the non-Federal Sitcum waterway.

1.2 Purpose and Need for Federal Action

The purpose of the proposed Federal action is to achieve transportation cost savings (increased economic efficiencies) at Tacoma Harbor. Depths of the Blair Waterway result in container ships often experiencing tidal restrictions due to inadequate channel depth. These tidal restrictions are operational inefficiencies and economic inefficiencies that translate into costs for the national economy.

1.3 Consultation History

The Tacoma Harbor Federal Navigation Channel includes the Hylebos Waterway, Blair Waterway, two training walls at the mouth of the Puyallup River, and the Thea Foss Waterway. During maintenance dredging of the existing Federal channel, dredged material determined suitable for aquatic disposal would be transported to the DMMP-managed multi-user Commencement Bay open-water disposal site, and material that is unsuitable for in-water disposal would be transported to an upland facility. The following documents represent the known history of ESA consultations relevant to the action area of the proposed action described in this document. The proposed navigation improvement action does not include any additional waterways or training structures at the mouth of the Puyallup River.

Multiuser DMMP sites

- NMFS Consultation No. WCR-2015-2975. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion, Section (a)(2) "Not Likely to Adversely Affect" Determination, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation, and Fish and Wildlife Coordination Act Recommendations: Multiuser DMMP sites in Puget Sound and Grays Harbor, December 2015
- USFWS Ref. 01EWFW00-2015-I-0724. Letter of Concurrence: Continued Use of Multiuser Dredged Material Disposal Sites in Puget Sound and Grays Harbor, July 2015
- USACE Biological Evaluation: Continued Use of Multiuser Dredged Material Disposal Sites in Puget Sound and Grays Harbor, May 2015
- NMFS Tracking No. 2010/06456. Letter of Concurrence: Endangered Species Act Section 7 Formal Consultation for the Continued Use of Puget Sound Dredged Disposal Analysis Program Dredged Material Disposal Sites, Puget Sound, Washington; November 2011
- USFWS Ref. 13410-2010-I-0542. Letter of Concurrence: Puget Sound Dredged Disposal Analysis Program, January 2011
- NMFS Tracking No. 2010/04249. Biological Opinion: Endangered Species Act Section 7 Formal Consultation for the Continued Use of Puget Sound Dredged Disposal Analysis Program Dredged Material Disposal Sites, Puget Sound, Washington; December 2010
- USACE Biological Evaluation: Continued Use of Puget Sound Dredged Disposal Analysis Program (PSDDA) Dredged Material Disposal Sites, August 2010

Blair Waterway Dredging Modification

- NMFS Tracking No. NWR-2011-2336. Blair Waterway, Minor Bank Stabilization Activities (NWS-2010-1340-WRD, Port of Tacoma)

- NMFS Tracking No. NWR-2008-6286. Maintenance Dredging at Washington United Terminal, Blair Waterway, Pierce County (NWS-2008-01128-WRD), Port of Tacoma
- NMFS Tracking No. NWR-2007-7908. Reinitiation - Blair Waterway Infrastructure Improvements (Dredging/Widening) (Port of Tacoma 200400818), Pierce County
- NMFS Tracking No. NWR-2007-5821. Reinitiation - Blair Waterway Infrastructure Improvements (Dredging/Widening) (Port of Tacoma 200400818), Pierce County
- NMFS Tracking No. NWR-2005-265. Blair Waterway Infrastructure Improvements (Dredging/Widening) (Port of Tacoma 200400818), Pierce County
- NMFS Tracking No. NWR-2004-751. Blair Waterway Infrastructure
- NMFS Tracking No. NWR-1999-1496. Blair Waterway Channel Deepening, Tacoma Harbor, WA

2 Description of the Project Area and Action Area

The project area is the Port of Tacoma near the city of Tacoma in the Blair Waterway (Figure 1 and Figure 2). The action area (i.e., the area affected directly or indirectly by the dredging project) is defined as the federally authorized navigation channel in the Blair Waterway and an approximately 3-mile radius surrounding the Blair Waterway (Figure 3). A 3-mile radius was chosen to fully capture effects within Commencement Bay and the lower Puyallup River. The lack of terrestrial species affected by the proposed project primarily limits the action area to the aquatic portions of the Blair Waterway, Saltchuk, and Commencement Bay; however, the action area also encompasses the intertidal portion of Saltchuk (Figure 3). The 3-mile radius encompasses the farthest extent of effects that could occur outside the project area, such as water quality impacts, noise and disturbance from vessel or equipment activity, potential entrainment, and transport of materials by boat to the transloading facility. The complete authorized Federal Navigation Channel within Tacoma consists of the Hylebos Waterway, Blair Waterway, two training walls at the mouth of the Puyallup River, and the Thea Foss Waterway. The proposed action will occur only in the Blair Waterway and potentially at Saltchuk. The current configuration of the Blair Waterway provides about 2.75 miles of deep draft navigation, including the turning basin, accessible from Commencement Bay, Puget Sound, and the Pacific Ocean. The entire length is currently dredged to -51 feet below mean lower low water (MLLW; hereafter expressed as -X MLLW, which indicates the number of feet below MLLW). The current federally authorized dimensions of the Federal Blair Waterway appear in Table 1. The current channel depth is -51 MLLW.

Table 1. Current Federally Authorized Widths by Channel Station on Blair Waterway.

Stations along the channel	Authorized widths (feet)
STA 0 to STA 12	520
STA 12 to STA 44	520 narrowing to 343
STA 44 to STA 52	520
STA 52 to STA 79	520 narrowing to 330
STA 79 to STA 100	330
STA 100 to STA 116	330 widening to 1,682
STA 116 to STA 140	1,682

Figure 1. Location of Tacoma Harbor within Washington State.

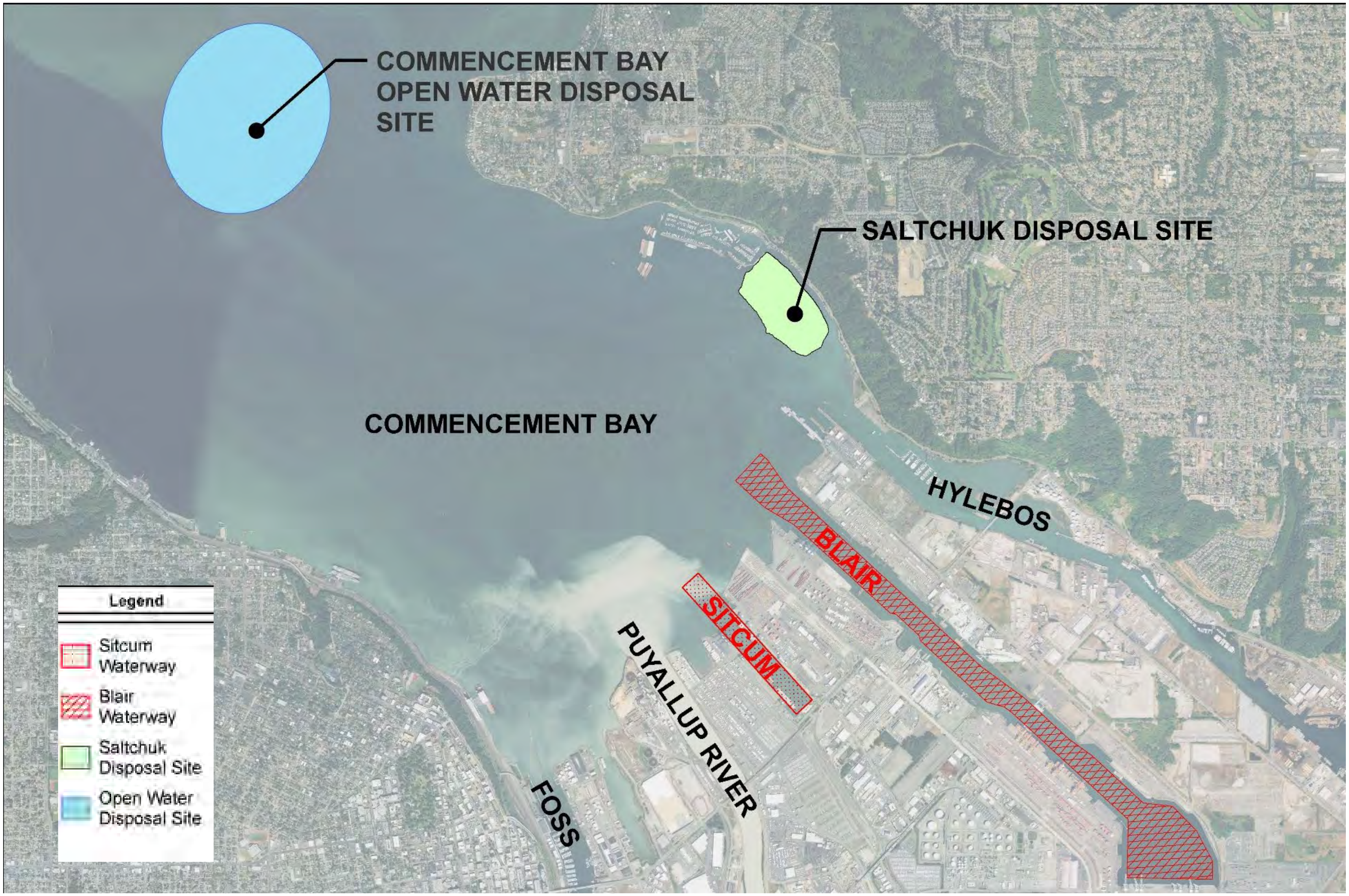

Figure 2. Tacoma Harbor Project Area, which includes Blair Waterway, Saltchuk disposal site, and Commencement Bay open-water disposal site. Navigation improvements to Sitcum Waterway are not being investigated.

Figure 3. Project area and action area with a 3-mile radius surrounding the project site (Blair Waterway).

3 Proposed Action

The Corps and Port of Tacoma determined the deepest channel that is economically justified is -57 MLLW (USACE 2019). This plan is the Tentatively Selected Plan (TSP), which is the plan that the Corps has identified to carry forward for public review during the feasibility study. The Corps will refine the TSP, if needed, based on public review and additional feasibility-level analysis to identify a recommended plan for approval and congressional authorization for construction. A detailed account of the TSP selection appears in USACE 2019. A summary of the proposal appears below:

- Deepen the existing Blair Waterway from an authorized depth of -51 MLLW to -57 MLLW
- Selective channel widening from 450 feet to 865 feet (Table 2)
- Ongoing evaluation of beneficial use at the Saltchuk site, based on preliminary analysis using the pending nearshore habitat valuation model (Appendix A)

Table 2. Federally Authorized and Proposed Widths by Channel Station (STA) at Blair Waterway.

Stations along the channel	Authorized widths (feet)	Proposed width (feet)
STA -5 to STA 0		865
STA 0 to STA 12	520	800
STA 12 to STA 44	520, 343	520
STA 44 to STA 52	520	520
STA 52 to STA 79	520,330	520
STA 79 to STA 100	330	450
STA 100 to STA 116	330, 1,682	525
STA 116 to STA 140	1,682	1,935

The feasibility level sediment sampling indicates that out of the estimated total 2,783,000 cubic yards (CY) of dredge material from this area, approximately 2.4 million CY should be suitable for open-water disposal sites, and 392,000 CY would be unsuitable requiring upland disposal. The estimated time to dredge is approximately 3 years. The in-water work window for material disposal at the Commencement Bay open-water disposal site (Figure 4) is from August 16 through February 15 based on avoiding impacts to the vulnerable life stages of sensitive fish species, including migration, spawning, and rearing. In-water work for other locations of Commencement Bay, including dredging, is July 16 through February 15 (Washington Administrative Code [WAC] 220-660-330; Corps 2017b). For this project, it is assumed that there would be one Operation and Maintenance (O&M) dredge event every 25 years, with a volume of approximately 100,000 CY.

Additional evaluation of beneficial use is included in the TSP because the incremental cost of beneficial use of dredged material at Saltchuk (Appendix A) is reasonable in relation to the environmental benefits achieved (Section 3.6.1.2 of the draft FR/EA; USACE 2019). Full placement at Saltchuk would involve the placement of about 1.8 million CY of suitable dredged material, reducing the quantity of material going to the DMMP Commencement Bay open-water disposal site by an equal amount. The Corps is continuing evaluation of environmentally beneficial use of dredged material at the Saltchuk site. At this stage of design proposals and scenario analysis, the Corps and non-Federal sponsor are evaluating only a conceptual-level design to determine whether any proposal for beneficial use would have environmental benefits, be a cost-effective scenario for dredged material disposal, and be technically feasible. Analysis must demonstrate the value of the environmental resources restored by the placement method, describe and quantify the environmental outputs, and show Federal and State resource agencies support for the environmentally beneficial disposal method.

Three primary areas of wood waste deposits cover approximately 13% (8 acres) of the 64-acre site. The wood waste present at Saltchuk is not known to be chemically treated, and thus not a suspected source of Hazardous, Toxic, and Radiological Waste (HTRW). This aspect of the proposed action would require additional investigation for how to meet the Sediment Management Standards as set forth by Washington Department of Ecology (Ecology) and how best to achieve environmental benefits while avoiding additional impacts that can sometimes occur from burying wood waste. This action is part of the TSP; therefore, the Corps and non-Federal sponsor will coordinate with Ecology and all other relevant natural resources agencies and tribes throughout the next stages of design.

The quantities of sediment that will need to be dredged to achieve this improvement are up to approximately 2,804,000 CY from the Blair Waterway. These quantities assume the proposed depth of -57 MLLW, and that the contractor removes the 2-foot allowable overdepth while dredging the channels. O&M needs of the Saltchuk site are assumed to be minimal and will be evaluated prior to the final FR/EA and would be the responsibility of the non-Federal sponsor, and are not included in this Federal proposed action.

The method for dredging is mechanical (using a clamshell bucket dredge), which will use a digging bucket to remove the material suitable for open-water placement, while an environmental bucket will be used for material unsuitable for open-water placement. Dredged material will be placed on a barge adjacent to the dredge.

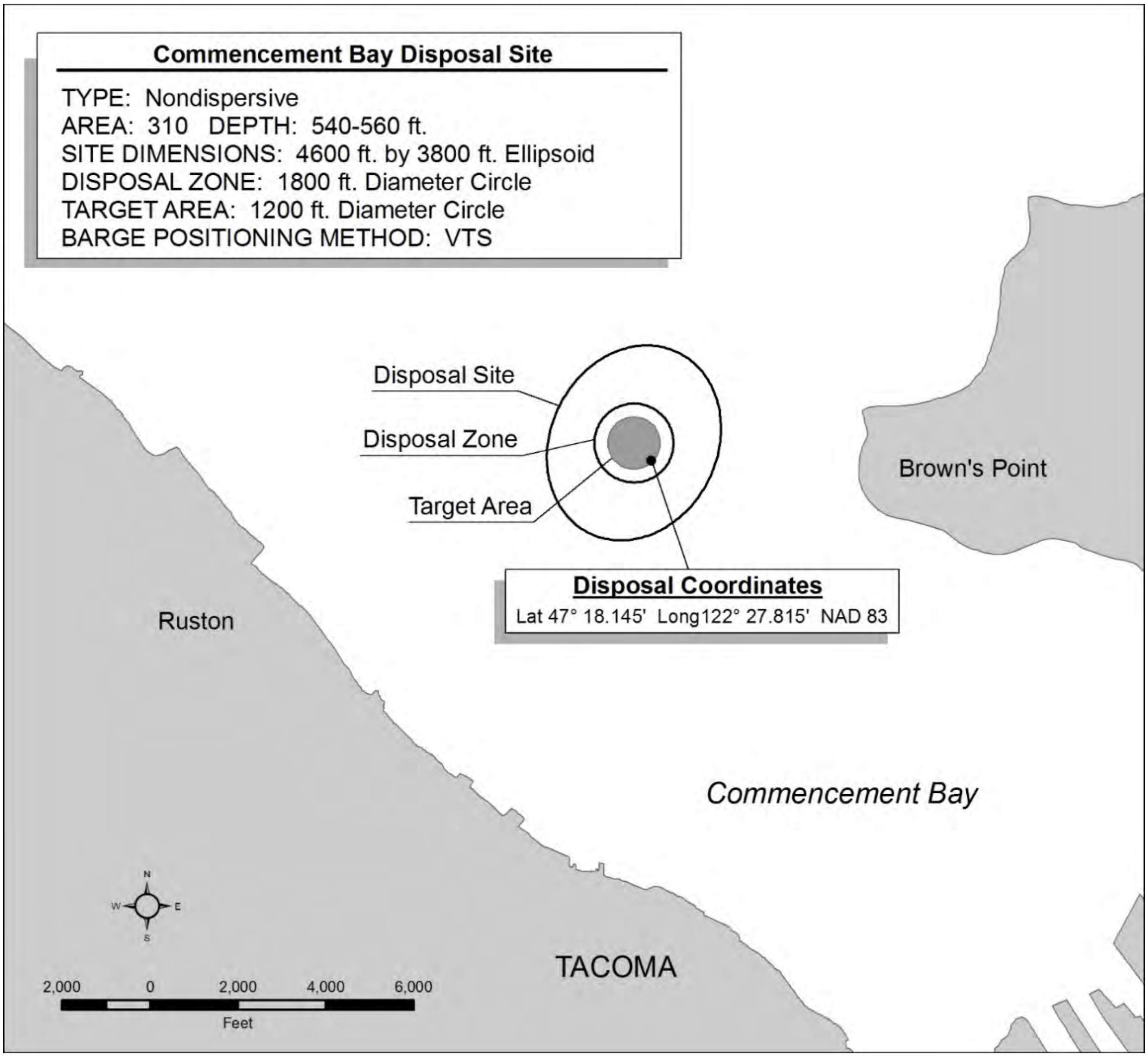

Figure 4. Commencement Bay Multi-user Dredged Material Disposal site.

The recommended sideslope for the Federal channel is a ratio of 2 horizontal on 1 vertical (2H:1V). This design is informed by an analysis of the Blair Waterway bathymetry survey from 2018, which indicates that the sideslopes from previous deepening projects have tended to stabilize at 2H:1V, or shallower. In other words, when the channel sideslope is at a ratio of 2H:1V or shallower, the Corps believes that engineered slope stabilization measures such as sheetpile or secant pile walls are not necessary to maintain the slope and prevent sloughing. Previous geotechnical work by others for berth expansions supports this assessment. In addition, Blair Waterway was last dredged approximately 20 years ago, which has provided ample time to see potential sloughing effects after dredging and stable slopes to develop. With this observed sideslope behavior, the Corps believes approximately 2H:1V slopes associated with the preferred alternative will not require engineered slope stabilization (e.g., sheetpile or secant pile walls) in most of the project. As needed, the Corps will consider sideslope stabilization measures at select areas in the Pre-construction Engineering and Design (PED) phase along the following stationing:

- Area 1: STA 44+00.00 to STA 48+00.00
- Area 2: STA 74+50.00 to STA 82+00.00
- Area 3: STA 94+50.00 to STA 97+50.00
- Area 4: STA 118+00.00 to STA 125+50.00

Figure 7 shows the potential locations where sideslope stabilization may be necessary for the navigation channel along the Blair Waterway. Sideslope stability requirements will be further analyzed and addressed in PED phase when ship simulation confirms the final channel alignment and width. Stabilization measures may include, but are not limited to, secant wall, sheet pile wall, and/or 1.5:1 slopes with rock toe stabilization. The actual stabilization method employed for each area will depend on whether or not the top of the slope in each area extends into the upland facilities and, if it does not, the available clearance (i.e., distance) between the top of the slope to upland facilities. Upland is land elevated above shore land, in an area above where water flows. Upland facilities include parking lots, buildings, utilities, or other infrastructure.

Several assumptions about sideslope stability measures are made in the draft FR/EA, to address the level of uncertainty given the range of slope stability measures in this planning document. To account for variations in cost among the range of slope stability measures, the draft FR/EA assumes that the project will include the most expensive stabilization measure of vertical slopes (i.e., secant wall) at Areas 1-4. To ensure that we have analyzed the most extensive potential impacts to the environment, we evaluated a range of slope stability measures that would have the greatest amount of physical impact (i.e., greatest area of fill material) and the greatest construction impacts (e.g., noise). Given the uncertainty of slope stabilization needs and design, this BA will examine a range of slope stabilization measures with feasibility-level preliminary design, and current information regarding each Area. The Corps will provide updated design information to the Services in PED, and the Corps will determine whether a request for reconsultation is warranted at that time, after assessing if there is new information that was not appropriately addressed in this consultation regarding the effect of the actual specific slope stabilization measures employed at these four locations.

Area 1 (STA 44+00.00 to STA 48+00.00) is about a third of the way into the channel on the southwestern side (Figure 7). Slopes extend to the edge of the adjacent uplands facilities, which consist of an asphalt-paved parking lot. There may be enough clearance so that additional stabilization measures are not necessary at this location, and the natural 2H:1V slope may be structurally appropriate for the final design. Alternatively, Area 1 may have to use a 1.5H:1V slope-rock toe combination. Additional analysis once the design is further refined in PED will be necessary to determine the actual appropriate engineering solution at this location. For purposes of this BA, it is assumed that additional stabilization measures in the form of 1.5 H:1V slope-rock toe combination will be required at this location.

Area 2 (STA 74+50.00 to STA 82+00.00) is about midway into the channel on the north side (Figure 7). Area 2 is Puyallup Tribe of Indians (Tribal) property, so Real Estate considerations may limit the work that can be performed here (Section 5.4 of the draft FR/EA; USACE 2019). A 2H:1V slope reaches well into the uplands in Area 2, likely prompting the need for stabilization measures. It is also unlikely that a 1.5H:1V slope-rock toe combination can be implemented in Area 2. HTRW material remains in place in the uplands at this location, also referred to as the Lincoln Avenue Ditch and Former Lincoln Avenue Ditch. This material is outside the proposed navigation channel alignment, adjacent to the east side of Blair Waterway (Area 2 on Figure 3-4 in the Draft FR/EA; USACE 2019), and has institutional controls in place to limit disturbance of the site in the upland (upland is land elevated above shore land, in an area above where water flows). Based on conceptual design information, the Corps assumes there is enough distance between the proposed navigation channel and existing institutional controls in the uplands that extend approximately 30 feet from the top of the bank to allow for an engineering solution that completely avoids the remaining contamination in this upland area. There is a strong probability that more substantial stabilization measures such as sheet piling or a secant wall may be necessary to protect the institutional controls in place. For purposes of this BA, it is assumed that additional stabilization measures in the form of sheep piling or a secant wall will be required at this location.

Area 3 (STA 94+50.00 to STA 97+50.00) is on the north side of the channel and is Puyallup Tribal property (Figure 7). As with Area 2, a 2H:1V slope extends into the uplands and a 1.5H:1V slope-rock toe solution may not completely prevent extension to the uplands. Depending on Real Estate considerations and further analysis, a 2H:1V cutback may be completed. If such a cutback cannot be done, a more substantial stabilization such as sheet piling would be anticipated for Area 3. For purposes of this BA, it is assumed that additional stabilization measures in the form of sheep piling will be required at this location.

Area 4 (STA 118+00.00 to STA 125+50.00) is on the north side of the channel within the entrance to the turning basin (Figure 7). It is similar to Area 1, where a 2H:1V slope barely extends into the uplands. This area does not include any uplands facilities or major infrastructure, the land here is owned by the Port, and it is used for storage. Depending on compatibility with upland use by the Port, Area 4 could have a 1.5H:1V slope-rock toe combination measure or a 2H:1V slope with no stabilization. For purposes of this BA, it is assumed that additional stabilization measures in the form of a 1.5H:1V slope-rock toe combination measure will be required at this location.

Local Service Facilities (LSFs) include terminals and transfer facilities, docks, berthing areas, and local access channels. The LSFs assumed for this project include berthing area deepening at Husky Terminal, Washington United Terminal (WUT), and Pierce County Terminal (PCT) for any depths below -54 MLLW. LSFs are 100 percent non-Federal costs. Port of Tacoma provided estimated lengths of slope strengthening required for each container facility (Figure 5). As shown, 1,140 feet, 2,010 feet, and 2,090 feet of slope strengthening are required for all berth deepening below -54 MLLW at Husky, WUT, and PCT, respectively. These improvements include reinforcement of the slope as well as construction of a new toe wall. State, local, or private actions that may affect shoreline or aquatic habitat in the action area will be required to obtain Federal permits, and as such will undergo separate Section 7 consultation and review.

Figure 5. Anticipated Slope Strengthening by Facility for Depth Below -54 MLLW.

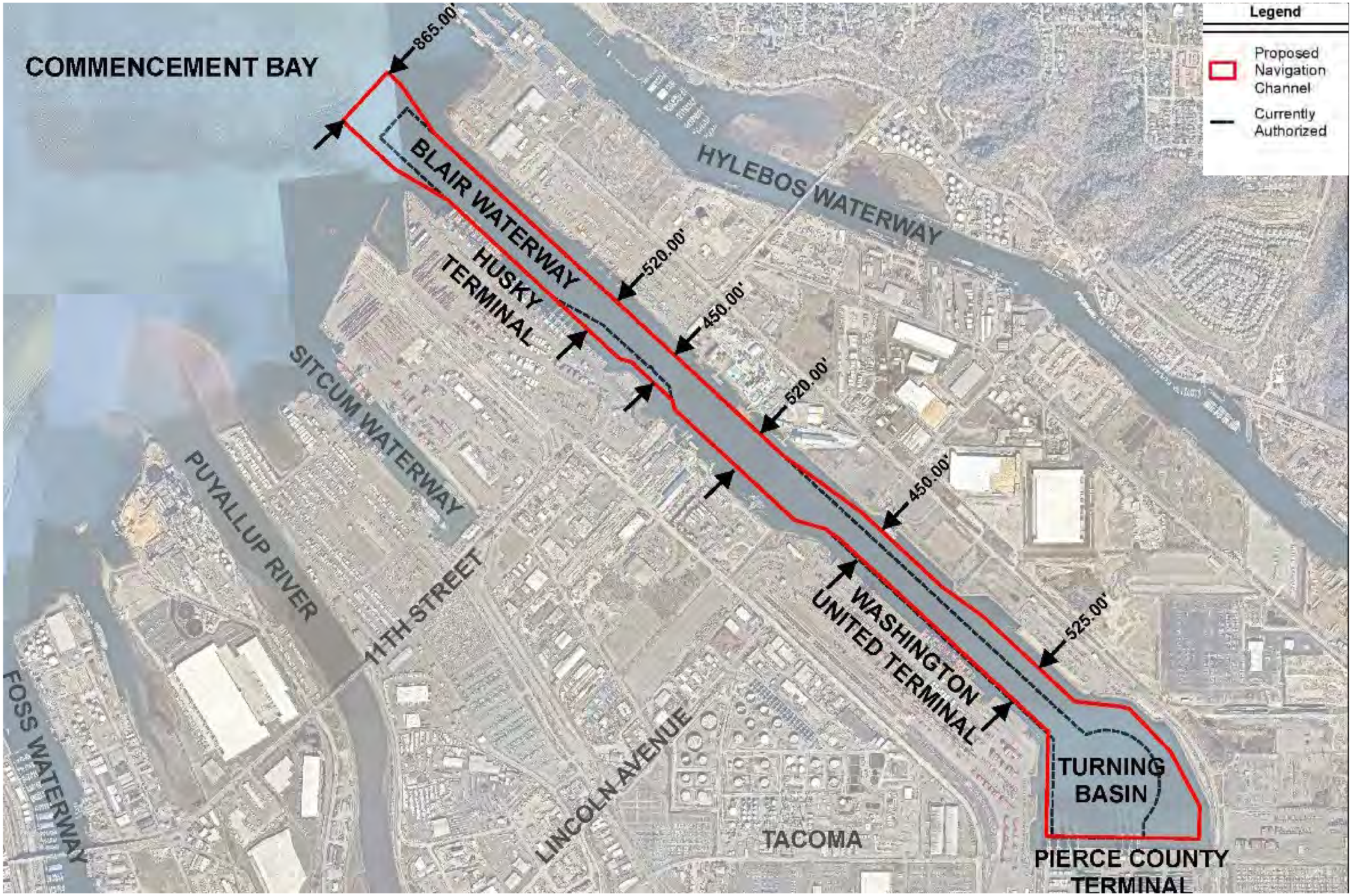

Figure 6. Tentatively Selected Plan (TSP) for the Tacoma Harbor Navigation Improvement Project, where the Blair Waterway would be dredged to -57 MLLW.

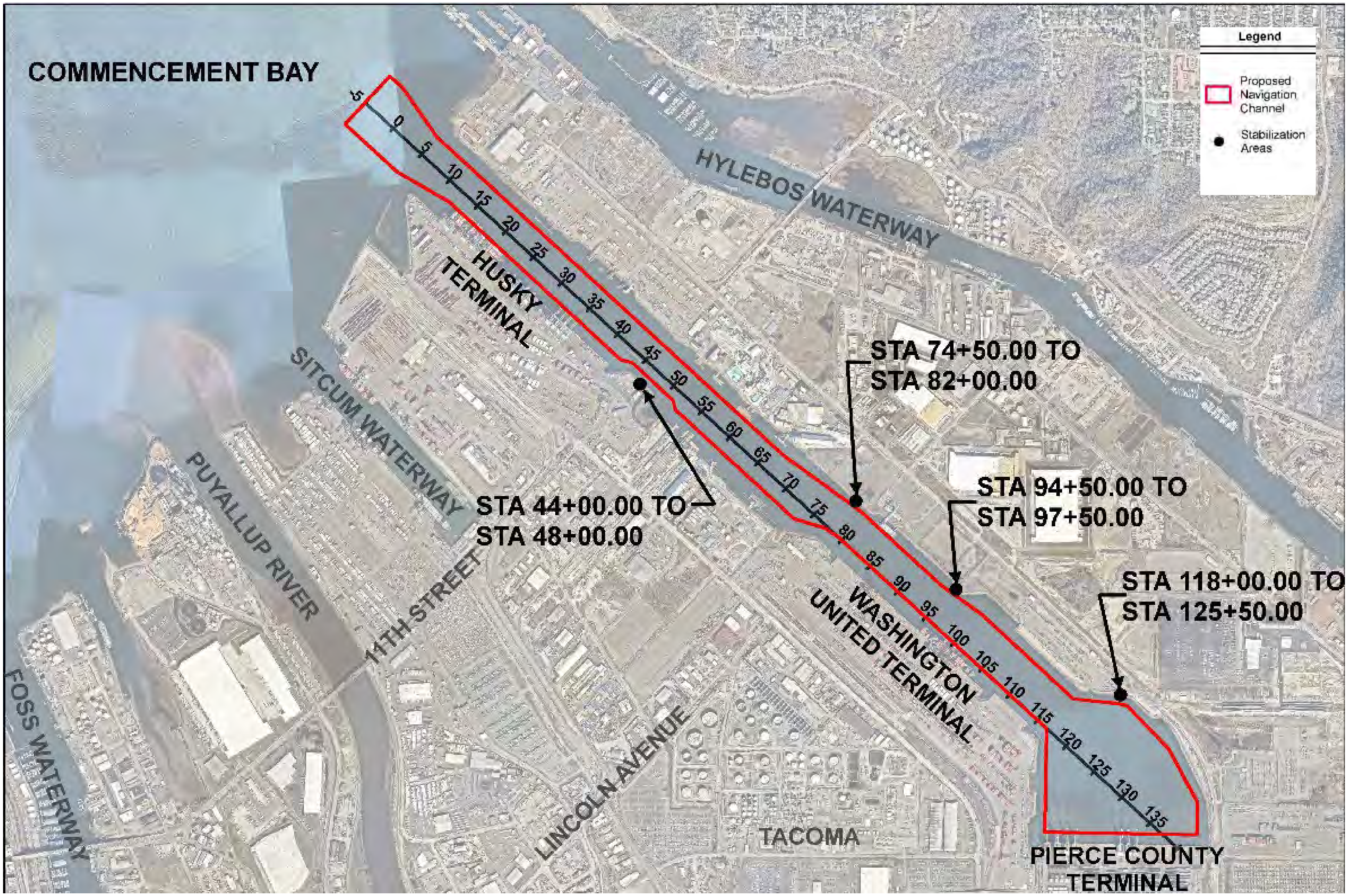

Figure 7. Potential Side Slope Stabilization Areas for the Tentatively Selected Plan (TSP).

To execute construction, several pieces of in-water equipment will be operating for up to 24 hours per day. Only one dredge will be operating at a time and will be running nearly continuously during the in-water work windows except for breaks for crew change or machinery maintenance. Vessels associated with the proposed transport and disposal activities are primarily tugboats with barges. One to two tugboats for towing barges is expected to be employed for the duration of this project transiting between the waterway and the Commencement Bay open-water disposal site. A survey vessel will slowly transit the area to measure dredging progress. The draft Water Quality Monitoring Plan (WQMP; Appendix B) calls for monitoring twice per day; a WQMP will be developed and provided to for approval by Ecology during PED phase. The duration of work will most likely be throughout the six- to seven-month work window (July 16 through February 15) in three consecutive years to accomplish the channel deepening. The in-water work window for material placement at the Commencement Bay open-water disposal site is from August 16 through February 15. In-water work in Commencement Bay, including dredging, is authorized to occur July 16 through February 15 (WAC 220-660-330; Corps 2017b). Therefore, Saltchuk construction may occur during this work window. The Corps would coordinate with Washington Department of Fish and Wildlife (WDFW) and affected tribes to confirm the appropriate in-water work windows.

Corps policy recommends dredged material placement in the least costly manner consistent with sound engineering practice and pursuant to all Federal environmental standards including the environmental standards established by Section 404 of the Clean Water Act of 1972 or Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972, as amended. These criteria determine the “base plan” for dredged material placement. The TSP as described above includes a base plan for disposal of dredged material that meets open-water disposal criteria to occur at the Commencement Bay open-water disposal site and for material unsuitable for aquatic disposal to be disposed of at an upland facility. The quantity estimated as suitable for open-water disposal is approximately 2.4 million CY.

The Saltchuk site is not the least cost placement site and is not the base plan. However, based on preliminary analysis and results, the TSP includes additional evaluation of beneficial use of dredged material at Saltchuk. Full placement at Saltchuk for beneficial use of dredged material would be about 1.8 million CY of dredged material, reducing the quantity of material going to the Commencement Bay open-water disposal site by an equal amount. Material would be placed via bottom-dump barge for the first bench (up to -20 MLLW). For placement of dredged material shallower than -20 MLLW, additional equipment such as flat deck barges and a barge-mounted excavator would be required to place and shape the material. If beneficial use of dredged material is not carried forward, then about 2.4 million CY would go to the Commencement Bay open-water disposal site. The remaining 392,000 CY in the Blair Waterway that may not meet open-water disposal criteria will be disposed upland at an appropriate facility.

This consultation document is intended to cover the complete action as described above, which is anticipated to take about three years to complete. Maintenance dredging of the navigation channel is expected to be necessary approximately once every 25 years and existing environmental documentation would be supplemented at such time that maintenance is needed.

4 Affected Resources and Environmental Baseline Condition

4.1 Baseline Conditions

The environmental baseline reflects the past and present impacts of all Federal, State or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02 [2019]). The ongoing consequences to the environment of the presence and operation of the facilities and structures under the current configuration constitute a portion of the pre-existing status quo. These continuing effects comprise part of the environmental baseline, to which the effects of the proposed action of waterway deepening and widening the Federal channel, as well as dredge material placement, would be added. The consequences of the proposed Federal action thus consist of the temporal impacts of construction, altered operational use of the Port, as well as the incremental long-term effects of alterations in configuration of the deepened waterway and modified nearshore from the beneficial use of the dredged material, in comparison to the environmental baseline.

Development of Commencement Bay as a port likely began with the Northern Pacific Railroad that crossed salt marsh from the City of Puyallup to Tacoma at Thea Foss Waterway in 1874 (USACE 1993). There was limited development before 1877 and the earliest photos and maps indicate that the main habitat types of Commencement Bay were 2,085 acres of intertidal mudflats and about 3,894 acres of salt/brackish marsh. Only about 180 acres of mudflat and 50 acres of salt/brackish marsh remained by 1999, although restoration projects have brought back about 235 acres of habitat (EarthCorps 2015).

Lingering effects of more than a century of human development combined with numerous ongoing activities in the industrial waterways have contributed to the currently degraded environmental baseline conditions in Commencement Bay, including the Blair Waterway. The most notable HTRW site within the study boundary is the Commencement Bay Nearshore Tideflats Superfund Site, placed on the National Priorities List (NPL) in 1981. The Record of Decision for the site was issued in September 1989. Blair Waterway was originally included as a component of the Superfund Site. The Operable Units (OUs) associated with Blair Waterway include the Commencement Bay/Nearshore Tideflats Sediments OU (OU1) and the Commencement Bay/Nearshore Tideflats Source OU (OU5; Map appears in Appendix H of the draft FR/EA; USACE 2019). The U.S. Environmental Protection Agency (EPA) issued a partial deletion in 1996 pertaining to the portions of the two separate OUs addressing sediments contained in and properties draining to the Blair Waterway (EPA 2014). As such, the environmental baseline assumes that no further Federal action is required to address remediation of sediments or associated sources to Blair Waterway. Additional HTRW site descriptions appear in Section 4.11 of the draft FR/EA (USACE 2019). There are no HTRW sites overlapping Saltchuk.

4.1.1 Terrestrial Habitat

The shorelines of Commencement Bay have been highly altered using riprap, and other materials to provide bank protection. The Port of Tacoma waterways were developed for industrial and commercial operations and the upland areas are heavily industrialized. Blair Waterway comprises seven percent of the total of armored shoreline that covers 71 percent of the length of the Commencement Bay shoreline. Commencement Bay contains dense industrial, commercial, and residential development and is a major shipping route for containerized and bulk cargo, which is consequently subject to high volumes of marine traffic. Air quality has been a local concern in the neighborhoods surrounding Tacoma's industrial area including the project area. The Port of Tacoma has been implementing emissions reduction programs and achieving a net reduction. Sediments, including those along the shorelines in the project area have been determined to be contaminated and require clean-up actions, which are already completed at some sites while work continues at others.

4.1.2 Aquatic Habitat

Aquatic portions of the project area are composed of intertidal and subtidal habitats. Intertidal habitat along the shorelines of the project area is limited by shoreline armoring and overwater structures. Commencement Bay has been highly modified by industrial development with large areas of fill, dredging, stabilization, and infrastructure (Simenstad 2000). Overwater structures in the form of piers for ship loading are prevalent along the shorelines of the project area. Based on shoreline surveys and aerial photo interpretation of the area, approximately five miles, or 20 percent of the Commencement Bay shoreline, is covered by wide over-water structures (Kerwin 1999). The Blair Waterway is altered from its natural state using riprap that provides low to medium quality feeding and refuge habitat for juvenile salmon. This shading affects the community of the subtidal organisms that serve as fish food or habitat structure in the form of eelgrass and kelp (Nightingale and Simenstad 2001). Piers and other overwater structures can inhibit juvenile salmon migration as physical barriers, shading that causes avoidance, and increased susceptibility to predation (Simenstad et al. 1982). The project area within the Blair Waterway contains no kelp or eelgrass patches, but there is some eelgrass near the mouth of the Hylebos Waterway.

Portions of Commencement Bay are on Ecology's 303(d) list of threatened and impaired waters, listed as "polluted" for specific parameters. Inner Commencement Bay is listed for Bis(2-Ethylhexyl)phthalate and polychlorinated biphenyls (PCBs). Within the inner bay, Thea Foss Waterway is listed for PCBs, and Hylebos Waterway is listed for dieldrin, PCBs, chlorinated pesticides, dichlorodiphenyltrichloroethane (DDT), and high molecular weight Polycyclic Aromatic Hydrocarbons The Blair Waterway is not on the 303(d) list, but it is listed under "waters of concern" for benzene, tetrachloroethylene, and trichloroethylene. Outer Commencement Bay, which includes Saltchuk, is listed for bacteria, DO, PCBs, and Bis(2-Ethylhexyl)phthalate.

Baseline conditions include regular disruptions on a daily basis when large shipping vessels transit the channel and displace fish and wildlife due to underwater noise and physical presence. Tacoma Harbor already receives calls from the 14,000 twenty-foot equivalent unit (TEU) capacity *Thalassa Axia*, which began calling in November 2018. The *Thalassa Axia* is the largest ship calling at Tacoma Harbor as of December 2019. This also includes regular maintenance projects and other planned infrastructure upgrades by the Port (Sections 1.4, 3.5, and 4.11 of the draft FR/EA; USACE 2019). Dredging and in-water work can cause fish to avoid areas due to noise of machinery or dredges and associated vessels. To minimize impacts to salmonids, dredging schedules and in-water work observe in-water work windows.

The in-water work window, established by State and Federal agencies, minimizes potential impacts to important fish, wildlife, and habitat resources. The in-water work window for material disposal at the Commencement Bay open-water disposal site is August 16 through February 15 to avoid impacts to vulnerable life stages of sensitive fish species, such as migration, spawning, and rearing. The Washington Administrative Code (WAC) and Corps' Regulatory Program authorize all other in-water work in Commencement Bay, including dredging, to occur July 16 through February 15 (WAC 220-660-330; USACE 2019).

The depth of sea floor in most of Commencement Bay (30-100 meters; 98-330 feet) and the depth of Blair Waterway (-51 MLLW) is not habitat that salmonids select for feeding or refuge. Some estuarine and marine fish and sub-tidal marine invertebrates inhabit and feed at deeper subtidal elevations within the action area. Additionally, the invertebrates inhabiting the substrate of the Blair Waterway, such as polychaete and nematode worms, do not contribute significantly to the salmonid food chain (Hiss and Boomer 1986). The Blair Waterway has side slopes of 2H:1V in most locations.

Wapato Creek drains to the head of the Blair Waterway. Salmonid habitat is limited due to extremely low summer and fall flows, poor water quality and heavy siltation due to residential and commercial development, agricultural and storm runoff, and heavy industry discharge. Intermittent surveys from the 1970s to the 1990s found an extremely limited number of coho and fall chum salmon use and spawn in the lower reaches of Wapato Creek and its tributary, Simon's Creek (E. Marks, PTI, pers. comm. 2019). In addition, although winter steelhead may utilize Wapato Creek, data is limited (SalmonScape 2019). There is no documentation of use of Wapato Creek by Chinook salmon or steelhead for twenty years, and NMFS does not believe Wapato Creek provides suitable habitat under existing conditions (J. Fisher, NMFS, pers. comm. 2013). Surveys of Wapato Creek have been inconsistent and low priority due to low salmon production and utilization, and limited accessibility (E. Marks, PTI, pers. comm. 2019).

The Corps sampled and tested sediments within the proposed dredge footprint in 2019 per the Washington DMMP to assess the materials' suitability for open-water disposal. The advisory memo (Appendix C) shows the majority of native sediments dredged for the navigation improvement project will be eligible for open-water disposal or beneficial use at Saltchuk. (The feasibility level sediment sampling indicates that, of the estimated total 2,783,000 CY of dredge material from this area, approximately 2.4 million CY should be suitable for open-water disposal sites, and 392,000 CY would be unsuitable requiring upland disposal).

4.1.3 Saltchuk

Existing habitat of the Saltchuk site is degraded due to previous log raft storage at the site. Lower shore zone habitat (LSZ; from +5 to -10 MLLW) is composed of a substrate that transitions to sand and silt substrate near MLLW. Lower shore zone and deeper habitat includes wood waste. One large area of wood waste was observed from shore during a low tide event, which starts at approximately +0 MLLW (GeoEngineers 2014a, as cited in GeoEngineers 2015). Based on previous wood waste studies, this wood waste concentration extends to a depth of approximately -30 MLLW. It is assumed that 10% of the wood waste (0.83 acres total) is located in the LSZ.

Wood waste has accumulated over approximately 100 years due to log storage at the Saltchuk site. Log storage is visible on a 1931 aerial photograph as well as all subsequent aerial photographs (GeoEngineers

2015) but is no longer used for log storage. Three primary locations within the log storage area were observed to contain wood waste during the 1999 dive survey. Of the entire 64 acre Saltchuk site, approximately 13% (8 acres) is currently covered by wood waste. Ecology (2013) describes three main issues that excess wood waste can have on the benthic environment: 1) the physical presence of wood waste, which prevents biota from thriving and recruiting in and on native, healthy substrate; 2) decreased dissolved oxygen due to microbial decomposition, which can create an unhealthy or toxic environment for biota, and; 3) decomposition by-products such as sulfides, ammonia, and phenols, which can cause or contribute to toxicity.

Macroalgae in the LSZ is largely composed of sea lettuce (Ulva ssp.) and was observed at approximately the MLLW line. No eelgrass was observed within the project area; however, one patch of eelgrass was identified to the southeast of the project area near Hylebos Waterway at depths of approximately -6 feet to -10 MLLW during the underwater video survey conducted August 2014 (GeoEngineers 2015).

The site contains approximately 53 acres of deep subtidal zone habitat (beyond -10 MLLW). This habitat at the site has been incompletely assessed during a SCUBA dive survey in 1999 (Leon 2014, as cited in GeoEngineers 2015) and through a limited underwater video recorded August 4, 2014 (GeoEngineers 2014b, as cited in GeoEngineers 2015). The majority of the deep subtidal habitat at the site consists of brown and black silt with wood waste over gray clay (Anchor 2008, as cited in GeoEngineers 2015).

Macroalgae is present in areas of the deep subtidal habitat and generally consists of brown or red algae (Anchor 2008, as cited in GeoEngineers 2015). Invertebrates were observed during the dive survey including; polychaetes (unidentified species; only burrows observed), anemone (*Metridium senile*), sea stars (*Evasterias trochelii* and *Piaster ochraceus*), red rock crab (*Cancer productus*), ghost shrimp (*Neotrypaea californiensis*), nudibranch (*Dirona albolineata*) and egg masses, and rosy octopus (*Octopus rubescens*;) (Leon 2014, as cited in GeoEngineers 2015). At least 63 creosote-treated timber piles approximately 12 inches in diameter are present in the shallow subtidal zone (GeoEngineers 2015).

4.1.4 Fish

Marine and estuarine fishes in Commencement Bay include three-spine stickleback, shiner perch, Pacific staghorn sculpin, Pacific tomcod, ratfish, copper rockfish, and snake prickleback and forage fish (Dames and Moore 1981). Flatfish such as sole species (English, rock, flathead, C-O, and sand sole), starry flounder, and speckled sanddab are very common throughout Commencement Bay in flat, sandy substrate. The most common species in the waterways are English sole, flathead sole, Pacific staghorn sculpin, Dover sole, ratfish, Pacific tomcod, and starry flounder (Dames and Moore 1981).

Forage fish present include Pacific herring, surf smelt, and sand lance (Dames and Moore 1981). Pacific herring do not spawn in Commencement Bay. The closest pre-spawner holding area is outside of Commencement Bay at the south end of Vashon and Maury islands, and they are likely present within the Bay (Dames and Moore 1981; WDFW 2018). Forage fish are primarily pelagic and would be swimming through the area looking for food; sand lance burrow into sandy substrate and remain from dusk to dawn. Forage fish larvae are ubiquitous in Puget Sound and are a common component of the nearshore plankton. There are limited spawning areas within Commencement Bay, but surf smelt spawning was observed in 2006 on either side of the Puyallup River and near Thea Foss waterway, while sand lance have spawned near the Puyallup River and the southwestern side of Commencement Bay (WDFW 2018).

Spawning is much more extensive along Browns Point and outside the bay. Larvae and juveniles prey on epibenthic invertebrates and crustaceans and are themselves important prey items for larger juvenile salmon and bull trout.

The Puyallup/White River watershed enters Puget Sound at Commencement Bay. Nine stocks of anadromous salmonids have been documented in the Puyallup River: winter steelhead, bull trout, coastal cutthroat trout, and spring/fall Chinook, fall chum, coho, sockeye, and odd-year pink salmon (Dames and Moore 1981; NWIFC 2019). These multiple migratory runs of native and hatchery-reared salmonid stocks occur in multiple seasons during the year in Commencement Bay. Rearing and foraging by juvenile salmonids occurs along the limited shoreline areas that are shallow or retain natural structural diversity. Returning adult salmon congregate at the mouth of the Puyallup River prior to upstream migration. Juvenile salmonids may use the nearshore reaches in addition to Commencement Bay to transition into marine waters. Juvenile salmonids generally enter Commencement Bay January through August, with peak outmigration in May (Marks et al. 2018).

4.1.5 Wildlife

The project area is primarily the aquatic habitat of Saltchuk and the Blair Waterway, a heavily used navigation channel, which are both in close proximity to industrial port infrastructure and activities. The marine mammals most likely to be present in Commencement Bay include harbor seals, Steller sea lion, harbor porpoise, California sea lions, gray whales, and rarely humpback whales, Bigg's (transient) killer whales, and Southern Resident Killer Whales (SRKW; Dames and Moore 1981). A variety of marine birds typical of developed areas in Western Washington occur within the project area, including osprey (*Pandion haliaetus*), glaucous-winged gull (*Larus glaucescens*), pigeon guillemonts, Caspian tern (*Hydroprogne caspia*), double-crested cormorant (*Phalacrocorax auritus*), and great blue heron (*Ardea herodias*). Birds and marine mammals in the project area are assumed to be habituated to the industrial port activities.

4.1.6 Benthic Invertebrates

Several factors determine the benthic invertebrate community, which includes small animals such as crustaceans, shellfish, worms, and insects that dwell in the sediment of estuarine and marine habitats. Factors that influence this community are primarily the substrate, period of inundation, and salinity as well as energy in the form of currents and wave action. The area where work is proposed, also known as the affected environment, is at the bottom of the channel and the areas that may require slope stabilization of the Blair Waterway. Saltchuk is also a component of the affected environment. The habitat classification is estuarine intertidal (Dethier 2014). Due to extensive dredging to create this navigable channel and the development of Commencement Bay, the estuarine habitat of the Blair Waterway is much deeper (-51 MLLW) than an average estuary.

The benthic invertebrate community in Blair Waterway has a high proportion of pollution-tolerant species (Partridge et al. 2010). Since 1999, the Blair Waterway benthic community has been described as adversely affected by natural or human stressors compared to the greater Puget Sound due to extremely low arthropod abundance, low species diversity, and high numbers of mostly stress-tolerant polychaetes (marine worms; Partridge et al. 2010). Benthic samples collected in 1999, 2008, and 2014 all had mollusks and arthropods, but bivalves (clams) and polychaetes were most abundant (Weakland et al. 2016).

4.2 Endangered Species Act Listed Species Present in the Action Area

Based on available information on the distribution of listed, proposed, and candidate species known to occur in the project area, and all consequences caused by the proposed action to ESA-listed species, the Corps has identified eight species or distinct population segments (DPS) that potentially occur in the action area of the Commencement Bay reach of Puget Sound or the Blair Waterway. These appear in Table 3 with their listing status and critical habitat status.

Table 3. ESA-listed species potentially occurring in the project area and their critical habitat designation.

Species	Listing Status	Critical Habitat
Bull trout (Coastal/Puget Sound DPS) (*Salvelinus confluentus*)	Threatened Nov. 1, 1999	Designated Oct. 18, 2010
Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened Mar. 24, 1999	Designated Sept. 2, 2005
Puget Sound steelhead (*O. mykiss*)	Threatened May 11, 2007	Designated Feb. 24, 2016
Bocaccio (*Sebastes paucispinis*)	Endangered Apr. 28, 2010	Designated; disposal site only Nov. 13, 2014
Yelloweye rockfish (*Sebastes ruberrimus*)	Threatened Apr. 28, 2010	Designated; disposal site only Nov. 13, 2014
Pacific Eulachon (Southern DPS) (*Thaleichthys pacificus*)	Threatened Mar. 18, 2010	Designated Oct. 20, 2011
Marbled murrelet (*Brachyramphus marmoratus*)	Threatened Sep. 28, 1992	Designated Oct. 4, 2011
Southern Resident killer whale (*Orcinus orca*)	Endangered Nov. 18, 2005	Designated Nov. 29, 2006

Other ESA-listed species may occur within uplands and marine areas of Commencement Bay and Puget Sound, but are not expected to occur in the project area. Upland species include streaked horned lark (threatened, *Eremophila alpestris strigata*), yellow-billed cuckoo (threatened, *Coccyzus americanus),* marsh sandwort (endangered, *Arenaria paludicola*), water howellia (*Howellia aquatilis*), and marine species include humpback whale (endangered, *Megaptera novaeangliae*), and leatherback sea turtle (endangered, *Dermochelys coriacea*). The Corps found no records of sightings of leatherback sea turtles in Puget Sound, and there are no breeding beaches in Washington.

The project area does not contain habitat that would attract streaked horned lark or yellow-billed cuckoo for breeding or feeding. Commencement Bay does not have coastal dune areas or airport runways where streaked horned lark nest, and the species is considered absent from former breeding sites on the Washington Coast north of Grays Harbor (Stinson 2016). Yellow-billed cuckoo records through 1941 suggest the Tacoma area was a historic nesting area, but the most recent sighting near Tacoma was before 1934 and the nearest nesting populations are in northern California and southern Idaho (Wiles and Kalasz 2017). The range of the marsh sandwort and the water howellia overlaps with landward portion of the action area but the urban and industrial landscape does not include suitable habitat for these species. There have been no recent sightings and both species are considered absent from the project area.

Humpback whales have been sighted in Central Puget Sound, and their overall numbers in the Salish Sea have increased in the last decade (Calambokidis et al. 2018); however, however healthy animals would not utilize areas near the waterway, nor would they be found near the shallow waters of the Saltchuk site. Therefore, humpback whales would not encounter effects of dredging based on the localized and short-term nature of effects.

The Corps has determined there will be no effect to these four species due primarily to the extremely low likelihood of their occurrence and/or the effects of the project would not extend to the species or harm their prey items or habitat in any measurable way.

4.3 Designated Critical Habitat in the Action Area

Of the ESA-listed species, only the salmonids and SRKW have designated critical habitat within the action area of the proposed project, including Saltchuk, considered in this document. Material dredged in this action that is determined suitable for aquatic disposal will be placed at the DMMP-managed Commencement Bay open-water disposal site. Use of the DMMP-managed disposal site has undergone consultation (see Consultation History in Section 2 of this document) and is therefore not considered in this document.

4.3.1 Bull Trout Critical Habitat

Critical habitat for Coastal/Puget Sound bull trout was designated by USFWS in September 2005 (70 FR 56211; USFWS 2005) and revised in October 2010 (75 FR 63898; USFWS 2010). In marine nearshore areas like the action area, the inshore extent of critical habitat is mean higher high water (MHHW), including tidally influenced freshwater heads of estuaries. Adjacent shoreline riparian areas, bluffs, and uplands are not critical habitat. The offshore extent of critical habitat for marine nearshore areas is to the depth of 30 meters (98 feet) relative to MLLW, which is the average depth of the photic zone. This proposed project falls within the geographical boundaries of Critical Habitat Unit 2 – Puget Sound (Marine).

4.3.2 Chinook Salmon Critical Habitat

Critical habitat for 12 species of salmonids including Puget Sound Chinook salmon was designated by NMFS in September 2005 (70 FR 52630; NMFS 2005a). In marine, estuarine, and nearshore areas like the action area, the line of extreme high water defines the inshore extent of critical habitat. The offshore extent of critical habitat for marine nearshore areas is to the depth of 30 meters (98 feet) relative to MLLW, an area that generally coincides with the maximum depth of the photic zone in Puget Sound. The action area lies within the nearshore marine areas critical habitat zone.

4.3.3 Steelhead Critical Habitat

Critical Habitat for Puget Sound steelhead was designated by NMFS in February 2016 (81 FR 9252; NMFS 2016a). In marine, estuarine, and nearshore areas like the action area, the line of extreme high water defines the inshore extent of critical habitat. The offshore extent of critical habitat for marine nearshore areas is to the depth of 30 meters (98 feet) relative to MLLW, an area that generally coincides with the maximum depth of the photic zone in Puget Sound. The action area lies within the nearshore marine areas critical habitat zone. Much of the Puyallup basin is mapped critical habitat for the species including the lower Puyallup and Commencement Bay with certain areas excluded for Tribal, WFP, and HFP lands. These areas include the portion of lower Puyallup River and Tacoma Harbor that falls within the Puyallup Tribe of Indians Reservation.

4.3.4 Southern Resident Killer Whale Critical Habitat

Critical habitat for SRKW was designated by NMFS in November 2006 (71 FR 69054; NMFS 2006). Puget Sound is one of the three specific areas are included in the designation. Based on the natural history of the killer whales and their habitat needs, the physical or biological features of designated critical habitat include water quality to support growth and development; prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and passage conditions to allow for migration, resting, and foraging. Designated critical habitat does not include waters shallower than 20 feet based on extreme high tide. SRKW critical habitat proposed along the outer coast of Washington in 2019 (84 FR 49214) would not be affected by the proposed action.

5 Evaluation of Project Effects on ESA-listed Species and Designated Critical Habitat

Evaluation of possible impacts of the proposed action is based on predicting changes from the baseline condition. This analysis focuses on the effects of the proposed action, as described in Section 3, on ESA-listed species and critical habitat. The dredging activities are proposed to occur for three years from August 16 through February 15, with in-water disposal of suitable material at the Commencement Bay DMMP site l, and from July 16 through February 15 for material placement at Saltchuk.

5.1 General Effects of the Proposed Action

5.1.1 Sediment

Shoaling (the accumulation of sediment within the channel) is estimated to remain steady at about 1,200 CY a year on average based on historic shoaling patterns. Additional information on the shoaling calculation is available in Appendix B of USACE 2019. It is estimated that about 30,000 CY of O&M dredging will be required every 25 years. Therefore, deepening the channels is not anticipated to change the amount of sedimentation in the Blair Waterway. This will not cause an increase in maintenance dredging quantities compared to the baseline conditions.

Sediments placed at Saltchuk would be a similar type and coarseness as some already present in the nearshore sites. Other areas with wood waste or fine material would be covered by native material. Overall sediment quality is expected to improve with beneficial use of dredged material at Saltchuk due to placement of native material and capping of wood waste.

Given the highly industrialized nature of Commencement Bay and Blair Waterway, there are numerous State and Federal cleanup sites immediately adjacent to Blair Waterway. There are 43 Model Toxics Control Act (MTCA) sites surrounding Blair Waterway, along with six Resource Conservation and Recovery Act (RCRA) sites, four Comprehensive Environmental Response, Compensation, and Liability Act sites, and four NPL sites. Fifteen of these sites have known contaminated groundwater and are located immediately next to Blair Waterway. An additional five sites are located one block further away from Blair. It is not known if these sites are leeching contaminated groundwater into Blair Waterway, but it is possible depending on the extent and direction of the plume of contaminated groundwater and the geologic material.Two of the NPL sites listed, Commencement Bay Nearshore Tideflats and Glenn Springs Holdings, are among the contaminated groundwater sites immediately next to, but not overlapping, Blair Waterway. Slope stability design for navigation purposes will receive additional consideration in the PED phase to ensure an engineering solution to address slope stability in the area also complete avoidance of disturbing HTRW material. Design of the side slope will also have to consider potential groundwater impacts, particularly related to any changes in the flow regime.

Because some of the dredged sediments are unsuitable for aquatic disposal, it is important to consider whether re-suspension of this material and its contaminants would cause biological effects to ESA-listed species. It is important to note that unsuitable material does not contain contaminants at levels that requires actionable cleanup under MTCA; instead, the material is unsuitable for aquatic placement. Assuming the standard 3% rate of re-suspension (AECOM 2012), approximately 13,000 CY of unsuitable material would be re-suspended during construction. This estimate is conservative and accounts for dredging to -58 MLLW, which is the maximum depth analyzed in the draft FR/EA (USACE 2019) and the total volume of dredged material includes 2 feet of overdepth during dredging. Different amounts of the mouth (85%), middle (40%), head (100%), and native material (all material approximately below -53 MLLW; 95%) are likely to be appropriate for beneficial use (DMMP 2019). While exact quantities are not available, the level of risk of harm to fish, wildlife, and invertebrates is estimated as low, given that the unsuitable material is a minor fraction of the sediments to be dredged.

Environmental dredging best management practices (BMPs) can mitigate sediment resuspension effects to a degree. Coarser sediments are likely to redeposit close to the dredge location; finer particles are likely to travel further downstream before resettling. The low current velocity in the Blair Waterway would limit the distance fine particles would travel from the dredge site. Resuspension occurs with much greater severity when subsurface debris is encountered. This is due to the dredging bucket not being able to close fully (because it is obstructed by debris) before removing sediments to the surface. The Corps assumes that all appropriate and feasible BMPs to reduce unsuitable material resuspension will be implemented depending on the nature of the sediment. However, some resuspension of unsuitable material during dredging is unavoidable, even with implementation of BMPs.

5.1.2 Water Quality

Some dredged material may contain sediment with biological and chemical oxygen demand that could temporarily lower local ambient dissolved oxygen (DO) levels during dredging. The upper portion of sediment is classified as loam to silt loam while native sediments are sand to loamy sand. Infaunal and benthic organisms inhabit the upper sediment, thus the likelihood of finding much anaerobic sediment in this stratum of sediment is small. Deeper sediment within the dredge prism is more likely to have anoxic conditions. Sediment with a biological oxygen demand will likely be a minor fraction, if any, of the material dredged (USACE 2015b); therefore, the Corps anticipates little or no reduction in ambient DO during dredging. No aspects of the project could change the temperature regime.

Clamshell dredging and material placement at nearshore locations such as Saltchuk typically results in short-term increases in turbidity in a linear plume downcurrent from the dredging activity. The small patch of eelgrass near the mouth of the Hylebos Waterway will be a consideration during material placement at Saltchuk. Water quality protection measures for the protection of eelgrass (e.g., turbidity curtains) would be refined when more detailed current information is available during the PED phase. Turbidity monitoring will occur during dredging to adhere to State water quality requirements as provided by the project's Water Quality Certification. The duration of work will most likely be the entire six- to seven-month work window in three consecutive years to accomplish the channel deepening. This work window is protective of sensitive species.

5.1.3 Fish, Wildlife, and Invertebrates

Dredging for deepening is expected to temporarily displace the bottom-dwelling resident fishes such as flounder, sole, and sculpins. Dredging activity affects only a small area at any given time of the total construction project and the benthic fishes are expected to return the area as the dredge moves to each sequential portion of the channel. The dredge equipment operates in a very small footprint compared to the 214.5 acres of the Blair Waterway channel; therefore, the mobile and migratory fish have a broad area for avoidance of the dredge equipment.

Most forage fish do not occur in the benthic areas of navigation channels and thus are not affected by maintenance dredging. Those that might be transiting navigation channels are not associated with one location, are highly mobile, and can avoid dredging operations, especially clamshell dredges due to the extremely low risk of entrainment. Although sand lance burrow into sandy substrates, it is assumed they would not select an area undergoing active dredging, and if dredging commenced where sand lance were present, they are at low risk of entrainment by clamshell dredges. The effect to the school of fish will be discountable. Likewise, the turbidity plume from the loam, silt loam, or loamy sand as the clamshell bucket rises through the water column may cause a school of forage fish to leave the area, however, no mortality is anticipated, as there is ample aquatic habitat for escape. While forage fish are a prey item for marbled murrelets, the slight displacement of the prey item out of the Blair Waterway is not expected to have any effect to prey availability or abundance.

Effects of dredging on the anadromous salmonids are short-term; these include noise and visual disturbance from the dredging activities and increased turbidity during dredging that may cause an avoidance response of adults during upstream spawning migration. Avoidance of the dredging or turbidity is expected to cause a slight detour around the dredging, particularly within the most constricted portions of the channel (e.g. 200- to 250-meter-wide). However, active dredging is unlikely to delay or substantially divert adult migrating salmonids because the adults can easily swim around a dredge operation without effects to their migration; in addition, they do not have to pass through the Blair Waterway to reach the Puyallup River. The Blair Waterway is an isolated channel that does not have an active outflow of water that would otherwise attract salmon to swim into the channel. Any turbidity plume associated with dredging the channel will be localized and of short duration as the sand settles quickly through the water column and would not be expected to extend more than several hundred feet downcurrent from the dredge. Juvenile salmonids typically move downstream in spring, generally follow the shoreline towards Saltchuk and across the entrance to the Blair Waterway, and are substantially protected by the in-water work windows; therefore, they are unlikely to be affected by dredge and disposal operations. Juvenile Chinook salmon may rear in nearshore areas into the early part of the in-water work window but are unlikely to remain in areas around the waterways due to the lack of useable shallow water habitats.

Any sediments determined to be unsuitable for aquatic disposal will be hauled off site to an appropriate upland disposal site. While this removes unsuitable sediment from the aquatic environment, some amount of resuspension will occur during the dredging process, estimated at approximately 3% or 13,000 CY for the proposed action. Bioaccumulative toxins appear in fish tissues collected throughout the Puget Sound region, and especially in urban areas (Puget Sound Action Team 2007). Concentrations of PCBs and other bioavailable contaminants in biota may have a minor increase during dredging. The increase in contamination concentrations in biota is a temporary effect, which will persist for a number of years following cessation of dredging. The resulting removal of sediment will be a net long-term benefit to the aquatic environment in the Blair Waterway, especially for bottom-dwelling fish that often test positive for contaminants in Puget Sound.

Placement of dredged material at the Saltchuk site would cause mortality of invertebrates present where the bulk of material lands. Larger organisms such as crabs would generally be able to flee the area. Sediments would be a similar type and coarseness as some already present in the nearshore sites. Other areas with wood waste or fine material would be covered by native material. Covering the wood waste with native material may initially harm habitat during early consolidation because any infauna and epifauna would be exposed to the pore water forced upwards from the wood waste below. Depending on the nature of the disposal material, and the wood waste being covered, this may be a transient, short-lived effect. The depth of the total habitat area available would be reduced to provide shallow water habitat for juvenile salmonids. In a relatively short period, organisms would reestablish in the placement area due to recruitment from adjacent non-disturbed areas. Based on these factors, effects to benthic invertebrate populations and their habitat due to dredging and material placement would be minor and insignificant.

Several pieces of equipment will be operating and producing underwater noise for up to 24 hours per day during the in-water work windows, for up to three years. Tugboats have a dominant frequency range of 100-500Hz with a peak output at 170dB_{RMS}, which is above the threshold for Level B harassment of fish (150 dB_{RMS}) and marine mammals (120 dB_{RMS}). Level B harassment has the potential for continuous noise to disturb but not injure for the species of concern in close proximity to the tug, and is expected to attenuate to background quickly with distance from the vessel (approximately 500 meters [1,640 feet]; Clarke et al. 2003). Fish behavior studies have shown that fish will avoid the area of noise and resume normal behaviors just beyond range of harassment noise levels, indicating discountable levels of effect would be occurring near dredging operations (Hastings and Popper 2005). In addition, noise measurements taken during dredging in the Snohomish River recorded a peak output of 168 dB re 1µP at 30 meters (98 feet) when a scow was moved into position by a tug (Pentec 2010). In a similar study, noise measurements during dredging at a frequency range of 100-500 Hz were 140-145 dB re 1µP at 100 meters (328 feet; less than the Level B harassment for fish; SAIC 2011 and RPS). Because the threshold for Level B harassment is measured in dB_{RMS}, which is the root mean square over some determined period and an "average," it is assumed the continuous noise of tug movements would generate a lower dB_{RMS} than the peak sound levels reported in the Snohomish River and be below thresholds or at ambient levels less than 500 meters (1,640 feet) from the tug. Audible frequencies ranges for marine mammals varies among species—pinnipeds begin at 500 Hz (Schusterman et al. 1972), mysticete whales at 10 Hz (Gordon and Moscrop 1996), odontocete whales at 100 Hz (Gordon and Moscrop 1996), and SRKW at 500 Hz (Hall and

Johnson 1971). The dredging location within the Blair Waterway, large size of Commencement Bay, and NMFS (2020) guidelines for viewing marine mammals by watercraft (50 yards from seals and sea lions; 100 yards from large whales; 200 yards from killer whales) are expected to be protective of marine mammals. When in motion, sound produced by the tugboats will be transient and expected to be below background levels a short distance (<500 meters [1,640 feet]) from the moving vessel with no lasting effects to fish, diving birds, or marine mammals.

Dredging causes direct mortality to benthic invertebrates that are incapable of avoiding the disturbance. The surface area that will be dredged is 214.5 acres in the Blair Waterway. The dredging will take up to three years to complete; therefore, the areas in which the benthic organisms are eliminated will not be the total surface area in a single dredging event. This will allow organisms to migrate from undisturbed areas into the deepened segments. Recovery begins with the early colonizers and takes less than a year for the short-lived organisms that have rapid growth and re-population strategies; this is followed by the longer-lived species that generally grow larger but have a slower recovery time of two to three years (Newell et al. 1998).

Slope strengthening in Blair Waterway may be necessary. The exact type of slope strengthening would be refined in PED, but it can be reasonably expected that the installation of slope strengthening would create a temporary disturbance (e.g., sheet pile driving or riprap placement) but BMPs such as vibratory pile driving, bubble curtains, or using the minimum amount of slope strengthening possible would minimize short-term and localized impacts. The Blair Waterway was artificially created and generally has a 2H:1V side slope and piers with varying degrees of slope strengthening (e.g., bulkheads, piles, and riprap) along the length of the channel. This habitat is not high quality aquatic habitat for juvenile salmonids or benthic invertebrates, so presence of engineered slope strengthening along about 8% (762 linear meters total) of the approximately 8,707 linear meters of overall Blair Waterway shoreline in areas of similar, existing development would not substantially degrade the habitat quality of this highly industrial and stabilized waterway.

Construction of slope stability measures in Areas 1-4 would create noise disturbances during construction, depending on the stabilization measure. Grading the slope to the appropriate channel depth would have in-water noise effects as described above for dredging. Construction of a 1.5H:1V slope with a rock toe would have in-water noise effects as described above for dredging. Barges would be used to transport and stage the riprap; the riprap would be placed in a controlled manner (i.e., gradually lowered into place), with the use of a skip box or clamshell bucket at the appropriate elevation above the sediment surface to minimize sediment disturbance.

Construction of slope strengthening with sheet piles or secant walls would temporarily create underwater noise in the Blair Waterway that would extend into Commencement Bay. For this project, vibratory pile driving is the preferred method for installation of sheet piles or secant piles as impact pile driving tends to produce the highest, most damaging noise levels. The vibratory hammer produces sound energy that is spread out over time and is generally 10 to 20 dB lower than impact pile driving therefore, vibratory pile driving is often an avoidance and minimization measure in pile driving projects, depending on the type of construction project and substrate conditions (Caltrans 2015). A similar project in the Blair Waterway found that noise levels were unlikely to exceed 160 dB_{RMS} during vibratory installation of 12-

24-inch concrete piles (BergerABAM 2012). The distance at which 160 dB_{RMS} was expected to attenuate to 120 dB_{RMS} was approximately 2.8 miles (BergerABAM 2012), which is approximately the distance between Area 1 and the mouth of Commencement Bay. The Blair Waterway and shape of Commencement Bay are expected to contain a substantial portion of noise generated. See Appendix E for an example of estimated noise propagation during sheet pile installation as shown in Berger ABAM 2012. A more refined noise analysis for slope stabilization using noise-generating construction methods such as vibratory or impact hammer installation would be provided in PED based on final designs of slope stabilization measures, materials, and installation details.

Economic forecasting has identified a substantial long-term benefit for fish, wildlife, and invertebrates: by the year 2035, navigation improvement is expected to reduce the number of vessel calls from 590 per year to 428 per year compared to the existing condition (USACE 2019). This approximately 27% reduction in vessel calls would reduce disturbance to not only fish in the waterway but also throughout Commencement Bay and the shipping channel in Puget Sound. The economic analysis assumes the same commodity throughput for deepening as the current depth. However, with channel deepening, vessels can load to their full summer loadline draft in order to carry more cargo in each transit. Larger ships results in fewer required transits for the same commodity throughput and a reduction in transportation costs. Table 4 summarizes vessel characteristics by class. Table 5 compares the current channel depth (-51 MLLW) calls to the estimated calls for each depth through -58 MLLW. The analysis assumes that with a channel depth of -57 MLLW, Tacoma Harbor will require 150 and 162 fewer calls in 2030 and 2035, respectively. The number of calls for Post-Panamax Generation 4 (PPX4) and Post-Panamax Generation 3 (PPX3; e.g., 14,000 nominal TEU capacity ship *Thalassa Axia*) vessels would remain the same for all channel depths from -51 (current channel depth) to -57 MLLW (proposed channel depth) in 2030 and 2035, but the number of vessel calls by smaller vessels are projected to reduce as the depth of the channel increases.

For maintenance dredging of the proposed -57 MLLW wider and deeper Federal channel, based on historic shoaling patterns, it is estimated the Blair Waterway will require approximately 30,000 CY of O&M dredging every 25 years to maintain the authorized depth of -57 MLLW.

Table 4. Fleet Subdivisions on Draft (distance from the bottom of vessel to the waterline), Beam (widest point), and LOA (length overall).

Vessel Fleet Subdivision (Containerships)	Dimension	From (feet)	To (feet)
Sub Panamax (SPX) (MSI[1] size brackets: 0.1-1.3, 1.3-2.9 k TEU)	**Beam**	0	98
	Draft	8.2	38.1
	LOA	222	813.3
	DWT	13,000	40,000
Panamax (PX) (MSI size brackets: 1.3-2.9, 2.9-3.9, 3.9-5.2, 5.2-7.6 k TEU)	**Beam**	98	106
	Draft	30.8	44.8
	LOA	572	970
	DWT	49,000	69,000
Post-Panamax (PPX1) (MSI size brackets: 2.9-3.9, 3.9-5.2, 5.2-7.6, 7.6-12 k TEU)	**Beam**	106	138
	Draft	35.4	47.6
	LOA	661	1,045
	DWT	66,000	86,000
Super Post-Panamax (PPX2) (MSI size brackets: 5.2-7.6, 7.6-12 k TEU)	**Beam**	138	144
	Draft	39.4	49.2
	LOA	911	1,205
	DWT	97,000	110,000
Ultra Post-Panamax (PPX3) (MSI size brackets: 5.2-7.6, 7.6-12, 12 k + TEU)	**Beam**	144	168
	Draft	40	53
	LOA	Up to 1,220	
	DWT	104,000	166,000
New Post-Panamax (PPX4) (MSI size brackets: 12 k + TEU)	**Beam**	168	200
	Draft	45	54
	LOA	1,150 and greater	
	DWT	150,000	205,000

[1] MSI = Maritime Strategies Inc.

Table 5. Vessel calls by year, class, and channel depth.

Vessel Class	-51 MLLW	-52 MLLW	-53 MLLW	-54 MLLW	-55 MLLW	-56 MLLW	-57 MLLW	-58 MLLW
2030								
SPX	0	0	0	0	0	0	0	0
PX	0	0	0	0	0	0	0	0
PPX1	49	25	4	0	0	0	0	0
PPX2	155	155	155	132	107	80	54	54
PPX3	229	229	229	229	229	229	229	229
PPX4	116	116	116	116	116	116	116	116
Total	**549**	**525**	**502**	**477**	**452**	**425**	**399**	**399**
2035								
PX	0	0	0	0	0	0	0	0
PPX1	81	55	29	5	0	0	0	0
PPX2	132	132	132	130	107	79	50	50
PPX3	189	189	189	189	189	189	189	189
PPX4	189	189	189	189	189	189	189	189
Total	**590**	**565**	**539**	**513**	**485**	**457**	**428**	**428**

5.2 Effects on Listed Species and Critical Habitat

5.2.1 Puget Sound Chinook salmon

Use of the Action Area

Two distinct populations of Chinook are present in the Puyallup River Basin: White River spring Chinook and Puyallup River fall Chinook. White River spring Chinook are the only spring Chinook stock in the south/central Puget Sound region (Marks et al. 2018). Adult spring Chinook salmon migrate through Commencement Bay to the Puyallup River as early as March or April, while adult fall Chinook salmon generally enter the Puyallup River June through early November on their way to spawning habitat far upstream from the action area (Marks et al. 2018). Adults will hold in moderate to deeper depths utilizing colder water in the action area. Adults may remain near the mouth of their natal river for days to weeks before entering the river.

Juvenile Chinook salmon typically use shallow water habitat and distributary channels for rearing habitat. These components were mostly eliminated by the industrial development and use of the estuary. Juvenile salmonid trapping by the Puyallup Tribal Fisheries Department observed juvenile Chinook salmon emigrating from the lower Puyallup River (River Mile 10.6) as early as January and as late as August, although the peak outmigration is typically late May (Marks et al. 2018). Historic beach seine sampling (1980-1995) in the Blair Waterway generally captured juvenile Chinook salmon after mid-February and before mid-August, with a peak around the end of May (Pacific International Engineering 1999).

Within the Blair Waterway, beach seine data consistently show juvenile Chinook salmon use of the Fairliner site (in the Blair Waterway) and near the mouth of the waterway (E. Marks, PTI, pers. comm. 2019). Beach seine sets in February and March 2004 at sites around Commencement Bay captured 2-7 juvenile Chinook salmon per set in the Fairliner Site and near the mouth of the waterway; meanwhile in 2005, 16 juvenile Chinook salmon were captured in one set at the Fairliner Site at the end of January and 1-23 fish were captured in February (E. Marks, PTI, pers. comm. 2019). In the Commencement Bay nearshore, 30-37 juvenile Chinook were sampled on two occasions in June 2013 for a contaminant study (O'Neill et al. 2015). No juvenile Chinook salmon were captured at Slip 5 or near the mouth of the Blair Waterway in 2016 sampling, but beach seine sets captured 0-4 and 0-2 juvenile Chinook salmon per set at the Fairliner Site in February and March 2016, respectively (E. Marks, PTI, pers. comm. 2019). Sampling at Squally Beach near Saltchuk in 2016 saw the most juvenile Chinook in a June 14th beach seine set (10 fish) and the fewest in a June 9th set (1 fish), while the other sampling dates in April and May had 2-4 fish each (E. Marks, PTI, pers. comm. 2019). These observations suggest that the timing of outmigrating and rearing juvenile Chinook in the Blair Waterway and Commencement Bay nearshore could have minimal overlap with construction or maintenance dredging at the end of the in-work window.

Effects of the Proposed Action

Dredging will occur throughout the in-water work window of July 16 (material placement) or August 16 (open-water disposal) through February 15 for up to three years to achieve target depths; maintenance dredging would follow this about once every 25 years. This timing overlaps with adult Chinook holding and upstream migration through the action area. This timing does not substantially overlap with the timing of when juvenile Chinook migrate downstream from the Puyallup River habitats outward toward Commencement Bay; juveniles outmigrate from the Puyallup River as early as January, but the peak in May is after the in-water work window has closed later in February (Marks et al. 2018).

The location of dredging will be restricted to only the proposed designated Federal navigation channel to depths of -51 MLLW to -57 MLLW with associated widening, plus two feet overdepth dredging. None of the dredging will occur in the intertidal zone or under the pier decking. The dredging location may overlap with areas of moderate to deeper, colder water where adult Chinook may be holding or migrating; however, these large and highly mobile fish are expected to be able to avoid the clamshell dredge and risk of entrainment is extremely low. Displacement of adults may occur on a minor scale as the dredge operates in a small area compared to the entire width of the navigation channel and aquatic habitat available. Dredging is not expected to cause any physical harm. Juvenile Chinook salmon typically migrate along channel margins in shallower water and their habitat use is not expected to overlap with the location of the dredging machinery. The shallowest material placement at Saltchuk extends to -5 MLLW, so very early outmigrating juvenile Chinook salmon may encounter material placement; however, this is a small proportion of Commencement Bay and the in-water work window is protective of the majority of juvenile Chinook salmon.

Underwater Noise

Underwater noise must be considered for projects that operate machinery in aquatic habitat. Noise levels that are considered harassment of salmonids are 150 decibels, root mean square (dB_{RMS}) for continuous exposure and 187 dB_{RMS} for pulsed (Blaxter and Hoss 1981, Knudsen et al. 1992). Dredging in the Snohomish River with a clamshell dredge generated peak noise levels as high as 170 dB re µP (SAIC and

RPS Evans Hamilton 2011). Another study in Cook Inlet recorded a peak noise level of 124 dB re µP when the clamshell hit a course substrate bottom (Dickerson et al. 2001). The Snohomish River study reported peak sound in dB re µP. Note that the thresholds listed above are in dB_{RMS}, which is the root mean square over some determined period. NMFS gives clear guidance for calculating dB_{RMS} for impact and vibratory pile driving, but there is no guidance for the type of sound generated by a clamshell dredge. Noise generated by clamshell dredges is characterized as continuous, since the elevated sound pressure occurs over several seconds (not milliseconds, as is the case with pulsed noise). It is assumed that since dB_{RMS} is an “average” that clamshell dredging would generate a lower dB_{RMS} than the peak sound levels reported in the Snohomish study. The Cook Inlet study also found that softer substrates are more effective at absorbing sound and peak sound measurements in softer substrates did not exceed thresholds for continuous sound. In addition, the dB_{RMS} reported in the Cook Inlet are just barely above harassment thresholds, and the substrate in the Blair Waterway is softer (sand and fine mixture) than that of both of studies and is therefore likely to better attenuate noise for overall lower sound levels.

Several pieces of equipment will be operating and producing underwater noise for up to 24 hours per day during the in-water work window for up to three years. It is assumed only one dredge will be operating at a time and will be running nearly continuously. One to two tugboats for towing barges will be transiting between the waterway and the Elliott Bay open-water disposal site. A survey vessel will slowly transit the area to measure dredging progress. Tugboats have a dominant frequency range of 100-500Hz with a peak output at 170dB_{RMS}, which is above the threshold for Level B harassment for salmonids in close proximity to the tug but is expected to attenuate quickly with distance from the vessel. When in motion, sound produced by the tugboats will be transient and expected to be below background levels a short distance from the moving vessel with no lasting effects, and therefore insignificant. Since the aquatic habitat in the waterway is 200 to 250 meters wide (650 to 820 feet wide), even when the dredge is in the center of the channel, there will be an area available for avoidance of harassment noise levels.

Noise generated by some slope stabilization measures (e.g., vibratory sheet pile driving or secant wall installation) would exceed the 150 dB_{RMS} threshold for harassment of salmonids. Based on previous vibratory pile installation (BergerABAM 2012), noise is not expected to exceed 160 dB_{RMS} and would attenuate to 120 dB_{RMS} at approximately 2.8 miles. In addition, previous pile installation work (Appendix E) has only elevated sound levels in Commencement Bay within a small area where Chinook salmon are unlikely to be present or noise is likely to be discountable.

Turbidity

Water quality parameters such as temperature, dissolved oxygen, and turbidity are correlated with discharge from the Puyallup River, large vessel traffic (e.g., 14,000 TEU ships and larger), and the greater Puget Sound water conditions (Puyallup River Watershed Council 2014). Turbidity is created when large ships enter the Blair Waterway due to the proximity of the propellers to the bottom of the waterway. Sediment can be disturbed and suspended, temporarily creating a plume of turbidity. This occurs when large ships (14,000 TEU and larger) enter the channel at the current -51 MLLW channel depth. The vessel classes calling at Tacoma Harbor would remain the same among depths (-51 MLLW to -57 MLLW), but a deeper channel would reduce the distance from the keel of the ship to the substrate and likely reduce sediment disturbance in the Blair Waterway. In addition, glacial meltwater and high loads of fluvial material generate turbidity in the Puyallup River and into Commencement Bay during times of peak flow, typically during spring and summer melt and fall-winter rains (Puyallup River Watershed Council 2014). These events overlap with some juvenile Chinook salmon presence in the Puyallup River. There are limited data on DO and temperature within the Blair Waterway, but DO measurements in December 1980 were about 6.4 to 7.7 mg/L in the Blair Waterway (Dames and Moore 1981). Outer Commencement Bay is recognized as impaired for DO because samples taken from 1993-2008 were below 6 mg/L (Ecology 2018). Although inner Commencement Bay is not included in this listing for DO impairment, the entire Commencement Bay is part of the Puget Sound Nutrient Source Reduction Project to address human sources of nutrients that may lower DO (Ecology 2019). Temperatures in October 1980 in the Blair Waterway were about 15 °C at the surface to 12 °C at the bottom, while temperatures in December were about 10 °C throughout the water column (Dames and Moore 1981). The proposed dredging is not likely to have an effect on temperature and dissolved oxygen, but can produce localized, short-term turbidity directly downcurrent from the dredging operation as the clamshell bucket lifts through the water column and at the placement site at Saltchuk.

The effects of turbidity on anadromous fish can be classified as behavioral, sublethal, or lethal, depending on the amount of material that becomes re-suspended generally measured as the level of turbidity (Newcombe and MacDonald 1991, Kjelland et al. 2015). Behavioral effects are described as any effect that results in a change of activity usually associated with an organism in an undisturbed environment. These effects include effects to avoidance responses, territoriality, feeding, and homing behavior (Sigler et al. 1984, cited in LaSalle 1988). Sublethal effects relate to tissue injury or alteration of the physiology of an organism. Sublethal effects are chronic in nature and while not leading to immediate death, may result in mortality over time. These may include effects such as gill trauma, or impacts to osmoregulation, blood chemistry, and reproduction and growth. Lethal effects kill individual fish and can cause overall population reductions, or damage the capacity of the system to support future populations.

Suspended sediment levels high enough to cause lethal effects generally are not attained in the natural estuarine environment or during dredging operations (Cordone and Kelley 1961, cited in Gregory 1988; LaSalle 1988) and are not expected to be present during the proposed dredging project. It is apparent that salmonids have the ability to cope with some level of turbidity at certain life stages (Gregory and Northcote 1993). Evidence of this is illustrated by the presence of juvenile salmonids in turbid estuaries prior to leaving for the ocean and in local streams characterized by high natural levels of glacial silt, and therefore high turbidity and low visibility (Gregory and Northcote 1993). However, salmonid populations not normally exposed to high levels of natural turbidity or exposed to anthropogenic sediment sources may be deleteriously affected by levels of turbidity considered to be relatively low (18–70 Nephelometric Turbidity Units [NTUs]; Gregory 1994). Based on the range of turbidity levels throughout the year from the Puyallup River of 1 milligram per liter (mg/L) to over 1500 mg/L during storm events, this would indicate that juvenile Chinook salmon in this river system are adapted to tolerating at least moderate levels of suspended solids during their outmigration.

Other factors to consider regarding turbidity caused by dredging are the coarseness of the material being dredged and the current speed in the waterbody. According to sediment sampling in 2019, the sediment in the top two feet of substrate is 24-90% sand (median 72%), and fine material content was 3.8-76%

(median 27.5%; DMMP 2019, Appendix C). Native material below the top two feet of substrate have a higher percentage of sand and lower percentage of fines than non-native material (DMMP 2019). The average speed of water currents is 0.05 meters per second (m/s; 0.16 feet per second) at the mouth to 0.01 m/s (0.03 feet per second) at the head of the waterway during all tidal phases. The typical quantity of re-suspension is 3% of dredged material (AECOM 2012). Given the grain size and current speeds, this material is expected to fall back to the sea floor in close proximity to the dredging location and Saltchuk without a substantial turbidity plume.

The severity of response of all listed salmonids is anticipated to be no greater than an avoidance of the immediate area of the narrow band of turbidity plume. The orientation of the plume will depend on a combination of dredge or barge location and tidal direction. The area of turbidity that is greater than background levels is expected to occur in only a minor portion of the waterway is being dredged or during material placement at Saltchuk. The Blair Waterway is currently 200-250 meters wide (650 to 820 feet wide) at its narrowest point and Saltchuk is along the open shoreline of Commencement Bay. Fish are expected to have ample area in the aquatic habitat to find refuge without harm from turbidity caused by dredging.

The Corps plans to submit of materials to Ecology for their certification under Section 401 of the Clean Water Act that the project meets State water quality standards. The preliminary estimate is for a 150-foot area of mixing, and the Corps will determine whether there will be a need for a 300-foot area of mixing based on modeling data for grain size, current velocity, and other factors in PED. The Corps anticipates that 150-300 feet will be sufficient distance for turbidity to dissipate to have no or very few exceedances of water quality criteria as measured in NTUs. For consistency with State water quality standards, the expectation is no more than 5 NTUs above background when ambient turbidity is less than 50 NTUs; and no more than 10 NTUs above background when ambient is above 50 NTUs at a distance of 150 feet down current of the dredge. The dredging contractor will conduct water quality monitoring during dredging, and will be required to implement BMPs to insure that potential effects of turbidity are minimized. Dredging requirements will include corrective measures that will be invoked if water quality parameters exceed established standards during dredging operations. These corrective measures emphasize the following: 1) modifying the dredging activity or equipment; 2) reducing the dredging rate; or 3) stopping dredging operations. These corrective measures apply until dredging operation demonstrates compliance with water quality standards. These requirements are expected to minimize water quality impacts during dredging to localized, short-term events. In the event that an extended area of mixing is requested, the request will apply only in areas where sediment has been determined suitable for open-water disposal or placement at Saltchuk.

Due to the low likelihood for a broad or lengthy turbidity plume and the lack of substantial overlap between timing and location of proposed dredging with juvenile Chinook salmon migration and habitat usage, there is low likelihood for behavioral and sublethal effects, and extremely low likelihood for lethal effects. Adult Chinook salmon migrating upstream past or moving in the waterway are large and highly mobile fish that are expected to be able to avoid deleterious effects of the small amount of turbidity associated with the dredging operation.

Effects to Critical Habitat

This section evaluates the potential for effects to the PBFs (physical and biological features) determined to be essential to the conservation of Puget Sound Chinook salmon.

PBF #1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.

> Dredging and the resulting channel improvements will not affect Chinook salmon spawning and larval rearing sites. These sites are in the mainstem Puyallup and White rivers and their tributaries. The dredge area is in Commencement Bay and the facility for transloading to upland disposal has not been identified but is assumed to be located in Commencement Bay. Therefore, the project will have no effect on this PBF.

PBF #2. Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

> Dredging will occur in deep water portions of the Blair Waterway in the middle of the channels away from the shore, and the waterway is estuarine, not freshwater, thus the dredge operations will not adversely affect freshwater rearing conditions. The facility for transloading to upland disposal has not been identified but is assumed to be located in Commencement Bay at an existing developed site that would not contain habitat conditions suitable to support growth and development of juvenile salmon. Therefore, the project will have no effect on this PBF.

PBF #3. Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channel, and undercut banks supporting juvenile and adult mobility and survival.

> Dredging and transloading for upland disposal will not adversely affect freshwater migration corridors because the project area is estuarine habitat, downstream of freshwater habitat. Therefore, the project will have no effect on this PBF.

PBF #4. Estuarine areas free of obstruction with water quality, water quantity, and salinity, conditions supporting juvenile and adult physiological transitions between fresh-and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

> The existing baseline does not support most of the required conditions in the Federal navigation channel. Since dredging will occur only in the center of the channels at depths of -51 to -57 MLLW, it is expected to have no effect on forage food organisms for salmon (e.g. insects and epibenthic organism in shallower, nearshore areas). Material placement at Saltchuk would cause mortality of invertebrates present where the bulk of material lands. Larger organisms such as crabs would generally be able to flee the area. In a relatively short period, organisms would reestablish in the placement area due to recruitment from adjacent non-disturbed areas. There will be no impact to

natural cover. The depth of the total habitat area available would be reduced to provide shallow water habitat for juvenile salmonids and to improve sediment quality at Saltchuk. This will not degrade any conditions or habitats that support juvenile and adult physiological transitions between fresh and saltwater. The effects of the project to this PBF are expected to be insignificant and discountable. Therefore, the project will not adversely affect this PBF.

PBF #5. Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

The existing baseline condition does not support the required conditions in the Federal navigation channel. The dredging site located in the Federal navigation channel and will not approach the intertidal zone of the nearshore area. No natural cover exists in the project area. Consequently, deepening the Blair Waterway and subsequent maintenance dredging will have no effect on nearshore marine areas. Placement of dredged material at Saltchuk will create shallow water habitat for juvenile salmonids. Changes to water quality would be localized and temporary during placement of beneficial use of dredged material at Saltchuk, and negative effects will be minimized with BMPs. The effects of constructing Saltchuk are expected to be insignificant and discountable. Therefore, the project will not adversely affect this PBF.

PBF #6. Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The dredging site is located within an industrial Port waterway. This area is adjacent to a migration corridor and baseline conditions do not support growth and maturation. Saltchuk is not located in an offshore marine area. Therefore, the project will have no effect on this PBF.

Effects Determination

There is limited concurrence of timing and location of dredging co-occurring with adult and juvenile Chinook salmon use of the Blair Waterway and Saltchuk. However, spring-run Chinook salmon are an important prey resource to SRKW and are the only spring Chinook salmon stock in the south/central Puget Sound region. Based on the importance of this species to SRKW and the low but not discountable probability that juvenile Chinook salmon may be present during temporary and localized effects of construction, this project may affect and is likely to adversely affect Puget Sound Chinook salmon. Based on the analysis of effects to each PBF of designated critical habitat, this project may affect, but is not likely to adversely affect critical habitat for Chinook salmon.

5.2.2 Puget Sound Steelhead

Use of the Action Area

Two distinct populations occur in the basin: Puyallup\Carbon winter steelhead and White River (Puyallup) winter steelhead (WDFW 2015). These populations typically start to enter the river in January and then hold throughout the river until moving to spawning grounds in March through June (NMFS 2005b). However, a few summer-run strays (unlisted), likely from the Green or Skykomish rivers, are caught annually during August and September in the lower Puyallup (Marks et. al 2014). Mainstem spawning occurs as low as RM 10 in the Puyallup River and RM 3 on the Carbon River (Pierce County 2013). Juvenile outmigration in the Puyallup River system generally occurs between April and July (Berger et al. 2011). Juveniles are not anticipated to be in the nearshore zone of the action area in large numbers because the majority of steelhead smolts migrate directly to the open ocean and do not rear extensively in the estuarine or coastal environments (Burgner et al. 1992). Adults are expected to occur in the deep, open-water areas around the Blair Waterway during the winter of their upstream spawning migration, and juveniles may occur in the shallow nearshore zone during typical outmigration periods in the spring and early summer. Adult fish would typically be oriented to the outflow of the Puyallup River. There is no information indicating that adults would enter and use waterways as a migratory route or holding area.

Effects of the Proposed Action

Channel dredging, disposal, and material placement at Saltchuk will occur throughout the in-water work window of July 16 or August 16 through February 15 for up to three years to achieve target depths. This timing overlaps with the early migration phase of adult steelhead to the Puyallup River. The in-water work window is closed for the duration of the juvenile outmigration period. Dredging activities would be adjacent to open-water areas where adult steelhead holding and migration may occur only when work is occurring near the opening to the waterway. Under that situation, these large and highly mobile fish are expected to be able to avoid the clamshell dredge and risk of entrainment is extremely low. Displacement of adults may occur on a minor scale as the dredge operates in a small area compared to the entire width of the navigation channel and aquatic habitat available. Dredging and material disposal at an upland facility or at Saltchuk is not expected to cause any physical harm.

Effects of dredging and material placement at Saltchuk would be expected to be the same for adult steelhead as those described for adult Chinook salmon regarding minor disturbances and behavioral effects from noise and turbidity.

Effects to Critical Habitat

The PBFs for steelhead critical habitat are identical to Chinook salmon critical habitat and all the effects identified for Chinook salmon are the same for steelhead; therefore, the analysis is not repeated here. The effects determination is the same.

Effects Determination

Based on limited coincidence of timing and location of dredging co-occurring with adult steelhead migration through Commencement Bay, this project may affect, but is not likely to adversely affect Puget Sound steelhead. Based on the analysis of effects to each PBF of designated critical habitat, this project may affect, but is not likely to adversely affect critical habitat for Puget Sound steelhead.

5.2.3 Coastal/ Puget Sound Bull Trout

Use of the Action Area

Five local bull trout populations are located within the Puyallup River Watershed Core Area; they consist of the (1) Carbon River; (2) Greenwater River; (3) Upper Puyallup and Mowich rivers; (4) Upper White River; and (5) West Fork White River (USFWS 2015). They exhibit resident, fluvial and anadromous life history forms. Spawning occurs in the late summer and early fall in the upper portion of the Carbon River and in the White River, above the limits of the action area (Marks et al. 2018).

During the fall and winter, migratory bull trout journey from spawning and rearing habitats in the upper watershed to foraging and overwintering habitats located lower in the river system. From spring through early summer, migrant bull trout commence their upstream journey to cooler spawning, rearing, and foraging refugium high in the watershed where spawning will occur primarily during the month of September (Marks et al. 2018). Migratory bull trout rear in upstream tributaries for 1 to 4 years before migrating downstream, usually in the spring, to a river, lake, or estuary/nearshore area (USFWS 2015).

Anadromous adult and sub-adult bull trout utilize marine waters for foraging and as a migratory corridor to reach other rivers. The period of marine occupancy is primarily March-July with most fish returning to freshwater no later than mid-July. In estuary and marine waters bull trout remain near the surface, seldom reaching depths greater than 30 feet. During fall and winter, only a very small number of bull trout (less than 1%) are expected to occupy marine areas, and only for short periods of time (Goetz 2016). Anadromous bull trout tagged with acoustic transmitters in the White River have been monitored entering and exiting Commencement Bay in late spring and early summer. During the same study, tagged bull trout were not observed entering any of the Commencement Bay waterways (USACE unpublished data).

Effects of the Proposed Action

Dredging will occur throughout the in-water work window of July 16 or August 16 through February 15 for up to three years to achieve target depths. This timing overlaps with the period of lowest bull trout abundance in estuary and marine winters, and the Blair Waterway and Saltchuk site are not considered quality estuarine or nearshore habitat. Therefore, it is assumed that very few fish would be affected by the dredging, transport for upland disposal, or material placement at Saltchuk.

The location of dredging will be restricted to only the proposed designated Federal navigation channel, as widened and to the depth of -57 MLLW. None of the dredging will occur in the intertidal zone or under the pier decking. The outer area of the dredging location may overlap with areas where bull trout may forage; however, these fish occupy shallower depths and are highly mobile, and therefore are expected to be able to avoid the clamshell dredge and material placement at Saltchuk, and risk of entrainment is extremely low. Additionally, they would be feeding on juvenile salmonids and forage fish, which are typically associated with the shallow areas along the shoreline rather than the deep water of the Blair Waterway. Material placement at Saltchuk will occur when fewer juvenile salmonids are foraging in Commencement Bay, so fewer bull trout are expected to be attracted to Saltchuk when there are fewer prey items available. Displacement of adults may occur on a minor scale as the dredge operates in a small area compared to the entire width of the navigation channel and aquatic habitat available. Dredging is not expected to cause any physical harm.

The effects of underwater noise and turbidity associated with the dredging project area and Saltchuk assumed the same for the adult and subadult bull trout as they are for adult Chinook salmon and steelhead as described in section 5.2.1. There may be minor behavioral effects as bull trout avoid noise and turbidity. The severity of effects is expected to be no greater than avoidance of noise and turbidity with sufficient aquatic habitat to avoid lethal or sublethal effects.

Effects to Critical Habitat

This section evaluates the potential for effects to the bull trout PBFs determined to be essential to the conservation of Coastal/Puget Sound bull trout.

PBF #1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

Dredging, transport of dredged material to a transloading facility for upland disposal, and material placement at Saltchuk will not have any effect to springs, seeps, groundwater sources, or subsurface water connectivity that contributes to water quality and quantity because there is nothing in the project that can effect these parameters. Therefore, the project will have no effects on this PBF.

PBF #2. Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

The Blair Waterway may function only minimally as a migratory corridor for bull trout; however, bull trout may enter the action area to feed on juvenile salmon and forage fish. Dredging and material placement at Saltchuk will result in temporary, localized increases in turbidity low in the water column, which could affect localized movements of bull trout (but will not block any kind of migratory corridor). If adult or subadult bull trout are present during dredging or material placement, they could easily avoid any areas of elevated turbidity, especially since the dredging operation is restricted to the central portion of the waterway allowing passage along either shoreline away from the dredge operation and Saltchuk is a minor portion of Commencement Bay. Therefore, the project will not have adverse effects on this PBF.

PBF #3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

Dredging will not affect terrestrial organisms because dredging will occur in the center of the waterway and will not affect shorelines or riparian vegetation. Dredging and material placement will affect benthic organisms in the dredge footprint and at Saltchuk. However, the aquatic macroinvertebrates (benthic only) at the depths of the waterway do not constitute significant prey for bull trout as they forage in shallower water. Saltchuk will improve sediment conditions for benthic organisms. Bull trout that might occur in the area are likely there to feed on salmon juveniles and forage fish. Regardless, because of the relatively small size of the dredge footprint and Saltchuk, the loss of benthic organisms from dredging will be insignificant compared to the total area of benthic forage areas available. Dredging could have a small but negligible indirect effect on bull trout through potential short-term effects to bull trout prey (juvenile salmonids and forage fish) and their habitat. However, bull trout prey is unlikely to be significantly affected by the proposed dredging operations. Therefore, the project will have discountable adverse effects on this PBF.

PBF #4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and un-embedded substrates, to provide a variety of depths, gradients, velocities, and structure.

Baseline conditions for this PBF in the Blair Waterway have none of the required characteristics to provide complex habitat. Dredging for the proposed navigation channel improvements and Saltchuk construction will not result in the degradation of shoreline complexity. Because the actions will take place in the center of the waterway and Saltchuk, side channels, pools, and undercut banks will not change. Further, navigation channel dredging and disposal at Saltchuk will not affect stream velocities or other hydraulic characteristics. Therefore, the project will have no measurable adverse effects on this PBF.

PBF #5. Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.

Dredging, material placement, and transport for upland disposal of sediment will not affect water temperatures. Therefore, the project will not have adverse effects on this PBF.

PBF #6. In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

The proposed action does not occur in spawning and rearing areas. Therefore, the project will not have adverse effects on this PBF.

PBF #7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.

The Blair Waterway and Saltchuk are not located in the Puyallup River. The dredging for the proposed navigation channel improvements and Saltchuk construction will have no effect on the hydrograph or river flows nor will it influence the tidal regime. Therefore, the project will not have adverse effects on this PBF.

PBF #8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

Dredging and Saltchuk construction will not affect the quantity of water available to bull trout. Short-term water quality degradation due to localized turbidity will not affect reproduction and will have negligible and discountable effects on growth and survival. Therefore, the project will not have adverse effects on this PBF.

PBF #9. Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

There is nothing in the project that will affect non-native predatory fish abundance or occurrence in Commencement Bay. Therefore, the project will not have adverse effects on this PBF.

Effects Determination

Based on limited coincidence of timing and location of dredging and Saltchuk construction co-occurring with adult and subadult bull trout use of the Blair Waterway and nearshore areas, this project may affect, but is not likely to adversely affect Coastal/Puget Sound bull trout. Based on the analysis of effects to each PBF of designated critical habitat, this project may affect, but is not likely to adversely affect critical habitat for bull trout.

5.2.4 Georgia Basin Rockfish: Bocaccio and Yelloweye

NMFS listed three species of rockfishes on July 27, 2010 (NMFS 2010a). Bocaccio was listed as endangered, while Canary and Yelloweye rockfish were listed as threatened. Puget Sound Canary rockfish and their critical habitat were delisted (NMFS 2016b).

Use of the Action Area

Three life stages are considered: larvae are not able to swim directionally, juveniles are larger and able to swim to preferred habitats, and adults are strongly associated with rocky substrates deeper than 160 feet (Love et al. 2002). According to Love et al. (2002), the larval stage of the ESA-listed rockfish species do not occur in the intertidal, nearshore, or shallow shelf habitats of Puget Sound; larval rockfish are present in surface waters in central and south Puget Sound apparently with two peaks of seasonal abundance that occur in early spring and late summer (Greene and Godersky 2012). Juveniles settle in nearshore rocky habitat or in kelp forests (Love et al. 1991), but this habitat type is not associated with the proposed dredging in the Blair Waterway primarily because the nearshore zone is at least 900 meters (2,950 feet) away from the channel and has a variety of armoring types that are not suitable rocky habitat. Adult rockfish are not expected to occur in navigation channels as the channels are in shallower, sandy-bottom habitat away from marine deep, rocky habitat and are not near typical spawning locations. Saltchuk is in nearshore habitat.

Adults of the two ESA-listed species of rockfish tend to inhabit water deeper than 160 feet with rocky substrate and only water with salinity greater than 28 parts per thousand (MBC Applied Environmental Sciences 1987, Yamanaka et al. 2006); the Blair Waterway and Saltchuk are less than 60 feet deep. Therefore, few if any adult rockfish are expected to inhabit the Blair Waterway or Saltchuk. Although juveniles inhabit shallower water than adults, they are also associated with rocky areas with kelp cover and sandy areas with eelgrass beds. None of these habitats are present in the action area with the exception of a small eelgrass patch near the mouth of the Hylebos Waterway. Juvenile yelloweye rockfish, unlike boccacio, are not typically found in intertidal areas and instead settle in waters deeper than 98 ft (NMFS 2013).

There is only a slight chance the larval stage of these species would be present at the project site because at this life stage they are pelagic drifters at the mercy of the currents. All three life stages of rockfish are very unlikely to be in the action area due the lack of deep water, suitable rocky substrate, and preferred aquatic vegetation (kelp and eelgrass).

Effects of the Proposed Action

For any rockfish that may be present in the project area during dredging operations or Saltchuk construction, the effects described for the salmonids would be similar for rockfish, namely displacement due to noise and turbidity. The sound pressure levels from dredging equipment, barges, and tugboats would not be above a lethal threshold but may cause fleeing and avoidance behaviors by rockfish. The minor turbidity plume anticipated to occur from dredging the sandy substrate may have sublethal effects such as gill irritation, and would cause rockfish to flee the area. Given the relatively narrow band of the turbidity plume compared to the 200- to 250-meter width of the navigation channel, any rockfish in the area would be capable of finding refuge in clearer water than in the small dredging footprint. Dredging in the navigation channels would have a discountable effect to rockfish due to the extremely low likelihood of their presence.

The Blair Waterway and Saltchuk are excluded from rockfish critical habitat.

Effects Determination

Based on the low likelihood for rockfish presence in the Blair Waterway and the minor and discountable effects of the proposed action, this project may affect, but is not likely to adversely affect Georgia Basin rockfish.

5.2.5 Southern Resident Killer Whale (SRKW)

Use of the Action Area

The SRKW spend considerable time in the Salish Sea from late spring to early autumn, with concentrated activity in the inland waters of the State of Washington around the San Juan Islands, and then move south into Puget Sound in early autumn. The Whale Museum has maintained a long-term dataset of reported sightings throughout the Salish Sea; the resulting set of maps organized by month indicates that the months with the highest number of sightings are January and December with 5 sightings over the greater than 60-year timeframe of recorded sightings compiled in the maps (Olson 2014). While the SRKW are sighted in Commencement Bay, they are not known to enter the navigation channels. Several factors affect survival and well-being of killer whales, but the main factors are physical disturbance of behavior patterns by boat noise or intrusive boating activities, reduction of food source (primarily adult resident Chinook salmon), and bioaccumulation of persistent bioaccumulative toxins.

Effects of the Proposed Action

As described in section 5.1.3 and 5.2.1, intrusive noise levels can have behavioral and physiological effects on animals. Effects to any killer whales that enter the project area may include abandoning hunting, diving or increasing swimming speed to flee the area, and interrupted communication between individuals or pods. Killer whales typically avoid the high-traffic area around Tacoma Harbor. Houghton et al. (2015) found that vessel speed is the greatest predictor of noise levels received by killer whales. Dredges and associated work vessels will be either stationary or traveling slowly for the purpose of surveying the bottom surface, maneuvering the dredge and barge, or transiting the barge to the disposal site. The slow rate of travel should minimize sound emitted from each vessel. Noise during slope stabilization construction would be temporary, and, likely limited, based on slope position and geography of Blair Waterway and Commencement Bay (Appendix E). Based on the short distance of sound attenuation from the dredges and associated work vessels and the very few if any killer whales likely to be present, effects of underwater noise from dredging and Saltchuk construction will be short duration, low intensity, and therefore discountable. The proposed action is estimated to result in about 27% fewer vessel trips to transport the forecasted cargo, which would mean reduced underwater noise throughout the central and northern half of Puget Sound on a daily basis, year-round.

Vessels associated with the proposed transport and disposal activities are primarily tugs and barges, which are slow moving, follow a predictable course, do not target whales, and should be easily detected by marine mammals. As a result, vessel strikes are extremely unlikely and any potential for effects from vessel strikes is therefore discountable. Vessel operations may cause temporary disturbance; however, such disturbance is likely to be short-term and localized, with no lasting effects, and therefore insignificant. When in motion, sound produced by the tug will be transient and expected to be below background levels a short distance from the moving vessel with no lasting effects, and therefore insignificant.

Effects to prey species from the proposed action are negligible and will not reduce populations; therefore, there are no effects to killer whales from this factor.

Concentrations of PCBs and other bioavailable contaminants in biota may increase during dredging. The rate of resuspension is estimated at 3% of material with an increased bioavailability for approximately two to three years (AECOM 2012; Patmont et al. 2018). This minor fraction would have a negligible effect to killer whale prey items and an undetectable contribution to the whales themselves. Analysis for the ESA consultation on continued use of the DMMP disposal sites concluded that effects of transport and disposal of dredged material containing biomagnifying substances to killer whales are discountable. A summary of the rationale provided is that the DMMP uses rigorous testing procedures to quantify effects and disposal sites are showing generally similar or lower concentrations of contaminants compared to nearby locations. The complete analysis appears in the USACE (2015a) Biological Assessment and the NMFS (2015) Biological Opinion, which are hereby incorporated by reference.

Effects to Critical Habitat

Critical habitat includes marine waters of Puget Sound. This section evaluates the potential for effects to the Southern Resident killer whale PBFs determined to be essential to the conservation of killer whales:

PBF #1. Water quality to support growth and development.

> Navigation channel dredging and Saltchuk construction will occur near areas where SRKW may swim; however, these activities will comply with water quality certification conditions established by Ecology. Any effects on water quality are temporary, typically lasting only minutes. Minor and temporary turbidity increases caused by resuspension of dredged material will not cause a significant decline in water quality such that growth and development of killer whales would be affected.

PBF #2. Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth.

> SRKW feed primarily on Chinook salmon and chum salmon. Adult Chinook and chum salmon can easily swim around dredges, dredged material transport barges, and tugs. Therefore, dredging and transport of dredged material will have no effect on this PBF. Dredging will occur in the Federal navigation channel away from the shorelines where juvenile Chinook and chum salmon are typically found. Material placement for Saltchuk in the nearshore may occur, and effects to juvenile Chinook and chum salmon are expected to be short-term and discountable due to BMPs that temporally separate most juveniles from material placement and minimize effects to water quality. While bioaccumulation of contaminants in tissues is a concern, the contribution of the dredging activities is negligible and discountable and has insignificant effects on the food web upon which the SRKW depend.

PBF #3. Passage conditions to allow for migration, resting, and foraging.

Dredges, tugs, and barges will not block passage of killer whales through the area, especially as encounters with killer whales are extremely rare. The killer whales are extremely unlikely to enter the Blair Waterway or the shallow Saltchuk site, and would not be migrating toward the Puyallup River. The proposed action may have negligible effects to SRKW and their critical habitat due to minor underwater noise from dredging, but these effects would not cause harm or have a longer duration than the dredging operations.

Effects Determination

Based on the low likelihood for Southern Resident killer whale presence in the Blair Waterway and Saltchuk, and the minor and discountable effects of the proposed action, this project may affect, but is not likely to adversely affect SRKW. Based on the analysis of effects to each PBF of designated critical habitat, this project may affect, but is not likely to adversely affect critical habitat for SRKW.

5.2.6 Eulachon

Use of the Action Area

Eulachon mostly spawn in major rivers such as the Columbia, and larger tributaries to the Columbia in late winter and early spring. Eulachon are far less common in south Puget Sound drainages and are not considered to be established in the Puget Sound Rivers (NMFS 2010b). However, they have been reported sporadically; for example, one was caught in a Nisqually River smolt trap in 2013 (S. Hodgson, Nisqually Indian Tribe, pers. comm. 2014). There were small numbers of adult eulachon captured in a juvenile salmon out-migrant screwtrap at river mile 10 in the Puyallup River (R. Ladley, PTI, pers. comm. 2013) and identification was confirmed by NMFS and the University of Washington (C. Olds and J. Fisher, NMFS, pers. comm. to R. Ladley, Puyallup Tribe of Indians, 2012; J. Orr, NMFS, and T. Pietsch, Univ. of Washington, pers. comm. 2013). One adult female eulachon with eggs was caught during beach seining at the Rhone-Poulenc restoration site in the Blair Waterway (A. Berger, PTI, pers. comm. 2019). Eulachon may rarely come into Puget Sound in large schools, but this has seldom been documented; the last such documented large school of eulachon in Puget Sound was in 1938 (NMFS 2010b). Although runs can be very sporadic, timing appears to be related somewhat to water temperature and high tides; depending on the river this can be January through March, or as early as November and as late as April (NMFS 2017). Spawning outside of the Columbia River is more likely when environmental conditions in the Columbia River are suboptimal, such as cold water conditions less than 4 °C that slow or stop migration, or due to sporadic straying (WDFW and ODFW 2001). Between late winter and early summer, adult and larval eulachon could migrate through Commencement Bay to move between their spawning areas and marine habitats.

Effects of the Proposed Action

Dredging will occur throughout the in-water work window of July 16 or August 16 through February 15 for up to three years to achieve target depths. This timing overlaps with about half of the most active time for eulachon life stages. The dredging location may overlap with areas where adult eulachon may be migrating; however, these highly mobile fish are expected to be able to avoid the clamshell dredge and risk of entrainment is extremely low. The risk of clamshell bucket strike, entrainment by clamshell dredge, and vessel collision is discountable due to the ability of eulachon to move away from the threat. Larval eulachon are not expected to be present during dredging or Saltchuk construction. Displacement of adults may occur on a minor scale as Saltchuk construction and dredging occurs in a small area compared to the entire width of the navigation channel and aquatic habitat available. Dredging is not expected to cause any physical harm. During placement of dredged material at Saltchuk, a limited number of adult or larval eulachon directly under or immediately next to the plume could be entrained and killed; however, this is not expected to have a measureable or significant effect due to the timing, scale of Saltchuk, and very small number of larval eulachon expected to be present.

Effects of dredging would be expected to be the same for eulachon as those described for adult salmonids regarding minor disturbances and behavioral effects from noise and turbidity. The action area does not contain eulachon critical habitat.

Effects Determination

Based on the low likelihood for eulachon presence in the Blair Waterway and at Saltchuk, and the minor and discountable effects of the proposed action, this project may affect, but is not likely to adversely affect eulachon.

5.2.7 Green sturgeon

Use of the Action Area

The green sturgeon (the Southern DPS is listed as threatened) is the most widely distributed member of the sturgeon family. They are found in waters from San Francisco Bay to Canada, but the only known spawning rivers are the Rogue, Klamath, Trinity, Sacramento and Eel rivers with peak spawning from May to June (Adams et al. 2007). Green sturgeon prefer relatively shallow marine depths (20-60 m; Huff et al. 2011). Many make a rapid, long-distance seasonal migration along the west coast between California and British Columbia in the fall to overwinter (Erickson and Hightower 2007; Lindley et al. 2008). Many green sturgeon then migrate south to spend summer among multiple bays, estuaries, or rivers, with large numbers observed congregating within these areas to feed on shallow mud flats (Moser and Lindley 2007; Dumbauld et al. 2008; Lindley et al. 2008). Sturgeon are benthic feeders that are most often found on or near the bottom while foraging or while moving within rivers and estuaries. They also tend to rest and feed in deep channels and pools during daylight hours. No spawning or critical habitat is located in Puget Sound, but a few green sturgeon are recovered in Puget Sound as incidental harvest (NMFS 2002), and have been tracked in Puget Sound at a very low abundance rate in winter and summer months (Lindley et al. 2011, so they may enter the Sound to forage. Their presence in the project area is considered unlikely.

Effects of the Proposed Action

Dredging will occur throughout the in-water work window of July 16 or August 16 through February 15 for up to three years to achieve target depths. Adult and sub-adult southern green sturgeon would be exposed to a small risk of entrainment during the proposed dredging and in-water dredged material placement (NMFS 2018). The most likely areas for the very few green sturgeon that may use Commencement Bay are likely in the deepest waters away from Saltchuk, or in areas of the lower Puyallup River, which reduces the risk of entrainment or harm from beneficial use of dredged material. In addition, there is little evidence of mechanical dredge (i.e., clamshell) entrainment, bucket strike, or direct collision of mobile organisms such as fish, sea turtles, and whales (NMFS 2018). Entrainment by clamshell bucket or material placement is not likely to cause detectable or significant effects to green sturgeon populations. In addition, alteration of benthic habitats may harm the prey base of green sturgeon (Section 5.1.3). However, these potential effects are considered discountable due to lack of substantial change to prey resources, limited affected area, and low likelihood of Commencement Bay representing a significant green sturgeon foraging area.

Effects of dredging would be expected to be the same for green sturgeon as those described for adult salmonids regarding minor disturbances and behavioral effects from noise and turbidity. Critical habitat within marine waters includes areas within the 60-fathom isobath from Monterey Bay to the U.S.-Canada border, and many coastal bays and estuaries are designated as critical habitat; however, Commencement Bay is not within critical habitat (NMFS 2010c).

Effects Determination

Based on the low likelihood for green sturgeon presence in the Blair Waterway and Saltchuk, and the minor and discountable effects of the proposed action, this project may affect, but is not likely to adversely affect green sturgeon.

5.2.8 Marbled Murrelet

Use of the Action Area

Marbled murrelets are permanent resident birds of Puget Sound, but the species is not abundant anywhere in Puget Sound. From 2001-2010 in Puget Sound and the Strait of Juan de Fuca, the murrelet population has decreased annually by 7.4% (95% CI = -11.2% to -3.5%) while the overall population decline for the Pacific Northwest, including coastal Washington, Oregon, and California, was by 3.7% (95% CI = -4.8 to -2.7%; Miller et al. 2012). They are occasionally sighted in Commencement Bay, most often off Browns Point (Seattle Audubon Society 2019). The primary prey items for marbled murrelets in Puget Sound include Pacific sand lance (*Ammodytes hexapterus*), Pacific herring (*Clupea harengus*), and krill (euphausiids; Burkett 1995). Murrelets could be found foraging on small fish such as sand lance in the marine waters adjacent to the action area, though they are likely to be very transient. Threats to murrelet populations include the loss of nesting habitat, reduced availability or quality of prey, increased densities of nest predators, and emigration, all of which could affect survival and fecundity (Miller et al. 2012). Marbled murrelet density is typically correlated to nesting sites in Strait of Juan de Fuca, The San Juan Islands, and northern outer coast, and during April to mid-September breeding murrelets make daily flights from marine foraging areas to tend inland nest sites (WDFW 2016). Marbled murrelets could be present year-round but because marbled murrelets generally stay close to shore and away from populated and industrial areas, they are unlikely to be present in the Blair Waterway.

Critical habitat for the marbled murrelet consists of forest areas suitable for nesting or roosting and is not found in the vicinity of the project. No marine areas are designated as critical habitat for marbled murrelets. Their presence is considered uncommon.

Effects of the Proposed Action

It is possible that murrelets flying over the area during construction would be disturbed by the noise, especially if slope stabilization methods are used (e.g., sheet piles or secant walls). However, they have the ability to avoid the area and are assumed to be habituated to this highly industrial area. The proposed action would not negatively impact foraging habitat in Commencement Bay, and Saltchuk construction may provide additional spawning areas for sand lance. Blair Waterway deepening and maintenance dredging, upland disposal of dredged material, and beneficial use of dredged material at Saltchuk are not expected to cause physical harm. Effects to forage fish are discussed in Section 5.1.3. Disturbance to marbled murrelet is not expected to measurably reduce foraging success or survival, and population-level effects are unlikely to occur.

Effects Determination

Based on the low likelihood for marbled murrelet presence in the Blair Waterway and at Saltchuk, and the minor and discountable effects of the proposed action, this project may affect, but is not likely to adversely affect marbled murrelet.

5.3 Cumulative Effects

Under the ESA, cumulative effects include the effects of future State, local, or private actions that are reasonably certain to occur in the action area (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7. Other State, local, or private actions that may affect shoreline or aquatic habitat in the action area will be required to obtain Federal permits, and as such will undergo separate Section 7 consultation and review.

Various factors have contributed to low quality habitat in Commencement Bay waterfront. Those factors include shoreline fill, armoring and subsequent loss of wetlands, persistent contaminants from past industrial practices, periodic dredging, vessel traffic, and other ongoing and future construction related activities that may result in elevated turbidity and noise that affect the wildlife itself and/or their prey resources. Given the degraded state of the waterfront, when combined with the proposed Federal Action to deepen and widen the Federal channel in the Blair waterway, and to place suitable material at Saltchuk, cumulative negative impacts to ESA-listed species would be insignificant.

Berth deepening or pier stabilization by the Port (LSFs; Section 3) that require additional dredging, riprap, sheet piles, secant walls, or other in-water work will still occur in Blair Waterway. Although it is not part of the Federal action it is included here as a cumulative effect because this work is reasonably certain to occur, and could be necessary to different degrees as slope stabilization. The LSFs and potential Federal slope strengthening (Section 3) are unlikely to occur at the same time, but would expose fish and wildlife to similar effects. Migratory salmonids may encounter re-suspended unsuitable material on their outward migration if they are in the project area during planned upgrade construction or the proposed Federal navigation improvement. These fish may then encounter underwater noise or turbidity disturbance during any of these same activities as they may occur during the homeward migration when the fish are adults. All effects are expected to be short-term and sub-lethal but could affect the overall level of success in growth and reproduction. Long-term effects from global climate change (increased water temperatures, lower DO, and lower pH) could also affect overall fitness. However, the combined effect is not anticipated to be a measurable cumulative effect on fish populations.

The benthic community at the depth range of the Blair Waterway is not an important prey source to the federally protected species or other commercially important species present. Therefore, the effects to benthic organisms from navigation channel dredging and material placement at Saltchuk, which would only endure for up to three years after dredging is complete, are not a significant impact to this ecosystem. Deepening may reduce disturbance to the benthic community that occurs when propellers of the largest ships (i.e., 14,000 TEU and larger) move close to the substrate, but the deeper depths that are not the preferred feeding depths of juvenile salmonids will persist. O&M dredging would likely occur on a 25-year cycle or less frequently as there is very little sediment input to the Blair Waterway. The benthic community would not be frequently disturbed. In addition, sea level change may reduce the need for O&M dredging, and would be much smaller than the area for deepening because the dredging would only target areas above the authorized depth; therefore, the benthic organisms would likely reach an equilibrium community condition between O&M dredging events. Because effects to benthic invertebrates would be minor and short-term, no cumulative effects would occur due to this proposed action.

5.4 Impact Avoidance and Minimization Measures

The Corps will employ Best Management Practices (BMPs) and conservation measures throughout the execution of the project to minimize negative effects to the environment. BMPs and conservation measures are determined on a project-specific basis according to the project area and type of ecosystem present in the action area. These include but are not limited to the following measures:

1. Comply with all applicable water quality standards and enforceable conditions issued in the water quality certification and adhere to monitoring protocols in the water quality monitoring plan (Appendix B).
2. Dredge only within the designated work window of August 16 through February 15 for material placement at the Commencement Bay open-water disposal site. In-water work for other locations of Commencement Bay, including dredging, is July 16 through February 15 (WAC 220-660-330; Corps 2017b).
3. The entire footprint of the area to be dredged will undergo sediment testing to determine suitability for aquatic disposal and all material determined unsuitable will be transported for upland disposal at an appropriate facility.
4. An environmental clamshell bucket will be used in all areas in which sediment has been determined unsuitable for aquatic disposal to minimize resuspension of contaminated sediment.
5. The sideslopes of the navigation channel will be graded to ensure no sloughing will occur. Bathymetric surveys during and after construction will show whether sloughing has occurred.
6. All equipment will be inspected daily to ensure that it is in proper working condition and has no leaks of fuel or hydraulic fluids. Each vessel will have a spill kit on board at all times.

In addition to the BMPs listed above, pursuant to Section 2(b) of the Fish and Wildlife Coordination Act (FWCA), NMFS had the opportunity to provide input during the planning process, and provided a Planning Aid Letter (PAL) that describes fish and wildlife resources in the project area, potential negative effects of the proposed project, and recommendations for mitigating the effects. The PAL appears in Appendix D. The potential negative effects identified include the following:

- Increased turbidity from dredging that can cause lethal, sublethal, and behavioral effects to fish
- Potential resuspension of contaminants from dredged sediments
- Habitat disturbance for Essential Fish Habitat species (groundfish such as English sole) that forage in deep water
- Container ships are identified as having a potential effect on feeding behavior of SRKW

Recommendations applicable to ESA-listed species included:

- Work with NMFS, USFWS, Pierce County, Washington State Department of Fish and Wildlife (WDFW), EPA, and the Puyallup Tribe to determine restoration actions to mitigate for project impacts
- Coordinate with NMFS throughout the development of the alternatives and design of the project to expedite the ESA section 7 consultation
- Develop a contingency plan for to minimize water quality effects should possible contaminants be discovered during sediment sampling prior to dredging
- Provide a full characterization of sediment quality that will be used in nearshore placement
- Include an analysis of vessel effects to marine mammals
- Maximize habitat restoration in the nearshore
- Perform monitoring of habitat restoration site

After initial coordination and receipt of the PAL, the Corps considered the four key items identified as potential negative effects and incorporated analyses of these points into the environmental effects analysis in Chapter 4 of the draft FR/EA (USACE 2019).

The Corps has coordinated closely with the natural resources agencies and Puyallup Tribe of Indians during the alternatives development phase. This coordination and consultation, including with the Muckleshoot Indian Tribe, will continue through design and implementation to avoid and minimize project impacts. Based on the determination that most project adverse effects would be short-term and temporary, and the only permanent adverse changes would have insignificant and discountable effects to environmental resources, the Corps has elected not to incorporate compensatory mitigation into the project design. In recognition of the identified potential negative effects listed in the PAL, the Corps will avoid and minimize effects by incorporating all applicable BMPs as described in the draft FR/EA sections 4.7 Water Quality, 4.11 Hazardous, Toxic, and Radiological Waste, and 4.18 Public Health and Safety (USACE 2019). The Corps will continue to coordinate with NMFS throughout the study as part of ESA Section 7 consultation. A full sediment characterization will be conducted for all dredged material in PED. Applicable BMPs would be implemented while dredging sediment unsuitable for open-water disposal to avoid and minimize effects of unsuitable sediment. Vessel effects to marine mammals appear in sections 4.14, 4.15, and 4.16 of the draft FR/EA (USACE 2019). Beneficial use of dredged material at Saltchuk would maximize habitat restoration in the nearshore within the scope of this project; additional evaluation of Saltchuk is recommended under the TSP. The Corps is considering the PAL recommendation to perform monitoring at Saltchuk to confirm that fish use is established at baseline or improved levels, and at what time frame, and will analyze its applicability during the feasibility level design phase.

5.5 Summary of Effects Determinations for ESA-Listed Species

Based on the preceding analysis of effects along with the impact avoidance and minimization measures, the Corps has concluded that the project may affect, but is not likely to adversely affect most ESA-listed species and their critical habitat in the action area of the proposed navigation improvement project at Tacoma Harbor. The project may affect, and is likely to adversely affect Puget Sound Chinook salmon and their critical habitat in the action area. These conclusions are outlined in Table 5.

Table 6. Effects determinations for ESA-listed species and their critical habitat.

Species	Species Effects Determination	Critical Habitat Effects Determination
Bull trout (Coastal/Puget Sound DPS) (*Salvelinus confluentus*)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Puget Sound Chinook salmon (Oncorhynchus tshawytscha)	May Affect, Likely to Adversely Affect	May Affect, Likely to Adversely Affect
Puget Sound steelhead (Oncorhynchus mykiss)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Bocaccio (Sebastes paucispinis)	May Affect, Not Likely to Adversely Affect	N/A
Yelloweye rockfish (Sebastes ruberrimus)	May Affect, Not Likely to Adversely Affect	N/A
Green Sturgeon (Acipenser medirostris)	May Affect, Not Likely to Adversely Affect	NA
Pacific Eulachon (Southern DPS) (Thaleichthys pacificus)	May Affect, Not Likely to Adversely Affect	N/A
Marbled murrelet (Brachyramphus marmoratus)	May Affect, Not Likely to Adversely Affect	N/A
Southern Resident killer whale (Orcinus orca)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect

6 Essential Fish Habitat Assessment

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267) requires Federal agencies to consult with NMFS on activities that may adversely affect Essential Fish Habitat (EFH). The Act defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." EFH is the habitat (waters and substrate) required to support a sustainable fishery and a managed species' contribution to a healthy ecosystem. Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish. Substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities.

6.1 Federal Action for Consultation

The proposed project is described in detail in Chapter 3 of this document. The Corps is the Federal action agency and the Port of Tacoma is the non-Federal partner for the project. The proposed action is for navigation improvements in the form of deepening and widening the existing Federal navigation channel in the Blair Waterway at Tacoma Harbor. This will be accomplished by dredging with in-water disposal of suitable material at the DMMP Commencement Bay open-water disposal site, as well as the ongoing evaluation of beneficial use of suitable dredged material at Saltchuk, and transportation of material determined to be not suitable for in-water disposal to a transloading facility for upland disposal at an approved facility. Construction will take approximately three years. Chapter 2 of this document provides a description of the action area for the project effects under consideration in this EFH assessment.

The objective of this EFH assessment is to determine whether the proposed action(s) "may adversely affect" designated EFH for relevant commercially, federally-managed fisheries species within the proposed action area. It also describes conservation measures proposed to avoid, minimize, or otherwise offset potential adverse effects to designated EFH resulting from the proposed action.

6.2 Identification of Essential Fish Habitat

Essential fish habitat is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include aquatic areas historically used by fish where appropriate. "Substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities (NMFS 1999).

Estuaries of Washington, including Puget Sound and the Pacific Ocean off the mouth of these estuaries, are designated as EFH for various groundfish, coastal pelagic species, and several of the Pacific salmon. The action area previously described in this document (see Chapter 2) lies within the Washington State coastal estuarine EFH composite and has been designated as EFH for various life stages of 25 species of groundfish (PFMC 1998), 5 coastal pelagic species, and 3 species of Pacific salmon according to Federal Fisheries Management Plans developed by the Pacific Fishery Management Council. The proposed action occurs within EFH and will affect EFH of Pacific coast groundfish, coastal pelagic species, and Pacific salmon species (Table 7).

Table 7. Essential fish habitat species and their life history stages that may be found in the project area.

Common Name	Scientific Name	Adult	Juvenile	Larvae	Egg
Groundfish Species					
Soupfin Shark	Galeorhinus galeus	X	X		X
Spiny Dogfish	Squalus acanthias	X	X		X
California Skate	Raja inornata	X	X		X
Ratfish	Hydrolagus colliei	X	X		
Lingcod	Ophiodon elongatus	X	X	X	X
Cabezon	Scorpaenichthys marmoratus	X	X	X	X
Kelp Greenling	Hexagrammos decagrammus	X	X	X	X
Pacific Cod	Gadus macrocephalus	X	X	X	X
Pacific Whiting (Hake)	Merluccius productus	X	X	X	X
Sablefish	Anoplopoma fimbria		X		
Black Rockfish	Sebastes melanops	X	X		
Bocaccio	Sebastes paucispinis		X	X	
Brown Rockfish	Sebastes auriculatus	X	X		X
Canary Rockfish	*Sebastes pinniger*	X	X	X	
Copper Rockfish	Sebastes caurinus	X	X		X
Quillback Rockfish	Sebastes maliger	X	X	X	X
English Sole	Parophrys vetulus	X	X	X	X
Pacific Sanddab	Citharichthys sordidus		X	X	X
Rex Sole	Errex zachirus	X			
Starry Flounder	Platichthys stellatus	X	X	X	X
Coastal Pelagic Species					
Northern anchovy	Engraulis mordax	X	X	X	X
Pacific sardine	Sardinops sagax	X	X	X	X
Pacific (chub) mackerel	Scomber japonicas	X	X	X	X
Jack mackerel	Trachurus symmetricus	X	X	X	X
Market squid	Loligo opalescens	X	X	X	X
Pacific Salmon					
Chinook salmon	Oncorhynchus tshawytscha	X	X		
Coho salmon	Oncorhynchus kisutch	X	X		
Puget Sound pink salmon	Oncorhynchus gorbuscha	X	X		

6.3 Potential Adverse Effects to EFH of the Proposed Project

The effects to water quality would be as described in Section 5.1.2; temporary and localized increases in turbidity, most notably near the seafloor as sediment escapes from the clamshell dredge. Dredging will take the duration of the six- to seven-month work window over three years of construction. Following construction, no permanent effects to water quality from turbidity would endure.

As described in Section 5.1.1, resuspension of sediments unsuitable for aquatic disposal is a concern for the project area. Bioaccumulative toxins appear in fish tissues collected throughout the Puget Sound region, and especially in urban areas (Puget Sound Action Team 2007). Concentrations of PCBs and other bioavailable contaminants in biota, including edible species, will have a minor increase during dredging. The increase in contamination concentrations in biota is a temporary effect that will persist for a number of years following cessation of dredging. The resulting removal of sediments unsuitable for aquatic disposal sediment will be a net long-term benefit to the aquatic environment in the Blair Waterway, especially for bottom-dwelling fish that often test positive for contaminants in Puget Sound.

Effects to the groundfish species such as sole and flounder would be as described in Section 5.1.3; the primary impact would be temporary displacement and entrainment in the small area where the dredge is working, during potential construction of slope stabilization measures, and with placement of materials as Saltchuk. Fish are expected to return to the area as the dredge moves away and after material is placed.

It is expected that benthic invertebrates within the proposed dredge prism will be eliminated by navigation channel dredging or material placement at Saltchuk, removing a potential prey source for groundfish in small areas at a time. As described in Section 5.1.3, invertebrates are expected to rapidly recolonize the dredged area and Saltchuk, and there would not be a permanent effect to the prey base for fish. Effects to habitat, which are expected to be discountable in the Blair Waterway environment, appear in Section 5.1.3. Post-remediation cap monitoring is recommended to verify the Saltchuk cap integrity and long-term recolonization of the benthic community; however, this monitoring is subject to approval and funding availability.

Temporarily elevated underwater noise will be an effect to EFH for all species groups. This is described in Section 5.1.3. Fish are not anticipated to suffer physical harm from the dredging equipment; however, they may avoid the area immediately around the dredge and associated vessels.

The only permanent changes to the benthic habitat are that the Blair Waterway will change from the uniform depth of -51 MLLW to become an even depth of -57 MLLW across the full length and width of the navigation channels, and slope stabilization may be installed at four locations along the waterway. This change in depth and potential slope stabilization measures do not constitute a substantial impact to EFH that would warrant mitigation.

6.4 EFH Conservation Measures

All of the BMPs and conservation measures as described in Section 5.5 that will be employed to protect the ESA-listed species are assumed equally protective of the waters and substrate that support the species with designated EFH in the project area. The Corps will employ the conservation measure of conducting maintenance dredging as infrequently as possible and only as needed to maintain navigability of the proposed authorized channel width and depth at -57 MLLW. Hydraulic modeling shows this is anticipated to be required approximately every 25 years. In addition, material placement at Saltchuk will have temporary and localized effects to EFH as described in Section 5, but will ultimately benefit juvenile Chinook salmon by creating shallow water habitat that is scarce in Commencement Bay and improving the benthic environment. This will have ancillary benefits for EFH species and habitat of Commencement Bay.

6.5 Conclusion

The project actions described in this document have the potential to adversely affect the EFH of federally managed species, but these effects are expected to be localized, temporary, and minimal. The minor and discountable effects from the proposed action will be offset by the overall improvement to EFH by the resulting removal of unsuitable sediment and beneficial use of dredged material at Saltchuk. The Corps believes the combination of the impact avoidance measures provided will reduce effects on EFH to the point that the effects will be insignificant and discountable, and thus the proposed dredging operation and Saltchuk construction will not adversely affect EFH.

7 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 (16 U.S.C. §1361-1407) restricts harassment of marine mammals and requires interagency consultation in conjunction with the ESA consultation for Federal activities. All marine mammals are protected under the MMPA regardless of whether they are endangered, threatened, or depleted. Marine mammal species that have been observed in the action area include harbor seal (*Phoca vitulina*), harbor porpoise (*Phocoena phocoena*), gray whales (*Eschrichtius robustus*), killer whale (*Orcinus orca*), Bigg's (transient) killer whales, and California sea lion (*Zalophus californianus*). Other species that may occur in Puget Sound, but are unlikely to enter the action area include humpback whale (*Megaptera novaeangliae*), Steller sea lion (*Eumetopias jubatus*), Northern elephant seal (*Mirounga angustirostris*), Dall's porpoise (*Phocoenoides dalli*), and Minke whale (*Balaenoptera acutorostrata*).

The project area is primarily the aquatic habitat of the high-use navigation channel and nearshore area (Saltchuk) surrounded by the industrial port infrastructure and activities. The marine mammals most likely to be present include harbor seals, California sea lions, and rarely killer whales. The marine mammals that occur regularly in the project area are assumed to be habituated to the industrial port activities.

The topics of concern for marine mammals include resuspension of contaminated sediments due to dredging, underwater noise from dredging and associated vessels, vessel traffic associated with construction, and effects to prey species. Each of these topics appears in Section 5.2.5 for the analysis of effects to SRKW. The effects are presumed to be the same for the other marine mammals potentially present in the action area; therefore, the analysis is not repeated here. Further information regarding underwater noise is presented below for analysis of its effects to the broader suite of marine mammal species.

Marine mammals use vocalizations to identify themselves, their location, territory, or reproductive status and communicate with each other about presence of prey, another animal, or danger. Loudness, frequency, duration, and types of sounds vary widely among the species, and can be compared to the audiogram for the species if one has been developed. Audiograms are the graphic display of hearing sensitivity, which plot frequency against hearing threshold. Available data show that whales' auditory thresholds can extend as low as 10Hz for the mysticetes (i.e. the baleen whales such as humpback and gray whales) and as high as 500kHz for some odontocetes (i.e. the toothed whales such as porpoise and killer whales) (Gordon and Moscrop 1996). California sea lions are most sensitive to sounds between 1 kHz and 28 kHz with peak sensitivity around 16 kHz (Schusterman et al. 1972). Harbor seals have a slightly broader range with ability to hear up to about 50 kHz for sounds over 60 dB (1 µPa @ 1 m; Richardson et al. 1995). The Steller sea lion hearing range is 500 Hz to 32 kHz with less sensitivity at the low and high frequencies.

Killer whales rely on their highly developed acoustic sensory system for navigating, locating prey, and communicating with other individuals (Ford 1989). Noise pollution from marine vessel traffic is one of the main concerns with decline in the endangered Southern Resident killer whale population because of how it may affect their vocalizations and hearing. Excessive noise levels may mask echolocation and other signals the species use, as well as temporarily or permanently damage hearing sensitivity. Vessel traffic negatively affects foraging behavior of the SRKW, which can have biologically significant consequences and is likely a factor in their low population level (Lusseau et al. 2009).

For a determination on whether construction related noise would affect marine mammals, one must consider the frequency, location, intensity, and duration of the sound source as well as the audiogram of the recipient species. If an audiogram is available for a species, then using that audiogram helps to analyze the effects of noise on important biological resources; otherwise, the hearing frequency range may be the best available information. Effects analysis requires calculating the sound exposure level that the animal receives. Table 8 displays data collected on hearing capabilities of marine mammals.

Table 8. Hearing capabilities of marine mammals and sound threshold for continuous and pulsed noise that can cause behavioral disruption and injury.

Species	Audible Frequencies	Level B harassment (continuous)	Level B harassment (pulsed)	Level A injury
Pinnipeds in general[1]	500Hz – 50kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
California sea lions	1kHz – 28kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
Harbor seals	1kHz – 50kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
Steller sea lions	500Hz – 32kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
Mysticete whales[2]	10Hz – 8kHz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}
Minke whale[2]	10Hz – 500Hz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}
Odontocete whales[2]	100Hz – 500kHz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}
Killer Whale (orca)[3]	500Hz – 105kHz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}

[1] Schusterman et al. 1972

[2] Gordon and Moscrop 1996

[3] Hall and Johnson 1971, Bain et al. 1993, Szymanski et al. 1999

Potential effects to marine mammals would come from elevated sound (underwater), which could disrupt foraging behavior, diving patterns, and social interactions. The established threshold for harassment of seals and sea lions is 120 dB_{RMS} for continuous sound, 160 dB_{RMS} for pulsed sound, and 190 dBRMS for injury (both pulsed and continuous). As described in Section 5.1.3 and 5.2.1 regarding potential noise from slope stabilization and dredging, evidence from previous studies compared to the Tacoma Harbor action area has led to the conclusion that the proposed clamshell dredging and vibratory installation of slope stabilization in the Blair Waterway would have a discountable effect of causing animals to avoid the area, but would not rise to the level of causing a significant impact.

Marine mammals are active in Commencement Bay, and take advantage of barges and buoys as resting areas. According to the Washington Department of Fish and Wildlife's Atlas of Seal and Sea Lion Haulout

Sites in Washington (Jeffries et al. 2000), the nearest harbor seal and sea lion haulout sites are in northeast Commencement Bay on buoys, floats, and discontinued log booms. Commencement Bay is not considered a major pupping and nursing site, and although the number of haul outs and sightings of pups were increasing in 2009, the discontinuation of log booms removed a major haul out location in Commencement Bay. The seals and sea lions that do enter the area are likely accustomed to a higher level of underwater noise due to the heavy vessel traffic around Commencement Bay and especially the Blair Waterway. Large shipping vessels can generate noise levels well above harassment and injury thresholds depending on variables like vessel speed, oceanic conditions, water temperatures, and bathymetry (McKenna et al. 2013, Richardson et al. 1995).

The resulting removal of sediment that contains contaminants will be a net long-term benefit to the aquatic environment in the Blair Waterway. No long-term changes to marine mammal use of the project area are anticipated. The navigation improvement project has a potential to reduce total number of vessel calls at the Port of Tacoma, which would reduce ambient underwater sound in the project area and throughout the shipping channel in the northern portion of Puget Sound.

Slope strengthening such as sheet piles, secant walls, or other vertical slope strengthening solutions at four locations in Blair Waterway may be necessary (Section 3 of this BA and Section 3.5 of the draft FR/EA; USACE 2019) and would be determined in PED after additional information is collected by ship simulation. Likewise, the construction method has not been determined at this point of the feasibility phase, but typical construction methods for slope strengthening could create a temporary disturbance to fish and wildlife in the area. Impacts of potential construction methods would be temporary and spatially limited due to the confined nature of the Blair Waterway that would reduce, but not completely eliminate, the noise transmission into inner Commencement Bay. In addition, potential slope strengthening locations within the Blair Waterway are away from areas that fish and wildlife utilize more frequently. Measures to minimize disturbance such as bubble curtains, in-water work windows, and construction techniques such as vibratory installation or auguring may be implemented, but the identification and feasibility of these measures would not be known until the type of slope strengthening and construction method is confirmed and designs are available in PED. An Incidental Harassment Authorization (IHA) would be obtained from NOAA in PED when design information is available, as warranted. Engineered slope strengthening and construction methods would be coordinated with the Services for impacts to ESA-listed species and consultation reinitiated as warranted. Given the location, limited duration, and potential slope strengthening designs and measures available to minimize disturbance, slope strengthening is unlikely to cause a significant effect to fish and wildlife populations.

Based on the preceding analysis showing low likelihood for harm to animals and overall negligible effects of dredging and material placement at Saltchuk or an upland facility, the Corps has determined there is no requirement to seek an Incidental Harassment Authorization for the Tacoma Harbor Navigation Improvement project during the feasibility phase. An Incidental Harassment Authorization (IHA) for effects associated with slope strengthening would be obtained from NOAA in PED when final design information is available, as warranted.

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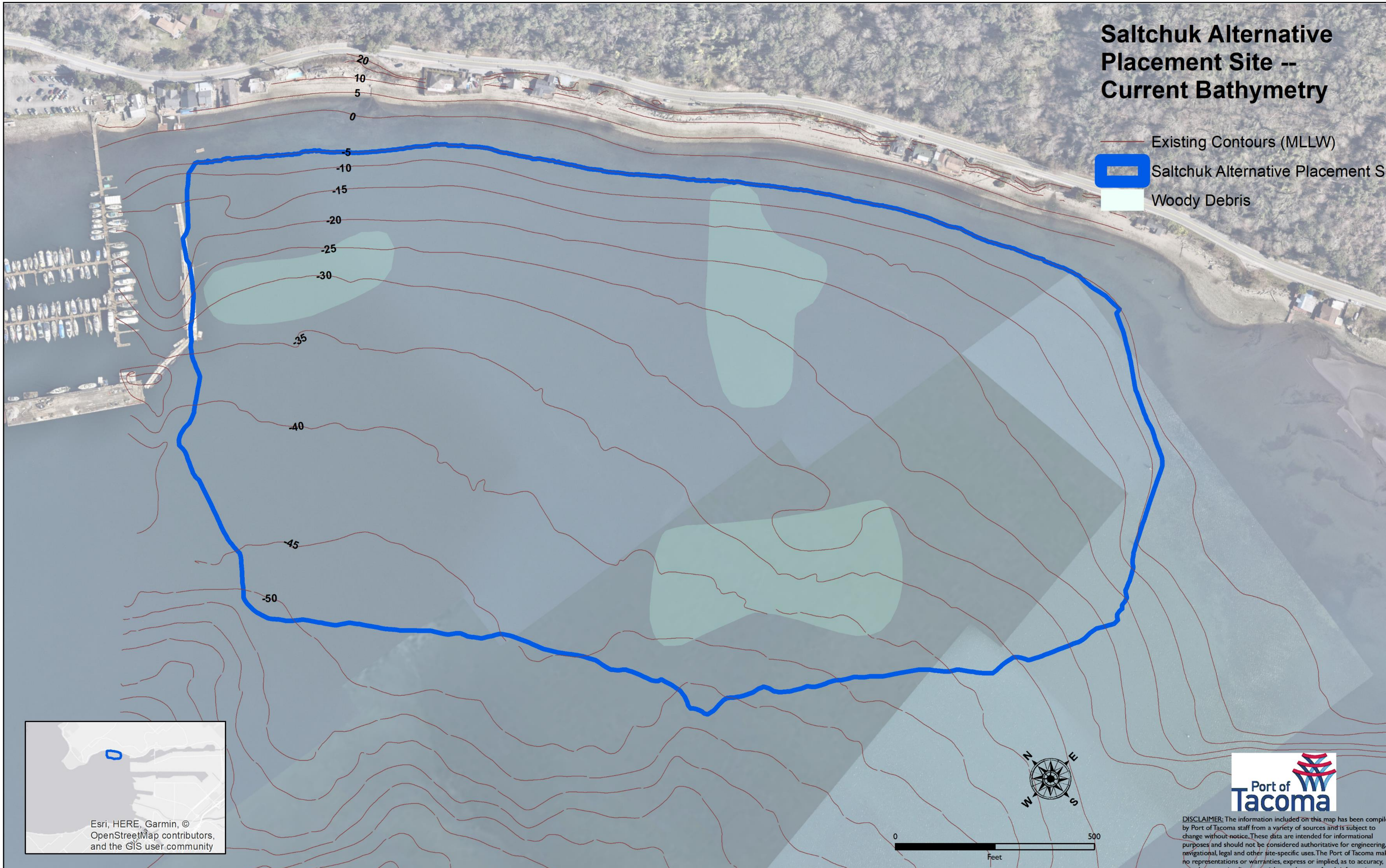
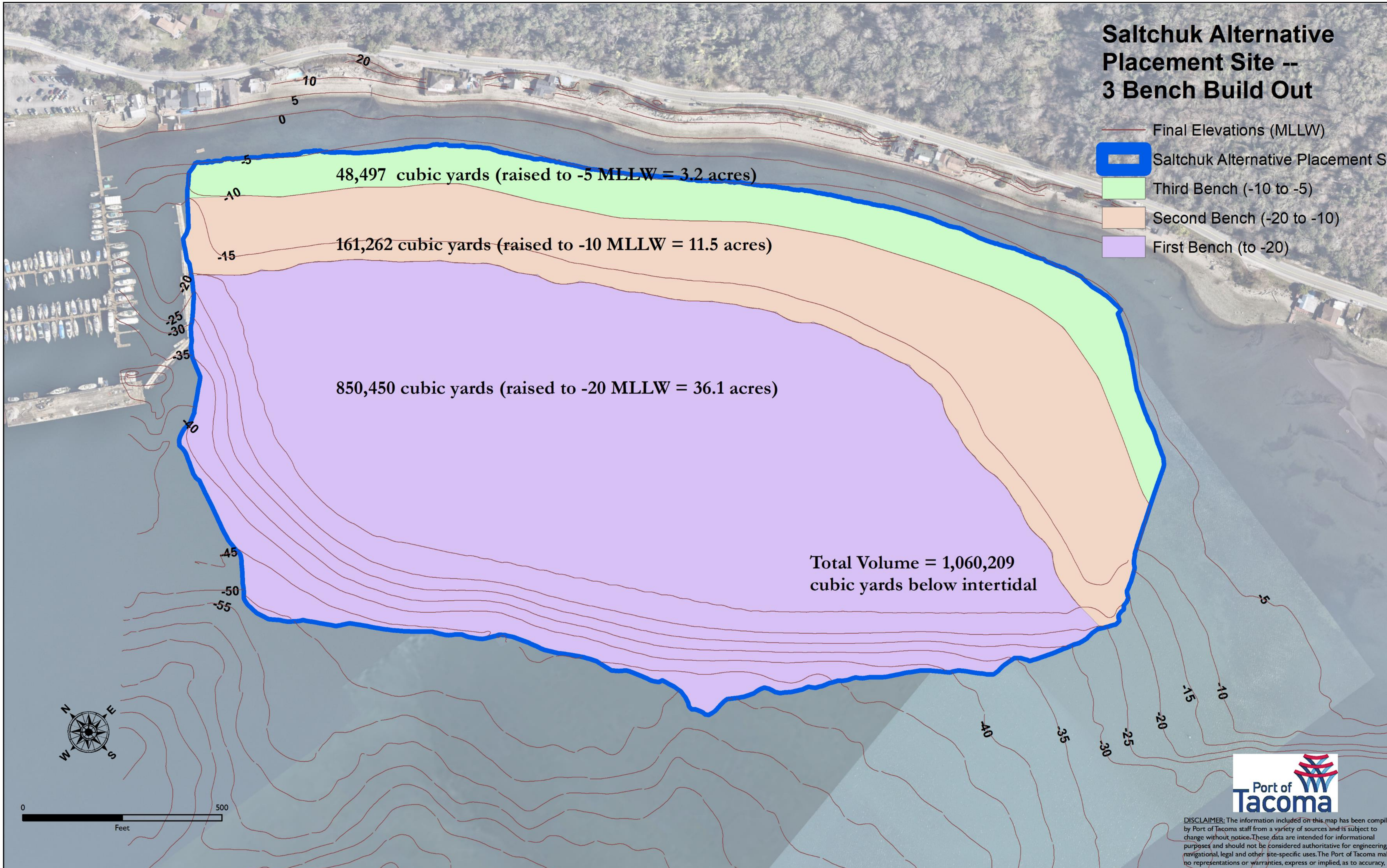
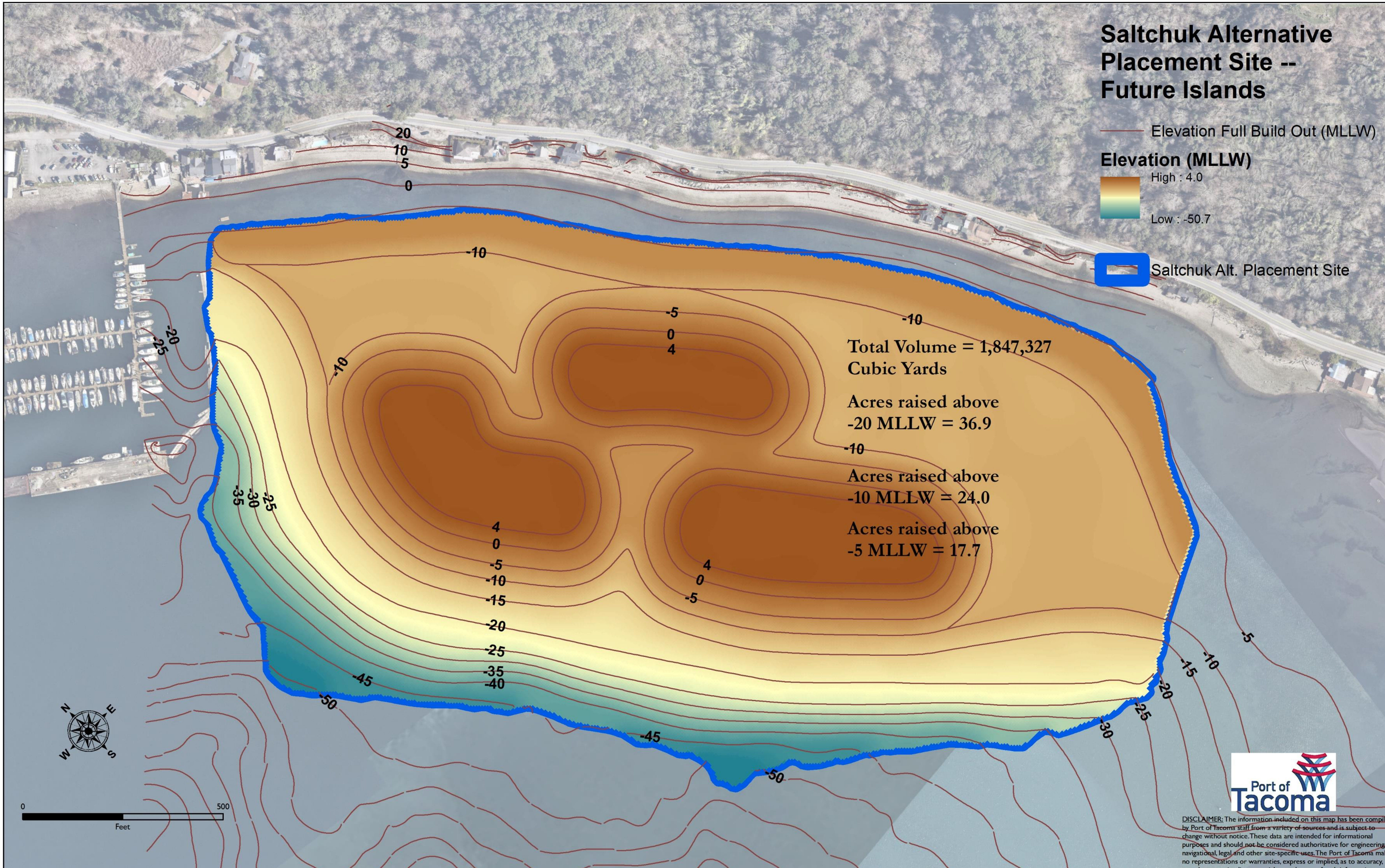


Saltchuk Alternative Placement Site -- Current Bathymetry
Existing Contours (MLLW)
Saltchuk Alternative Placement Site
Woody Debris
20
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
N
E
S
W
0
500
Feet
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Port of Tacoma
DISCLAIMER: The information included on this map has been compiled by Port of Tacoma staff from a variety of sources and is subject to change without notice. These data are intended for informational purposes and should not be considered authoritative for engineering, navigational, legal and other site-specific uses. The Port of Tacoma makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information.



Saltchuk Alternative Placement Site -- 3 Bench Build Out
Final Elevations (MLLW)
Saltchuk Alternative Placement Site
Third Bench (-10 to -5)
Second Bench (-20 to -10)
First Bench (to -20)
48,497 cubic yards (raised to -5 MLLW = 3.2 acres)
161,262 cubic yards (raised to -10 MLLW = 11.5 acres)
850,450 cubic yards (raised to -20 MLLW = 36.1 acres)
Total Volume = 1,060,209 cubic yards below intertidal
0
500
Feet
Port of Tacoma
DISCLAIMER: The information included on this map has been compiled by Port of Tacoma staff from a variety of sources and is subject to change without notice. These data are intended for informational purposes and should not be considered authoritative for engineering, navigational, legal and other site-specific uses. The Port of Tacoma makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information.



Saltchuk Alternative Placement Site -- Future Islands
Elevation Full Build Out (MLLW)
Elevation (MLLW)
High : 4.0
Low : -50.7
Saltchuk Alt. Placement Site
Total Volume = 1,847,327 Cubic Yards
Acres raised above -20 MLLW = 36.9
Acres raised above -10 MLLW = 24.0
Acres raised above -5 MLLW = 17.7
0
500
Feet
N
E
W
S
Port of Tacoma
DISCLAIMER: The information included on this map has been compiled by Port of Tacoma staff from a variety of sources and is subject to change without notice. These data are intended for informational purposes and should not be considered authoritative for engineering, navigational, legal and other site-specific uses. The Port of Tacoma makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information.

Final
September 2019

Tacoma Harbor Beneficial Use Habitat Evaluation Model Approval Request

Contents

1 Background

The Tacoma Harbor, WA Deep Draft Navigation General Investigation Study (Tacoma Harbor GI) is evaluating the feasibility of deepening the Blair Waterway at the Port of Tacoma, Washington. The Base Plan is to dispose of material at the Commencement Bay open-water site, but there is an opportunity for beneficial use of dredged material at the Saltchuk site located along the northeastern shoreline of Commencement Bay (Figure 1).

The U.S. Army Corps of Engineers (Corps) is required to predict and quantify environmental benefits using models to justify federal investment in restoration projects.[1,2] For environmentally beneficial disposal methods with incremental federal costs that exceed the lesser of 25% of total Base Plan disposal costs or $300,000, the incremental costs must be justified by demonstrating that the monetary and non-monetary benefits (outputs) of the ecosystem restoration project justify its incremental costs above the Base Plan. It must be demonstrated that the environmental resources to be restored are valuable, the environmental outputs can be quantified and described, and federal and state resource agencies support the environmentally beneficial disposal method.

Beneficial use of dredged material has support from multiple agencies and the public. The Commencement Bay open-water disposal site is managed by the Dredged Material Management Program (a consortium of the Corps, Washington State Department of Ecology (Ecology), U.S. Environmental Protection Agency (EPA), and the Washington Department of Natural Resources), which encourages beneficial use of dredged material when available and feasible (SAIC 2009). In addition, Endangered Species Act (ESA) conservation measures for the Commencement Bay open-water site include evaluating dredged material for beneficial use such as in-water habitat restoration projects as an alternative to disposal (NMFS 2015). During the Tacoma Harbor GI scoping period, a comment received from the U.S. Environmental Protection Agency (EPA) encouraged the Corps to consider beneficial re-use of suitable sediment, especially in the nearshore zone. The Washington State Department of Ecology (Ecology) issued general guidance for wood waste cleanup in aquatic environments in 2013, which includes in situ capping as an option. Citizens for a Healthy Bay, a local environmental organization that represents and engages the public for the protection of Commencement Bay, tentatively supports beneficial use of dredged material depending on the sediment suitability

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[1] Planning Guidance Notebook, ER 1105-2-100, Appendix E. April 22, 2000.

[2] Implementation Guidance for Section 204 of the Water Resources Development Act of 1992, as amended by Section 1038(2) of the Water Resources Reform and Development Act of 2014 and Section 1122(i)(2) of Water Resources Development Act 2016 - Regional Sediment Management. February 16, 2018.

determination. Finally, one scoping comment from an individual citizen referenced potential beneficial use of dredged material and it was in favor of this use.

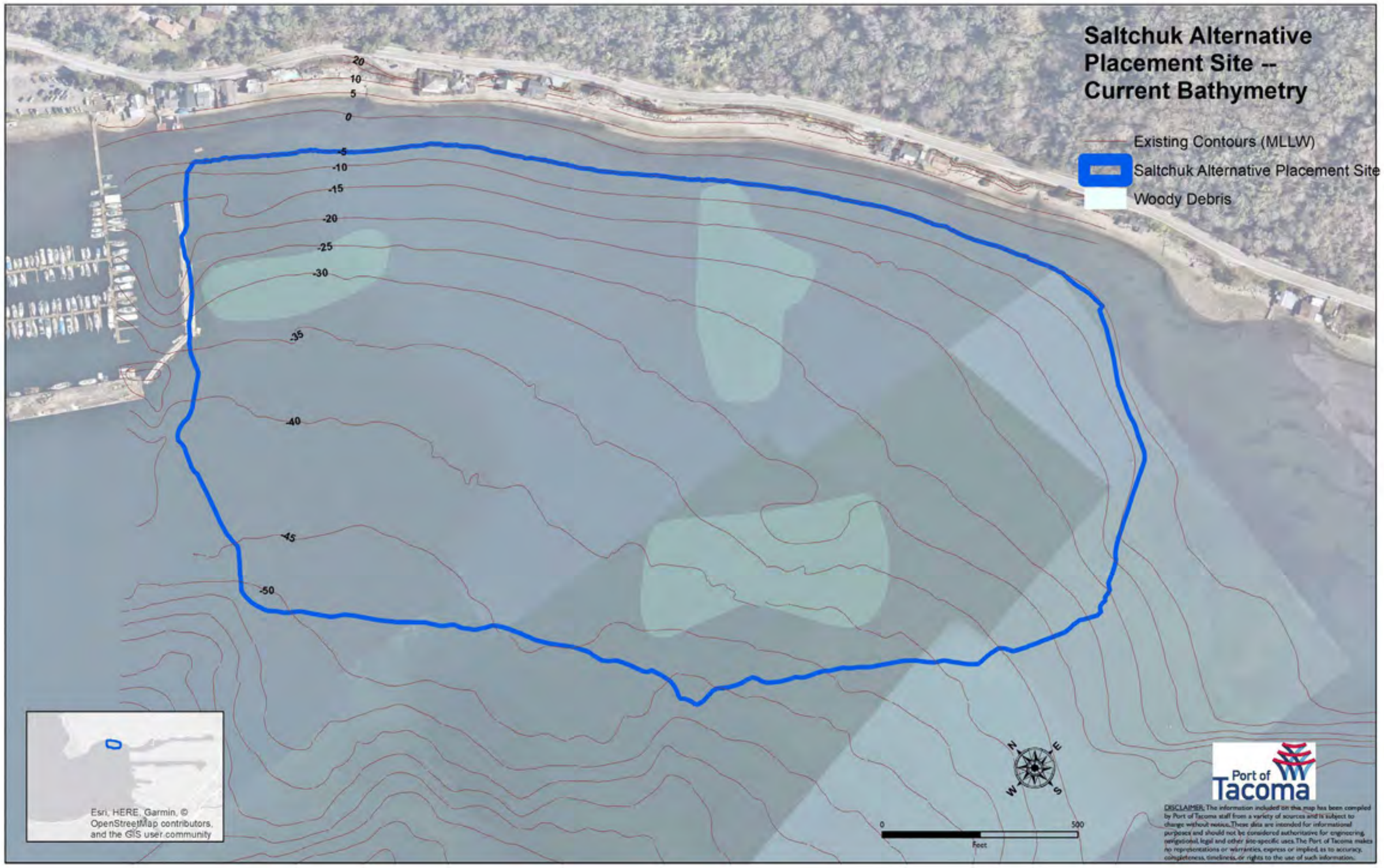

Figure 1. Saltchuk footprint within Commencement Bay with existing bathymetry and wood waste areas (Scenario A).

1.1 Problem Statement

A model is needed to assess quality of intertidal and subtidal marine habitat in Commencement Bay to evaluate the beneficial use of dredged material. Salmon habitat suitability index (HSI) models are based on freshwater life stages, which are not applicable to this project location in an estuary. The Seattle District considered using approved U.S. Fish and Wildlife Service HSI Models (i.e., “Blue Book” models) to assess habitat changes in the nearshore zone for species that have habitat requirements analogous to juvenile salmon. In particular, the juvenile English sole model (Toole et al. 1987) was considered based on correlation of juvenile English sole benefits to juvenile salmonids. However, after review of approved models, it was determined that these models did not use enough variables affected by beneficial use of dredged material or that they would not adequately capture the benefits to Chinook salmon (*Oncorhynchus tshawytscha*) brought about by placement of dredged material.

Many methods have been developed to assess impacts of proposed projects to anadromous fish species, especially salmonid species in the Pacific Northwest, with varying degrees of complexity (e.g., Lower Willamette River 2014, Skokomish River 2013, Willamette River 2012, and Skagit River 2011). These models tend to be fairly site specific and not appropriate for evaluation of beneficial use of dredged material at sites in the Commencement Bay nearshore zone.

1.1.1 Existing Conditions

The proposed beneficial use site is referred to as Saltchuk and is located along the northeastern shoreline of Commencement Bay. Over approximately 120 years, almost all the natural habitat in Commencement Bay was lost to human development; prior to 1877, the main habitat types of Commencement Bay were 2,085 acres of intertidal mudflats and about 3,894 acres of salt/brackish marsh (Corps 1993). By 2015 there were 106 acres of mudflat habitat and 72 acres of saltwater marsh (Kerwin 1999; EarthCorps 2015). Existing conditions at Saltchuk were documented prior to 2015 by Leon 2014 and GeoEngineers 2014b, as cited in GeoEngineers 2015. No restoration projects have been implemented at Saltchuk and it is assumed conditions have not changed significantly from the following description.

Lower Shore Zone (LSZ) habitat is composed of substrate that transitions to sand and silt substrate near mean lower low water (MLLW). LSZ habitat includes significant amounts of wood waste and one large area of wood waste starts at approximately MLLW. Based on previous wood waste studies, this wood waste concentration extends to a depth of approximately -30 MLLW. Macroalgae in the LSZ is largely composed of sea lettuce (Ulva spp.) at approximately the MLLW line. No eelgrass was observed within the project area; however, one patch of eelgrass was identified southeast of the project area at depths of approximately –6 feet to –10 MLLW during an underwater video survey conducted August 2014.

The site contains approximately 60.7 acres of deeper critical habitat zone (DZ) habitat (below -10 MLLW). The majority of the DZ habitat at the site consists of brown and black silt with wood waste over gray clay. Wood waste has accumulated over approximately 100 years due to log storage at the Saltchuk site. Log storage is visible on a 1931 aerial photograph as well as all subsequent aerial photographs. Three primary locations within the log storage area were observed to contain large quantities of wood waste during a 1999 dive survey.

Macroalgae is present in areas of the DZ and generally consists of brown or red algae. Invertebrates were observed during the dive survey including; polychaetes (unidentified species; only burrows observed), anemone (*Metridium senile*), sea stars (*Evasterias trochelii* and *Pisaster ochraceus*), red rock crab (*Cancer productus*), ghost shrimp (*Neotrypaea californiensis*), nudibranch (*Dirona albolineata*) and egg masses, and rosy octopus (*Octopus rubescens*; Leon 2014, as cited in GeoEngineers 2015). Ecology's Urban Bays monitoring program sampled the benthic community near Saltchuk at about -23 MLLW in 2014, and found 53% of the community was mollusks and 45% was annelids; only 0.59% was arthropoda and 0.82% was Echinodermata (Weakland et al. 2016). At least 63 creosote-treated timber piles approximately 12 inches in diameter are present from -5 MLLW to -15 MLLW. These piles are no longer associated with structures and would be removed by the Port of Tacoma.

1.1.2 Proposed Beneficial Use of Dredged Material

The objective of beneficial use of dredged material at Saltchuk is to restore nearshore intertidal and subtidal habitat substrate conditions for several fish and wildlife species, including ESA-listed species. The target species to benefit from the proposed project include juvenile and adult Chinook salmon, steelhead, and bull trout. Restoration actions are based on improving habitat conditions for these species and their prey species, such as forage fish and epibenthic and benthic invertebrates.

Dredged material would be placed by bottom dump barge or via excavator to enhance deep subtidal habitat and create and enhance shallow subtidal habitat. A range of scenarios appear in Table 1, including a minimum disposal scenario to build a bench to -20 ft MLLW (Scenario B), add benches to -10 ft MLLW (Scenario C) and -5 ft MLLW (Scenario D; Figure 2), and a full build-out (maximum disposal) to include island creation built on top of the benches (Scenario E; Figure 3).

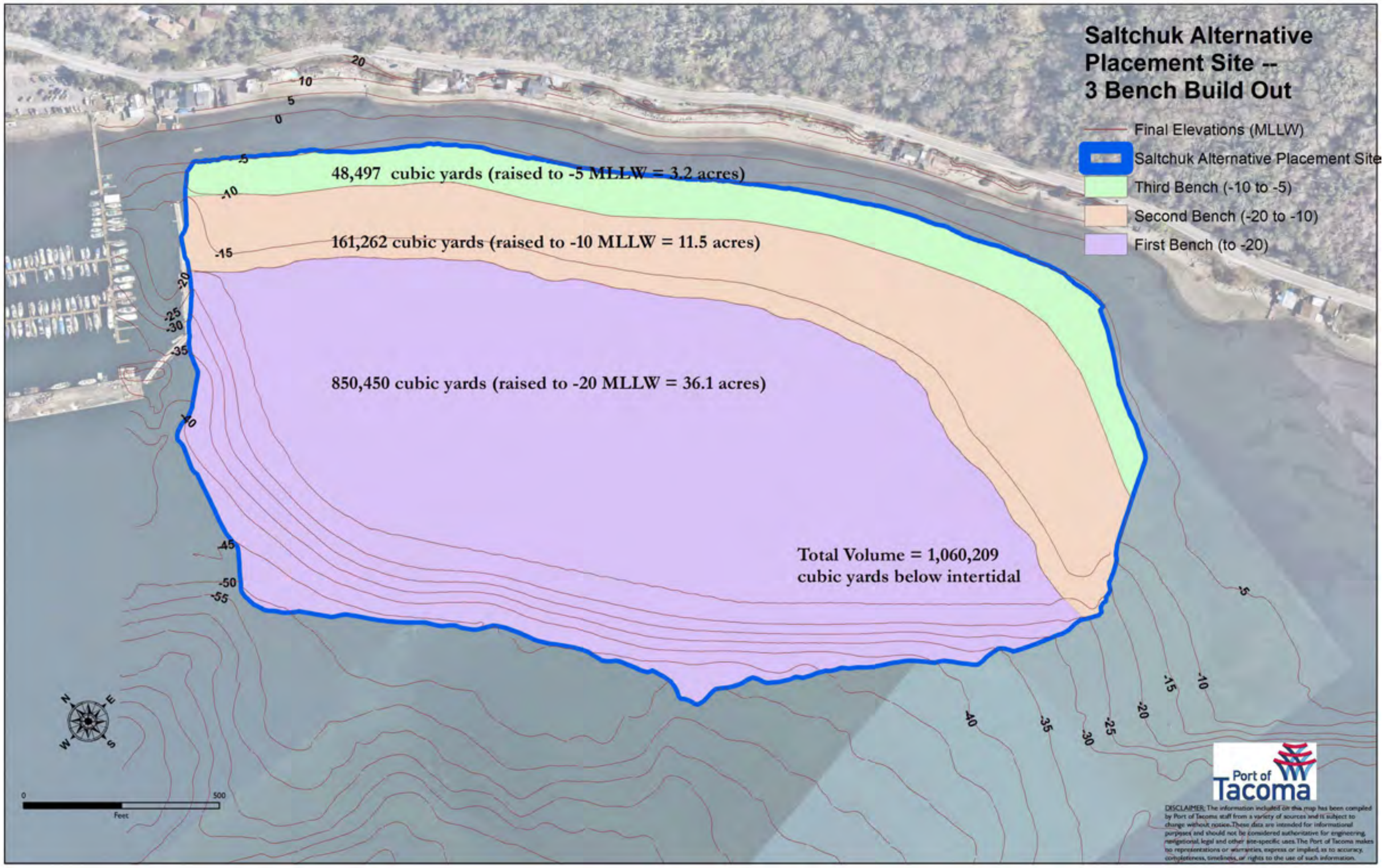

Figure 2. Proposed beneficial use of dredged material at Saltchuk. The first bench (to -20 MLLW) is Scenario B, the second bench (to -10 MLLW) is Scenario C, and the third bench (to -5 MLLW) is Scenario D.

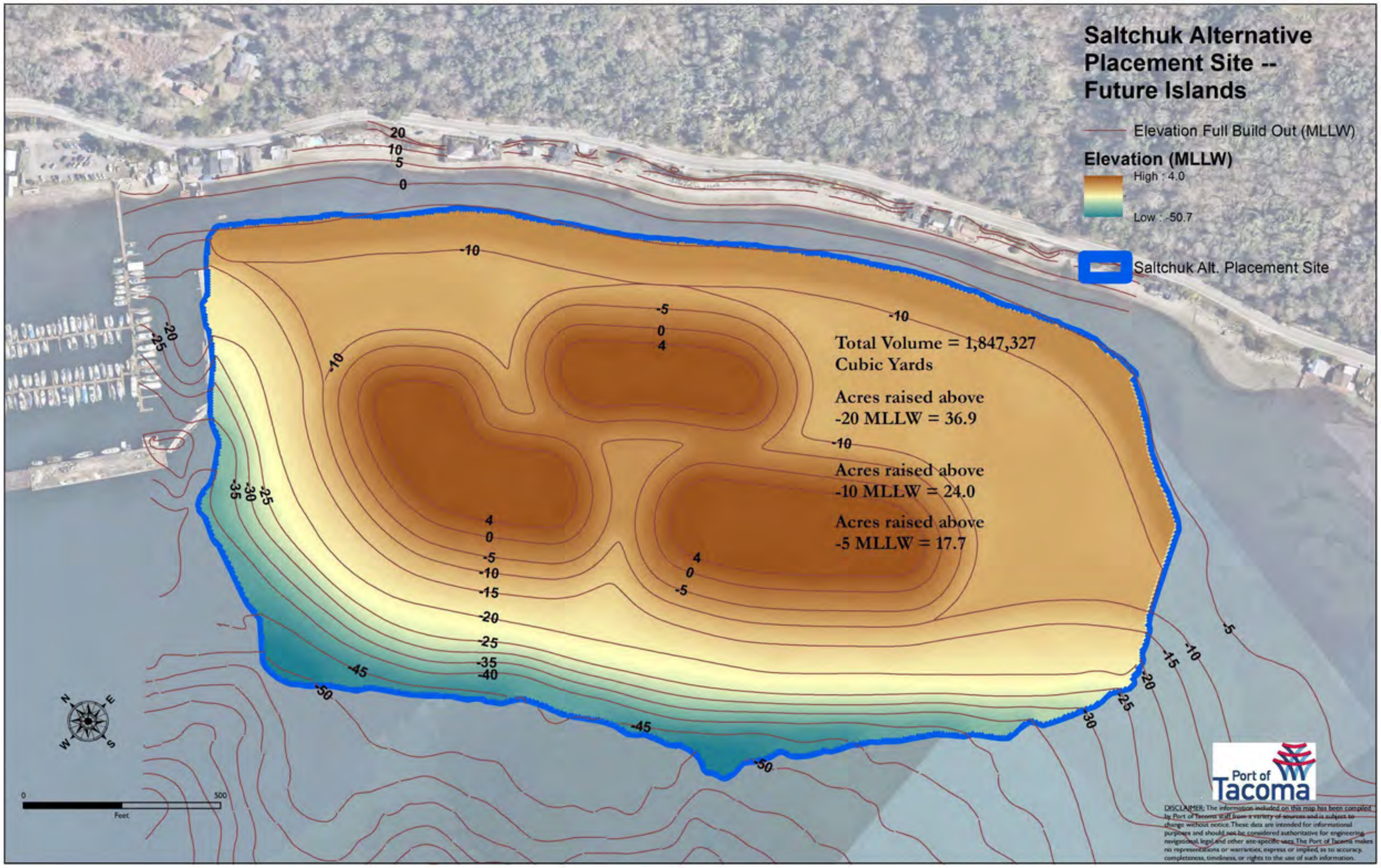

Figure 3. Full build-out of Saltchuk (Scenario E) has islands placed after the three benches (Scenarios B, C, and D) are constructed.

1.1.3 Anticipated Benefits

The majority of the DZ habitat within the project area will be converted to LSZ. LSZ habitat will be extended waterward to replace up to approximately 40.9 acres of DZ habitat under the full build-out Scenario E (Table 1). This habitat type provides the highest functional values in the NHV model.

Beneficial use of dredged material at Saltchuk will accomplish two goals: 1) wood waste will be capped with sediment and 2) additional intertidal and shallow subtidal habitat will be created. Areas that remain as DZ habitat will be configured as a slope ranging from approximately -15 MLLW to -40 MLLW. Proposed benefits within the DZ include decreasing bottom depth and capping existing wood waste, both of which may increase benthic production within this zone.

Placement of clean sediment over the wood debris will improve habitat conditions for benthic invertebrates. The epibenthic invertebrate community at the surface of the substrate is mostly copepods and amphipods that feed on detritus and/or plants (Dames and Moore 1981). Juvenile Chinook, chum (*Oncorhynchus keta*), and coho salmon (*O. kisutch*) in the Commencement Bay estuary feed primarily on epibenthic invertebrates such as copepods, amphipods, and aquatic insect larval and pupal stages; they transition from epibenthic prey to pelagic prey (such as aquatic insects, chironomids, and planktonic prey) with growth (Meyer et al. 1981; Simenstad 2000). Log storage was discontinued to remove the input source for wood waste impacts to the benthic environment.

Several studies have demonstrated that benthic organisms rapidly recolonize habitats disturbed by dredging and dredged materials placement and return these habitats to reference conditions (Wilber and Clarke 2007; Ponti et al. 2009). Recovery begins with the early colonizers and takes less than a year for the short-lived organisms with rapid growth and re-population strategies; this is followed by the longer-lived species that grow larger but have a slower recovery time of two to three years (Newell et al. 1998; Desprez 2000).

At full build-out, the shallow subtidal bench will start at approximately -10 MLLW and slope gradually up to approximately -6 MLLW across the bench. This is the observed elevation range of the eelgrass bed adjacent to the site to the east. Eelgrass may establish in this area naturally from the nearby eelgrass patch, or eelgrass could be artificially propagated through several methods including transplanting and seeding. Increasing potential eelgrass habitat will increase potential spawning habitat for Pacific herring and create important nursery habitat for other marine species.

The target species of the proposed Saltchuk are Chinook salmon, steelhead (*O. mykiss*) and bull trout (*Salvelinus confluentus*); including their prey species such as forage fish and terrestrial and benthic invertebrates. In addition to improving habitat conditions for listed salmonids and their prey, the project will indirectly benefit additional listed species. Chinook salmon is the primary prey of ESA-listed Southern Resident Killer Whales (SRKW; *Orcinus orca*), while Pacific sand lance (*Ammodytes hexapterus*) and Pacific herring (*Clupea pallasii*) are primary prey for ESA-listed marbled murrelets (*Brachyramphus marmoratus*). Although SRKW and marbled murrelets are not expected to occur within the project area, habitat enhancement for their prey species could increase prey populations and, in turn, increase dispersal and migration of these prey species into suitable habitat for SRKW and murrelets. Benefits of the action would accrue to the ecosystem well beyond the project site.

2 Model Background and Purpose

The purpose of this report is to present model evaluation of the Puget Sound Nearshore Habitat Valuation (NHV) Model that was developed by the National Marine Fisheries Service (NMFS) in 2015 (Appendix A). The purpose of the NHV model is to quantify habitat services for threatened juvenile Puget Sound Chinook and Hood Canal summer-run chum salmon in the Puget Sound nearshore zone during ESA consultations (Ehinger et al. 2015). Only benefits to juvenile Chinook salmon will be evaluated at Saltchuk due to the project location in Commencement Bay.

The NHV model uses a checklist scoring system to define habitat value, based primarily on elevation, vegetation, substrate conditions, anthropogenic impacts, and landscape context to provide a criteria-based and repeatable method for establishing habitat value. NMFS provided guidance to use the NHV model with Habitat Equivalency Analysis, but the Seattle District will use the Corps-certified planning model IWR Planning Suite (Section 4) to evaluate beneficial use of dredged material. Appendix A, Chapter 2 describes the NHV model development in detail and is summarized herein (Section 3).

This model will be used to establish base habitat values for the two elevation zones within the assessment area: LSZ and DZ. The Riparian Zone (RZ) and Shallow Subtidal Zone (SSZ) portions of the model will not be used due to real estate limitations and the scope of this proposed beneficial use.

2.1 Model Objectives and Limitations

Model objectives are the following:

- To quantify habitat benefits among proposed material placement alternatives
- “Assess the PCEs present at a project site and derive a habitat value through averaging across the values assigned to PCE functions for Puget Sound Chinook and Hood Canal chum within nearshore strata delineated by elevation relative to the Mean Lower Low Water” (MLLW; Ehinger et al. 2015).

Limitations of this model include that it is not meant to project changes in population numbers of any life stage or species and is meant to capture changes in the ecosystem as result of Corps activities. Additionally, although the parameters were chosen and quantified primarily using the critical habitat features of Chinook and chum salmon, the model is meant to represent suitability of the system for all anadromous and other fish species of concern.

2.2 Conceptual Model

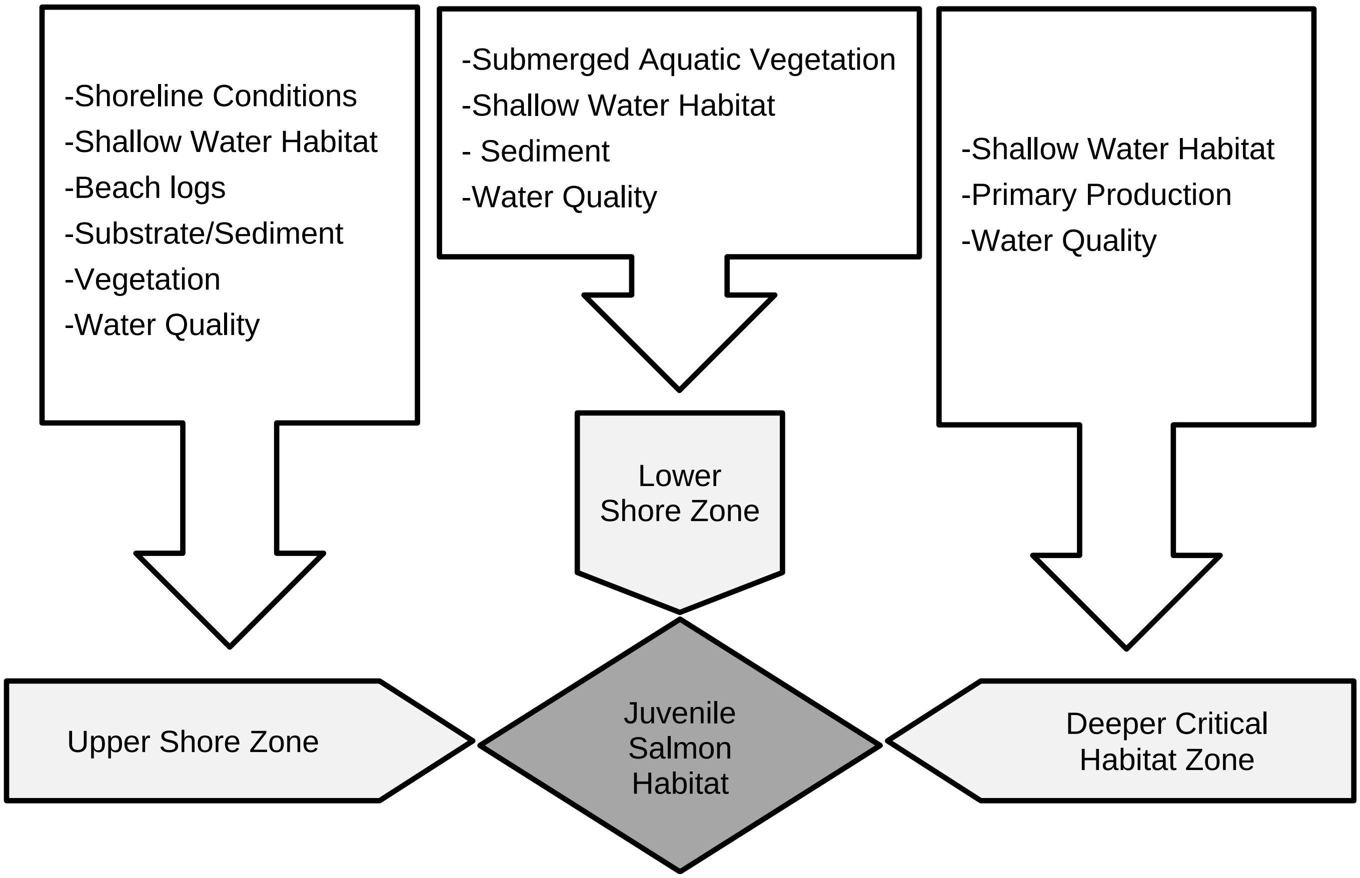

Figure 4. Conceptual model for key habitat considerations in nearshore juvenile salmonid habitat that could be impacted by placement of dredged material.

3 Model Parameters

The NHV Model uses checklists to score PCEs of Puget Sound Chinook and Hood Canal summer-run chum salmon. Ehinger et al. (2015) provided rationale for model parameter inclusion (Appendix A, Chapter 2); this is summarized below and incorporated by reference.

3.1 Depth

Shallow water along natural shorelines in the upper shore zone provides refuge from predators and a migratory corridor. Chinook salmon smolts use the shallow nearshore to avoid predation by piscivorous predators, such as staghorn sculpin and larger salmon. Willette (2001) found that juvenile pink salmon in Prince William Sound leave the shallow nearshore zone when the biomass of large copepods, their food, declined. With the juvenile pink salmon foraging in deeper water, the mean daily individual predator consumption of salmon increased by a factor of five.

Feeding habitats of juvenile salmon shift from the epibenthic zones to neritic (zooplankton) prey during downstream migration, yet focus primarily on shallow-water habitats (Hiss and Boomer 1986). Juvenile Chinook, chum, and coho salmon in Commencement Bay feed primarily on epibenthic invertebrates such as copepods, amphipods, and aquatic insect larval and pupal stages (Meyer et al. 1981). Stomach contents of Chinook salmon less than 90 mm collected east of Saltchuk were primarily planktonic-neritic and marine benthic-epibenthic species, while fish greater than 90 mm fed mostly on marine planktonic-neritic prey species (Olson et al. 2008). Juvenile salmon transition from epibenthic prey to pelagic prey (such as aquatic insects, chironomids, and planktonic prey) with growth (Meyer et al. 1981; Simenstad 2000).

3.1.1 LSZ

Shallow Water Habitat			
#	Indicator of Physical Habitat	Question	Maximum Possible Score
2a	Shallow Water Habitat, Accessibility and Presence	What shallow water area [in sqft] is lost to juvenile rearing? This loss could be the result of the construction of three-dimensional structures that result in the loss of shallow water habitat during some tides. Such structures include piles, bulkheads, and fill, or the conversion of shallow water habitat to deep water habitat via dredging. Not included as impacts to this habitat parameter are low profile structures like boat ramps, rails, and low concrete rubble. The effect of boat ramps and debris are considered with the Substrate rating below.	1
2b	Dredging	Is habitat loss dredging related? Y or N. If so, NHV for LSZ gets multiplied with 0.3, because maximum habitat value for deeper habitat is 0.3.	

3.1.2 DZ

Shallow Water Habitat			
#	Indicator of Physical Habitat	Question	Maximum Possible Score
1	Water Habitat, Accessibility and Presence	What water area [in sqft] is lost to Chinook use? This loss could be the result of the construction of three-dimensional structures that result in the loss of shallow water habitat during some tides. Such structures include piles, bulkheads, and fill.	3

3.2 Sediment

Ecology (2013) describes three main issues that excess wood waste can have on the benthic environment: 1) the physical presence of wood waste, which prevents biota from thriving and recruiting in and on native, healthy substrate; 2) decreased dissolved oxygen due to microbial decomposition, which can create an unhealthy or toxic environment for biota, and; 3) decomposition by-products such as sulfides, ammonia, and phenols, which can cause or contribute to toxicity. Capping the wood waste with native material may initially harm habitat during early consolidation because any infauna and epifauna would be exposed to the pore water forced upwards from the wood waste below. Depending on the nature of the capping material, and the wood waste being capped, this may be a transient, short-lived effect. Post-remediation cap monitoring is recommended to verify the cap integrity and long-term recolonization of the benthic community.

It is assumed that 10% of the wood waste (0.83 acres total) is located in the LSZ.

3.2.1 LSZ Only

Sediment			
#	**Indicator of Physical Habitat**	**Question**	**Maximum Possible Score**
3a	Substrate Size select one	Is the surface substrate in the littoral zone of the action area >25% mud or mixed fines?	0.5
3b		Is the surface substrate in the littoral zone of the action area >25% sand or larger grained gravels?	1
3c		Is the surface substrate in the littoral zone of the action area >25% rocky?	1
	Habitat Loss from Development	**Sediment lost to low and high structures:** What area [in sq ft] is lost to structures including boat ramps, riprap, concrete rubble, jetties, and bulkheads.	
3d	Habitat Degradation Resulting from Development	**Habitat Reduction**: % for entire affected area not covered up by low structures. Is the substrate in the affected area unnaturally compacted or coarsened as a result of a bulkhead or riprap; has the beach grade lowered? Consider effects within the affected area, only, like downdrift part of drift cell. This is the area calculated by dividing habitat loss from development (sq ft) by total area (sq ft).	

3.3 Water Quality

Juvenile salmonids require optimal water quality conditions to support growth and maturation, which include optimal dissolved oxygen levels, minimal sediment and turbidity levels, and free of contaminants. Water quality is a function of several variables that are influenced by the intensity of shoreline development. Nearshore marine water quality is influenced by the level of contaminant inputs from, including but not limited to storm water, waste water treatment plant effluent, residential septic inputs, marina and ferry activities, and long-term Superfund Site cleanup activities.

The NHV model uses a surrogate approach to quantitatively evaluate water quality. In the absence of detailed water quality information, biologists use the surrounding habitat conditions listed above to determine which of the three simplified ratings of poor, medium, or excellent is appropriate. Localized water quality may be improved by covering wood waste, but the overall water quality of Commencement Bay would not change. It is expected the benefits of covering wood waste would be primarily to the benthic community and captured by the sediment variable. This section is a yes or no choice and all cells must be answered.

3.3.1 LSZ

Water Quality			
#	Indicator of Physical Habitat	Question	Maximum Possible Score
4a	Water Quality Condition, select one	Is water quality in action area optimal? Use location as surrogate if no data. If action area is in undeveloped part of Puget Sound choose "yes".	1
4b		Is water quality in action area free of major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated stormwater inputs? Use location as surrogate if no data. If action area is in little to medium developed part of Puget Sound, like Wollochet Bay, Horsehead Bay, Gig Harbor, choose "yes".	0.5
4c		Is WQ impacted by major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated stormwater inputs? Use location, as surrogate if no data. If action area is very developed and has WQ effects from industrial sources, like Commencement Bay, Duwamish, choose "yes".	0

3.3.2 DZ

Water Quality			
#	Indicator of Physical Habitat	Question	Maximum Possible Score
6a	Water Quality, select one	Is water quality in action area optimal? Use location as surrogate if no data. If action area is in undeveloped part of Puget Sound choose "yes".	2
6b		Is water quality in action area free of major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated stormwater inputs? Use location as surrogate if no data. If action area is in little to medium developed part of Puget Sound, like Wollochet Bay, Horsehead Bay, Gig Harbor, choose "yes".	1
6c		Is WQ impacted by major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated stormwater inputs? Use location, as surrogate if no data. If action area is very developed and has WQ effects from industrial sources, like Commencement Bay, Duwamish, choose "yes".	0

3.4 Aquatic Vegetation

Juvenile salmon preferentially select eelgrass (Simenstad 2000; Johnson et al. 2010) and kelp (Johnson et al. 2010), and there is a correlation between salmon abundance and cover density. The preferentially selected eelgrass and kelp habitats provided more cover and vegetative biomass than the habitats (filamentous green algae, non-vegetated habitat) with less salmonid abundance. NMFS uses these studies that show a preference of juvenile salmon for some macroalgae that provide abundant structure to formulate a working hypothesis for the NHV model. The assumption underlying the quantification of SAV value in the NHV model is that the more structure native aquatic macrophytes provide the higher is its value to juvenile Puget Sound Chinook and Hood Canal summer-run chum.

A project goal is to create habitat elevations that will support eelgrass and other macroalgae; however, eelgrass was not historically widespread in Commencement Bay, likely due to the high sediment loads from the Puyallup

River (Kerwin 1999). Additional restoration work such as seeding may be necessary if natural recruitment does not occur.

3.4.1 This section is a yes or no choice and all cells must be answered. LSV

Submerged Aquatic Vegetation (SAV)			
#	Indicator of Physical Habitat	Question	Maximum Possible Score
1a	SAV condition, select one	Aquatic vegetation value high	4
1b		Aquatic vegetation value medium, incl. native oyster beds	3
1c		Aquatic vegetation value medium low	2
1d		Aquatic vegetation value very low	1
1e		Aquatic vegetation value none	0

3.4.2 DZ

Primary Production			
#	Indicator of Physical Habitat	Question	Maximum Possible Score
2	Primary Production	Primary production from algae. Assumed always present.	1

3.5 NHV Scores

The maximum quality score is 0.3 for DZ and 1.0 for LSZ. The LSZ can provide prime rearing conditions for juvenile Chinook salmon. While the DZ provides important migratory and rearing habitat, due to its depth (deeper than -10 MLLW) and lack of submerged aquatic vegetation (SAV), it cannot provide as much cover or produce as much food as the LSZ.

Indicators most strongly associated with at least one of the PCEs assessed receive a maximum score of 4, indicators strongly associated with at least one of the PCEs assessed receive a maximum score of 3, indicators moderately associated with at least one of the PCEs assessed receive a maximum score of 2, indicators little associated with at least one of the PCEs assessed receive a maximum score of 1, and indicators not associated with any of the assessed PCEs receive a score of 0.

To derive the NHV for a subject site, the sum of the points awarded for each “Indicator of Physical Habitat” for the LSZ is divided by the maximum possible points for the zone (Section 3.5.1). This normalization exercise expresses the NHV for each of the zones as a percentage of the maximum possible habitat value, 1. For the DZ (Section 3.5.2), sum of the “Indicator of Physical Habitat” is divided by 20 to normalize the NHV to a maximum of 0.3 (0.3=6/20).

3.5.1 LSV

#	Indicator of Physical Habitat	Maximum Possible Score
1	SAV	4
2	Shallow Water Habitat	1
3	Sediment – Substrate Size	1
4	Water Quality Condition	1
	Total Possible Score	**7**

3.5.2 DZ

#	Indicator of Physical Habitat	Maximum Possible Score
1	Shallow Water Habitat	3
2	Primary Production	1
6	Water Quality Condition	2
	Total Possible Score	**6**
	Number added to divisor to set max possible NHV at 0.3	14
	Divisor for NHV calculation	**20**

For Saltchuk, the DZ scores did not change among the scenarios due to lack of overwater structures and no change to water quality or aquatic vegetation. A large proportion of benefits were derived from having fewer acres of DZ habitat after each scenario, in addition to changes to LSZ habitat quality.

4 Methodology

Table 1 displays acres by elevation stratum for each alternative scenario to be analyzed as part of a cost effectiveness and incremental cost analysis (CE/ICA) using the Corps-certified planning model IWR Planning Suite, version 2.0.9.1. Area, or acres impacted, is one component of habitat unit (HU) calculations where HUs are equal to the acres multiplied by a normalized quality score (i.e. score between 0 and 1). For Corps studies, environmental restoration projects evaluate changes in habitat and HUs over the 50-year planning period of analysis to compute average annual habitat units (AAHUs). AAHUs are computed for each restoration scenario, including the No Action or future without project condition. Benefits of a proposed restoration project are the net change in AAHUs from the No Action scenario.

As shown in the table below, the existing condition, or No Action scenario, includes mostly DZ habitat for a substrate elevation range of -98 to -10 MLLW. As bench and island increments are added, acres shift from lower value DZ to higher value LSZ with an elevation range of -10 to +5 MLLW. The total area possible for the Saltchuk site is 64 acres. The LSZ and DZ acreages shown in red are carried forward to compute HUs.

Table 1. Saltchuk Acres by Habitat Zone

		Acreage After Scenario Implementation					**Acreage After Scenario Implementation (Subtotal)**		
Zone		**LSZ**	**LSZ**	**DZ**	**DZ**		**LSZ**	**DZ**	
Scenario		**≥ -5 MLLW < +5 MLLW**	**≥ -10 MLLW < -5 MLLW**	**≥ -20 MLLW < -10 MLLW**	**≥ -98 MLLW < -20 MLLW**	**Total Acres**	**≥ -10 MLLW < +5 MLLW**	**≥ -98 MLLW < -10 MLLW**	**Total Acres**
A	No Action (Existing/ Future Without Project Condition)	0	3.3	11.7	49	64	3.3	60.7	64
B	Saltchuk – First Bench (raised to -20 MLLW)	0	3.3	48.6	12.1	64	3.3	60.7	64
C	+ Second Bench (raised to -10 MLLW)	0	14.2	36.1	13.7	64	14.2	49.8	64
D	+ Third Bench (raised to -5 MLLW)	3.2	11.5	36.1	13.2	64	14.7	49.3	64
E	+ Islands (Full Build-Out)	21.2	19.7	9	14.1	64	40.9	23.1	64

The evaluation of HU will take into consideration changes over the 50-year period of analysis for the Tacoma Harbor feasibility study with analysis of years 0, 3, and 50. The LSZ indicators are about submerged aquatic vegetation (SAV; e.g., kelp and eelgrass) and shallow water habitat (which includes foraging habitat, i.e., benthic invertebrates). Depth, water quality, and sediment are all immediately functioning. The time to establishment for benthic invertebrates is estimated to take 3 years in the LSZ and DZ. The DZ indicators are similar to LSZ with 3 years for the establishment of benthic invertebrates. The NHV model will be expanded to include quality scores (i.e. normalized habitat quality scores between 0 and 1) for each year and scenario analyzed. The maximum quality score is 0.3 for DZ and 1.0 for LSZ.

Table 2. Habitat types, current values, and years to fully functioning.

Habitat Type	Elevation	Years to Fully Functioning	Source
Lower Shore Zone (LSZ)	From +5 MLLW to -10 MLLW	3	Newell et al. 1998; Desprez 2000; Wilber and Clarke 2007; Ponti et al. 2009
Deeper Critical Habitat Zone (DZ)	From -10 MLLW to -98 MLLW	3	Newell et al. 1998; Desprez 2000; Wilber and Clarke 2007; Ponti et al. 2009

Table 3 displays NHV quality scores that are carried forward for the computation of average annual habitat units. The acres impacted are carried forward from the red cells in Table 1. The NHV quality scores reference the computations in their respective sheets in the Excel file on the ‘DZ’ and ‘LSZ’ tabs.

Table 3. Saltchuk NHV Quantity and Quality Summary*

Metric	Scenario A (No Action)		Scenario B		Scenario C		Scenario D		Scenario E	
	DZ	LSZ	DZ	LSZ	DZ	LSZ	DZ	LSZ	DZ	LSZ
Acres	60.7	3.3	60.7	3.3	49.8	14.2	49.3	14.7	23.1	40.9
Year 0 NHV	0.20	0.34	0.20	0.34	0.20	0.35	0.20	0.43	0.20	0.43
Year 3 NHV	0.20	0.34	0.20	0.48	0.20	0.50	0.20	0.57	0.20	0.57
Year 50 NHV	0.20	0.34	0.20	0.48	0.20	0.50	0.20	0.57	0.20	0.57

As previously mentioned, HUs are quantity multiplied by quality of habitat, where quantity is the acres for a given zone and quality is the NHV quality score. HUs were computed for each scenario, year, and habitat zone as shown in Table 4. The total HU for a scenario and year is the sum of HUs for DZ and LSZ, as shown in the following formula.

$$\textit{Total HUs}_{\textit{year x}} = (\textit{DZ acres}_{\textit{year x}} \times \textit{DZ NHV}_{\textit{year x}}) + (\textit{LSZ acres}_{\textit{year x}} \times \textit{LSZ NHV}_{\textit{year x}})$$

For example, computation of Scenario D HUs for year 0 is as follows:

$$\textit{Scenario D HUs}_{\textit{year 0}} = (\textit{Scenario D DZ acres}_{\textit{year 0}} \times \textit{Scenario D DZ NHV}_{\textit{year 0}}) + (\textit{Scenario D LSZ acres}_{\textit{year 0}} \times \textit{Scenario LSZ NHV}_{\textit{year 0}})$$

$$= (49.3 \times 0.2) + (14.7 \times 0.43) = 16.2$$

* Values shown in the yellow cells have not yet been computed and are for demonstration purposes only.

Table 4. Saltchuk Alternative HU Inputs

Year	Scenario A (No Action)			Scenario B			Scenario C			Scenario D			Scenario E		
	DZ	**LSZ**	**Total**	**DZ**	**LSZ**	**Total**	**DZ**	**LSZ**	**Total**	**DZ**	**LSZ**	**Total**	**DZ**	**LSZ**	**Total**
0	12.1	1.1	13.3	12.1	1.1	13.3	10.0	5.0	15.0	9.9	6.3	16.2	4.6	17.5	22.1
3	12.1	1.1	13.3	12.1	1.6	13.7	10.0	7.0	17.0	9.9	8.4	18.3	4.6	23.4	28.0
50	12.1	1.1	13.3	12.1	1.6	13.7	10.0	7.0	17.0	9.9	8.4	18.3	4.6	23.4	28.0
AAHU*			***13.3***			***13.7***			***16.9***			***18.2***			***27.8***
Net AAHU Gain**			***0***			***0.4***			***3.6***			***4.9***			***14.5***

** AAHU = Average Annual Habitat Units computed in IWR Planning Suite Annualization Calculator*

***Net AAHU Gain = net change in AAHU relative to the Scenario A (No Action). This is the benefit input for the cost effective and incremental cost analysis in IWR Planning Suite.*

Total HU values for each scenario and year are used for computing AAHU using the IWR Planning Suite Annualizer Tool. Years 0, 3, and 50 Total HU values shown in the green cells from Table 4 are input for a given scenario (or Annualization Set) in the NER Outputs tab of the Annualization Calculator. Linear interpolation between years is assumed. Figure 5 displays a screen shot from IWR Planning Suite with the computation of AAHUs for Scenario D. Years 2018 (0), 2021 (3) and 2068 (50) are input. AAHU output over the 50-year period of analysis is 18.237.

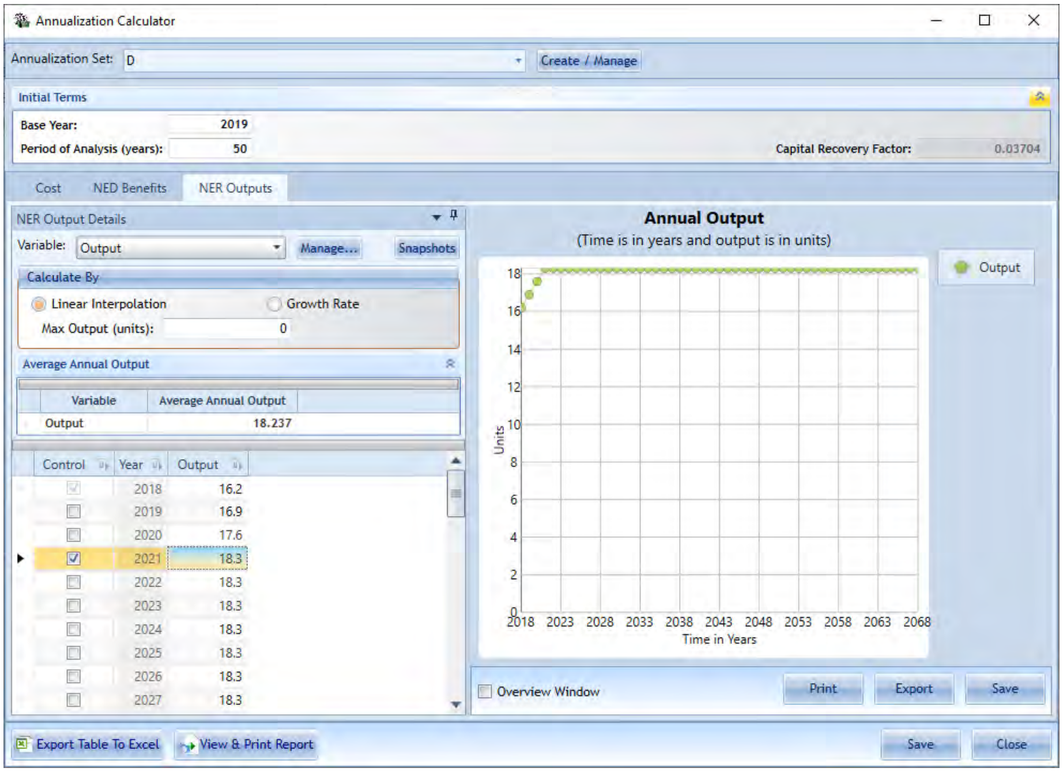

Figure 5. IWR Planning Suite Annualization Worksheet for Scenario D

A CE/ICA analysis will use net AAHU gain relative to the No Action for the benefit input along with incremental average annual costs for beneficial use placement at Saltchuk site above Commencement Bay disposal cost (referred to as the Base Plan) to determine a best buy plan that reasonably maximizes net environmental benefits in a cost effective and efficient manner.

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For help in using this spreadsheet see:
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Zone		Acreage After Scenario Implementation				
		LSZ	LSZ	DZ	DZ	
Saltchuk Scenarios		≥ -5 MLLW	≥ -10 MLLW < -5 MLLW	≥ -20 MLLW < -10 MLLW	≥ -98 MLLW < -20 MLLW	Total Acres
A	Existing Condition (also No-Action)	0	3.3	11.7	49	64
B	Saltchuk – First Bench (raised to -20 MLLW)	0	3.3	48.6	12.1	64
C	+ Second Bench (raised to -10 MLLW)	0	14.2	36.1	13.7	64
D	+ Third Bench (raised to -5 MLLW)	3.2	11.5	36.1	13.2	64
E	+ Islands (Full Build-Out)	21.2	19.7	9	14.1	64

Notes:
Max NHV scores possible: LSZ (≥ -10 MLLW < +5 MLLW) DZ (≥ -98 MLLW < -10 MLLW)

1.0

0.3

Nearshore Habitat Value Determination Model
Lower Shore Zone < +5 MLLW
Yellow Cells are to fill in.

Affected area	Scenario A (No Action)	Scenario B	Scenario C	Scenario D	Scenario E
Acres	3.3	3.3	14.2	14.7	40.9
Sq. ft.	143,748	143,748	618,552	640,332	1,781,604

				Scenario A (No Action)			Scenario B				
				Years 0, 3, and 50			Year 0			Years 3, 50	
#	**Indicator of Physical Habitat**	**Question**	**Maximum Possible Points**	**Site Condition**	**Project Points**	**Summary Project Points by Category**	**Site Condition**	**Project Points**	**Summary Project Points by Category**	**Site Condition**	**Project Points**
Submerged Aquatic Vegetation (SAV)											
1a	**SAV condition, select one (y/n)**	Aquatic vegetation value high	4	n	0		n	0		n	0
1b		Aquatic vegetation value medium, incl. native oyster beds	3	n	0		n	0		n	0
1c		Aquatic vegetation value medium low	2	n	0		n	0		y	2
1d		Aquatic vegetation value very low	1	y	1		y	1		n	0
1e		Aquatic vegetation value none	0	n	0	1	n	0	1	n	0
Shallow Water Habitat											
2a	**Shallow Water Habitat, Accessibility and Presence**	What shallow water area [in sqft] is lost to juvenile rearing? This loss could be the result of the construction of three-dimensional structures that result in the loss of shallow water habitat during some tides. Such structures include piles, bulkheads, and fill, or the conversion of shallow water habitat to deep water habitat via dredging. Not included as impacts to this habitat parameter are low profile structures like boat ramps, rails, and low concrete rubble. The effect of boat ramps and debris are considered with the Substrate rating below.	1.00	0	1.00		0	1.00		0	1.00
2b	**Dredging**	Is habitat loss dredging related? Y or N. If so, NHV for LSZ gets multiplied with 0.3, because maximum habitat value for deeper habitat is 0.3.		n	1.00	1.00	n	1.00	1.00	n	1.00
Sediment											
3a	**Substrate Size select one (y/n)**	Is the surface substrate in the littoral zone of the action area >25% mud or mixed fines?	0.5	y	0.50		y	0.50		y	0.50
3b		Is the surface substrate in the littoral zone of the action area >25% sand or larger grained gravels?	1	n	0.00		n	0.00		n	0.00
3c		Is the surface substrate in the littoral zone of the action area >25% rocky?	1	n	0.00	0.50	n	0.00	0.50	n	0.00
	Habitat Loss from Development	**Sediment lost to low and high structures:** What area [in sqft] is lost to structures including boat ramps, riprap, concrete rubble, jetties, and bulkheads.		36,100	0.37		36,100	0.37		36,100	0.37
3d	**Habitat Degradation Resulting from Development**	**Habitat Reduction**: % for entire affected area not covered up by low structures. Is the substrate in the affected area unnaturally compacted or coarsened as a result of a bulkhead or riprap; has the beach grade lowered? Consider effects within the affected area, only, like downdrift part of drift cell. This is the area calculated by dividing habitat loss from development (sq ft) by total area (sq ft).		0.25	0.37	0.37	0.25	0.37	0.37	0.25	0.37
Water Quality											
4a	**Water Quality Condition, select one**	Is water quality in action area optimal? Use location as surrogate if no data. If action area is in undeveloped part of Puget Sound choose "yes".	1	n	0.00		n	0.00		n	0.00
4b		Is water quality in action area free of major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated storwater inputs? Use location as surrogate if no data. If action area is in little to medium developed part of Puget Sound, like Wollochet Bay, Horshead Bay, Gig Harbor, choose "yes".	0.5	n	0.00		n	0.00		n	0.00
4c		Is WQ impacted by major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated storwater inputs? Use location, as surrogate if no data. If action area is very developed and has WQ effects from industrial sources, like Commencement Bay, Duwamish, choose "yes".	0	y	0.00	0.00	y	0.00	0.00	y	0.00
		Sum of maximum possible points	**7.00**		**Total Points**	**2.37**		**Total Points**	**2.37**		**Total Points**
					NHV	**0.34**		NHV	**0.34**		NHV

Habitat Value Determination Model for Deeper Critical Habitat Zone

The "Deeper Critical Habitat Zone" extends from, 98 feet off shore, or -10 feet, or the lowest extend of

Yellow Cells are to fill in.

Affected area	Scenario A (No Action)	Scenario B	Scenario C	Scenario D	Scenario E
Acres	60.7	60.7	49.8	49.3	23.1
Sq. ft.	2,644,092	2,644,092	2,169,288	2,147,508	1,006,236

				Scenario A (No Action)			Scenario B				
				Years 0, 3, and 50			Year 0			Years 3, 50	
#	Indicator of Physical Habitat	Question	Maximum Possible Points	Site Condition	Project Points	Summary Project Points by Category	Site Condition	Project Points	Summary Project Points by Category	Site Condition	Project Points
Shallow Water Habitat											
1	Water Habitat, Accessibility and Presence	What water area [in sqft] is lost to Chinook use? This loss could be the result of the construction of three-dimensional structures that result in the loss of shallow water habitat during some tides. Such structures include piles, bulkheads, and fill.	3.00	0	3.00	3.00	0.00	3	3.00	0	3
Primary Production											
	Primary Production	Primary production from algae. Assumed always present.	1		1	1		1	1		1
Water Quality											
6a	Water Quality, select one (y/n)	Is water quality in action area optimal? Use location as surrogate if no data. If action area is in undeveloped part of Puget Sound choose "yes".	2	n	0.00		n	0.00		n	0.00
6b		Is water quality in action area free of major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated storwater inputs? Use location as surrogate if no data. If action area is in little to medium developed part of Puget Sound, like Wollochet Bay, Horshead Bay, Gig Harbor, choose "yes".	1	n	0.00		n	0.00		n	0.00
6c		Is WQ impacted by major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated storwater inputs? Use location, as surrogate if no data. If action area is very developed and has WQ effects from industrial sources, like Commencement Bay, Duwamish, choose "yes".	0	y	0.00	0.00	y	0.00	0.00	y	0.00
Sum		Sum of maximum possible points	6.00		Total Points	4.00		Total Points	4.00		Total Points
NHV					NHV	0.20		NHV	0.20		NHV

14	Number added to divisor to set maximum possible NHV at 0.3

Summary of Parameters Needed for NHV and IWR Planning Suite AAHU Computation

Zone		Acreage After Scenario Implementation					Acreage After Scenario		
		LSZ	LSZ	DZ	DZ	Total Acres	LSZ	DZ	Total Acres
Scenario		≥ -5 MLLW < +5 MLLW	≥ -10 MLLW < -5 MLLW	≥ -20 MLLW < -10 MLLW	≥ -98 MLLW < -20 MLLW		≥ -10 MLLW < +5 MLLW	≥ -98 MLLW < -10 MLLW	
A	Existing Condition	0	3.3	11.7	49	64	3.3	60.7	64
B	Saltchuk – First Bench (raised to -20 MLLW)	0	3.3	48.6	12.1	64	3.3	60.7	64
C	+ Second Bench (raised to -10 MLLW)	0	14.2	36.1	13.7	64	14.2	49.8	64
D	+ Third Bench (raised to -5 MLLW)	3.2	11.5	36.1	13.2	64	14.7	49.3	64
E	+ Islands (Full Build-Out)	21.2	19.7	9	14.1	64	40.9	23.1	64

Notes:
NHV cells are populated based on computations in DZ and LSZ sheets.

Quanity and Quality Score Summary Table

Metric	Scenario A (No Action)			Scenario B			Scenario C			Scenario D			Scenario E	
	DZ	LSZ		DZ	LSZ		DZ	LSZ		DZ	LSZ		DZ	LSZ
Acreage	60.7	3.3		60.7	3.3		49.8	14.2		49.3	14.7		23.1	40.9
Year 0 NHV	0.20	0.34		0.20	0.34		0.20	0.35		0.20	0.43		0.20	0.43
Year 3 NHV	0.20	0.34		0.20	0.48		0.20	0.50		0.20	0.57		0.20	0.57
Year 50 NHV	0.20	0.34		0.20	0.48		0.20	0.50		0.20	0.57		0.20	0.57

IWR Planning Suite Habitat Unit (HU) Entry Information for AAHU Calculation (Acres x NHV)

Year	Scenario A (No Action)			Scenario B			Scenario C			Scenario D			Scenario E		
	DZ	LSZ	Total, by Year	DZ	LSZ	Total, by Year	DZ	LSZ	Total, by Year	DZ	LSZ	Total, by Year	DZ	LSZ	Total, by Year
0	12.1	1.1	**13.3**	12.1	1.1	**13.3**	10.0	5.0	**15.0**	9.9	6.3	**16.2**	4.6	17.5	**22.1**
3	12.1	1.1	**13.3**	12.1	1.6	**13.7**	10.0	7.0	**17.0**	9.9	8.4	**18.3**	4.6	23.4	**28.0**
50	12.1	1.1	**13.3**	12.1	1.6	**13.7**	10.0	7.0	**17.0**	9.9	8.4	**18.3**	4.6	23.4	**28.0**
AAHU, computed in IWR Planning Suite			***13.3***			***13.7***			***16.9***			***18.2***			***27.8***
Net AAHU Gain			***0.0***			***0.4***			***3.6***			***4.9***			***14.5***

IWR Planning Suite Annualizer tool will be used to compute AAHU for Scenarios A-E using the computed totals by year in the green cells.
Calculation will assume linear interpolation between points.
Computed AAHU scores will be carried forward into a CE/ICA using IWR Planning Suite, where the benefits of Scenarios B-E are the net change in AAHU from the Scenario A (No Action).

Tacoma Harbor, WA Navigation Improvement Project
Water Quality Monitoring Plan
Blair Waterway and Saltchuk at Port of Tacoma
November 2019

DRAFT FOR PRE-SUBMITTAL COORDINATION

Constituents Monitored

Based on WAC 173-201A-260(3)(e), in brackish waters of estuaries, where different criteria for the same use occurs for fresh and marine waters, the decision to use the fresh water or the marine water criteria must be selected and applied on the basis of vertically averaged daily maximum salinity, referred to below as “salinity.”

i. The fresh water criteria must be applied at any point where ninety-five percent of the salinity values are less than or equal to one part per thousand, except that the fresh water criteria for bacteria applies when the salinity is less than ten parts per thousand; and
ii. The marine water criteria must apply at all other locations where the salinity values are greater than one part per thousand, except that the marine criteria for bacteria applies when the salinity is ten parts per thousand or greater.

Therefore, the water quality standards for marine waters will apply to this project.

The Tacoma Harbor, WA Navigation Improvement Project is located in Water Resources Inventory Area (WRIA) 10 (Puyallup/White), in Puget Sound. The project is in a marine area listed as “good quality” for Aquatic Life use designation, which requires monitoring the following parameters pursuant to WAC 173-201A-612, Table 612 (2012).

- Aquatic life **Turbidity** applicable criteria:
  - Turbidity readings shall not exceed 10 NTU (nephelometric turbidity units) over background when the background is 50 NTU or less, or a 20 percent increase in turbidity when the background turbidity is more than 50 NTU.
- Aquatic life **Dissolved Oxygen (DO)** criteria:
  - DO concentrations are measured as a 1-day minimum in milligrams per liter. DO readings shall not be lower than the lowest 1-Day Minimum 5.0 mg/L.
- Aquatic life **Temperature** criteria:
  - Temperature is measured as a 1-day maximum temperature (1-DMax). Temperature readings shall not exceed the highest 1-DMax 19°C (66.2°F).

Washington State Department of Ecology Turbidity Monitoring Conditions

- Placeholder for specific water quality monitoring conditions from the Washington State Department of Ecology (Ecology).

Request for Extension of Area of Mixing

The Corps may submit a request that the 150 down-current sample location be moved to 300 feet down-current; the 150 down-current sample location would become an early warning station. This only applies to areas in which material has been determined suitable for aquatic disposal. Further project refinement during Preconstruction Engineering and Design phase is needed before a request is submitted; this draft water quality monitoring plan would be revised accordingly to reflect this request.

Sampling Approach

- The contractor shall establish water quality conditions according to the following:
  - The contractor shall measure turbidity, temperature, and DO using a meter (HydroLab or similar), starting at least one hour after the dredging equipment has been operating, to ensure readings and observations are reflective of conditions during active operations.
  - The contractor shall verify the calibration of the meter and calibrate as necessary with standardized samples prior to the start of each day's monitoring, per the manufacturer's specifications.
  - The contractor shall collect readings within the water strata:
    - near the surface (~ 2 feet below)
    - mid-depth
    - near the bottom (~2 feet above)
- The contractor shall compare water quality readings taken at the point of compliance to background levels within the water column strata (i.e., surface level at points of compliance compared to surface level at background stations) to determine compliance with constituent standards.
- The contractor shall visually monitor turbidity beyond the point of compliance and record the findings at the same time the turbidity levels are measured.
- The contractor shall visually monitor turbidity within the disposal area and record the findings every disposal action during daylight hours.

Background Conditions

- Measurements of turbidity, dissolved oxygen, and temperature will be recorded using a water quality meter (HydroLab or similar). Sampling will start about one hour after the dredging equipment has been operating, to ensure samples are reflective of water quality conditions during active operations. Determination of background water quality conditions will be made according to the following:
  - The water quality meter will be calibrated with standardized samples prior to the start of each day's monitoring, per the manufacturer's specifications.
  - Samples will be collected at least 150 feet up-current of the area to be dredged (background location), in an area where there is no influence from the dredging activity.
  - Samples will be collected near the surface (~ 2 feet below), mid-depth, and near the bottom (~2 feet above) at each background monitoring location.

Monitoring Locations

- ❖ The area of mixing Point of Compliance for turbidity, DO, and temperature during clamshell dredging is 150 feet down-current from the point of clamshell dredging and thus will move as the dredging progresses.
- ❖ The Monitoring Points shall be the following:
  - Measured Background: A minimum of 150 feet up-current from the dredging where there is no influence of the dredging activity as described above.
  - Measured Downstream Early Warning – 75 feet down-current of the dredging.
  - Measured Downstream Point of Compliance – 150 feet down current of the dredging.
  - Visual Downstream of Point of Compliance – monitor and record any visual turbidity beyond 150 feet down current of the dredging at the same time the turbidity levels are measured.
- ❖ The contractor shall establish channel transect Monitoring Points across the navigation channel for the Early Warning station (75 feet down-current) and the Point of Compliance (150 feet down-current of the dredge) to determine the lateral extent of turbidity. This transect shall be:
  - Monitored twice per day.
  - Located at a minimum of three (3) points spaced roughly equidistant across the navigation channel.
    - Collect three (3) readings within the water strata**:** Samples will be collected from near the surface (~ 2 feet below), mid-depth, and near the bottom (~2 feet above) of the water column.
  - Visually monitor downstream of the Point of Compliance.
- ❖ Samples collected at the mid-point and at the Point of Compliance shall be adjusted within the depth range to target the turbidity plume which will be tracked visually. If no distinct turbidity plume can be identified within the depth range, the samples will be taken at the standard depths.
- ❖ Turbidity, dissolved oxygen, and temperature samples taken at the Early Warning station and the Point of Compliance station and compared to background levels within each water column strata (i.e., surface level at points of compliance compared to surface level at background stations) to determine compliance with water quality standards.
- ❖ The contractor shall monitor and record visible turbidity within the disposal area for every disposal action during daylight hours.

Frequency of Monitoring

- ❖ The contractor's dredging equipment shall be operating for at least one hour prior to the collection of turbidity, DO, and temperature readings to ensure readings and observations are representative of water quality conditions during active operations.
- ❖ The contractor's water quality monitoring will correspond with; 1) slack tide and 2) strong ebb or flood tidal conditions to the extent these times adequately reflect periods of active dredging and occur during daylight hours.

- The contractor shall monitor for turbidity, instrument-measured and visually; for DO and temperature, instrument-measured, daily, during daylight hours:
  - Record data as described above, twice per day for the first five (5) consecutive days of dredging, assuming no exceedances.
  - Record visible turbidity down-current of the Point of Compliance at each reading collected at the Point of Compliance the first five (5) consecutive days of dredging, assuming no exceedances.
  - Record visible turbidity within the disposal area at every disposal action during daylight hours the first five (5) consecutive days of dredging, assuming no exceedances.
  - No monitoring shall occur before sunrise or after sunset unless authorized by the Corps.
- Upon completion of the instrument measured monitoring days, the contractor shall send the monitoring data report to the Corps within 24 hours of completion of monitoring activity.
  - If there are no exceedances in water quality within the five (5) consecutive days, the contractor shall discontinue instrument monitoring, unless otherwise directed by the Corps, if required by Ecology.
  - If there are exceedances in water quality within the five (5) consecutive days, the contractor shall continue monitoring following the steps listed in "Exceedances and Exceedances Protocol."
- The contractor shall continue to monitor and record (written) daily visual monitoring at the Point of Compliance every day the dredge is in operation. If at any point, visual monitoring indicates an exceedance, the contractor shall take a physical reading to confirm/verify if an exceedance has occurred. If an exceedance is confirmed/verified through physical monitoring, the protocol outlined under "Exceedances and Exceedances Protocol" shall be followed.
- Upon completion of the instrument measured monitoring days, the contractor shall send the monitoring data report to the Corps within 24 hours of completion of monitoring activity. If there are exceedances in water quality during the dredging of the unsuitable material, the contractor shall follow the steps listed in "Exceedances and Exceedances Protocol."

Locations and Frequency for Unsuitable Material

- The contractor shall follow all steps and directions as listed above for Locations and Frequency of Monitoring with the following changes:
  - The contractor's water quality monitoring will occur three (3) times per day and will correspond with 1) as soon as safely possible after sunrise, 2) mid-day, and 3) the latest in the day that is safely possible before sunset.
  - The area of mixing Point of Compliance for turbidity, DO, and temperature is 150 feet down-current from the point of clamshell dredging and thus will move as the dredging progresses.

Exceedances and Exceedance Protocol

- If measurements taken at the down-current location show that recorded turbidity is greater than 10 NTU over background where the background is less than 50 NTU, or if more than a 20 percent increase in turbidity when the background turbidity is more than 50 NTU, occurring at the outer limit of the mixing zone, the Corps will notify Ecology within 24 hours and, assuming dredging continues, will continue to monitor per the exceedance protocol below. If there are exceedances in dissolved oxygen, the exceedance procedures detailed below will also be followed.

- If the 75-ft early warning sample is in exceedance (> 10 NTU), then the water quality monitor shall notify the Corps project manager immediately, who will then notify the dredge operator supervisor who will check to ensure best management practices (BMPs) are being followed, that the dredge bucket is closing properly and the barge dewatering process is functioning properly.
- The Corps shall be responsible for notifying Ecology of any exceedance of the turbidity standard at the point of compliance sample site (150-ft down current).

Step 1: Verification of the problem

- If monitoring indicates an exceedance in turbidity levels, immediately take another series of samples (~ 2 feet below), mid-depth, and near the bottom (~2 feet above) in the same location.
- If the exceedance still exists ('strike one'), then another series of samples must be taken at the nearest upstream background station to determine if the exceedance is caused by the dredging and disposal or by a change in background conditions (for example due to a heavy rainfall event).
- The Corps will notify Ecology by phone within 24 hours after there has been a measured exceedance.
- The Corps will then notify the dredging contractor that a measured exceedance occurred and request that the dredging contractor implement BMPs, as appropriate and applicable, to reduce turbidity.
- In the event of exceedances such that dredging is temporarily stopped during the first 5 days of monitoring, the Corps will consult with Ecology to determine the number of additional days of monitoring required with no exceedances to terminate monitoring.

Step 2: Increased monitoring

- Another sample will be taken no more than one (1) hour after the exceedance is recorded to verify the dredging operation has been altered to reduce the exceedance to within acceptable limits.
- If the second sample, taken 1 hour later, still shows an exceedance ('strike two'), the Corps will again notify the dredging contractor of the situation and request that all measures possible be taken to reduce turbidity.
- Finally, a third sample will be taken no more than two (2) hours after the first exceedance is recorded.

Step 3: Stop dredging or disposal

- If the third sample, taken two (2) hours later, still shows an exceedance ('strike three'), the Corps will order the contractor to stop work. The Corps will then notify Ecology of the situation.

Step 4: Continued sampling until compliance is achieved

- After the dredging contractor has stopped work, samples will be collected at hourly intervals until turbidity and dissolved oxygen levels return to background. For safety reasons, no water quality sampling will take place between sunset and sunrise.
- Once compliance has again been achieved, the Corps will order the dredging contractor to resume work.
- The Corps' Project Manager or Biologist will notify Ecology that work has resumed.
- The normal schedule of water quality sampling will resume as per specific requirements above.

Step 5: Reporting

- Ecology must be informed by phone within 24 hours for an exceedance at the point of compliance. Turbidity elevated at the warning point does not need to be reported within 24 hours, as long as the dredge supervisor was informed and the processed checked to ensure BMPs are still working properly.
- Any shut downs will be documented with an incident report, which will be transmitted to Ecology by email and by mail within 2 working days of the incident.
- The incident report will document any exceedances and will include the date, time, location, activity, water quality data collected, name of person collecting the data, names of persons notified of the exceedance, and summary of how the exceedance was resolved following the above protocol.
- Incident reports will be transmitted to the Corps' Contracting Officer, Project Manager, or Biologist within 24 hours of the exceedance.
- Ecology may require additional days of monitoring based on the monitoring report and/or incident report.
- Within 60 days of termination of the dredging and disposal activities, the Corps will submit the water quality monitoring data and a summary report to Ecology.

Responsibility and Communication Plan

- The Corps will oversee turbidity monitoring conducted by the contractor.
- The Corps will be responsible for coordinating with Ecology and submitting the Turbidity Monitoring Reports and data provided by the contractor.
- The Corps will notify Ecology within 24 hours if an exceedance occurs.
- The Corps will coordinate with the dredging contractor.
- The contractor shall provide a Turbidity Monitoring Report and data to the Corps, as directed.
- The contractor shall notify the Corps within 2 hours if an exceedance occurs.
- The Corps Contracting Officer is Elizabeth Chien, Coastal Program Manager (206-316-3968).
- The Corps Point of Contact for turbidity monitoring is Katie Whitlock, Environmental Coordinator (206-764-3576).
- The Ecology Point of Contact is NAME, Federal Permit Coordinator (phone number).
- The Contractor will supply the Corps and Ecology with their Points of Contact for the project.

June 25, 2019

Prepared by:
Dredged Material Management Office
Seattle District, U.S. Army Corps of Engineers

MEMORANDUM FOR: RECORD

SUBJECT: DMMP ADVISORY DETERMINATION REGARDING THE POTENTIAL SUITABILITY OF PROPOSED DREDGED MATERIAL FROM THE BLAIR WATERWAY IN TACOMA HARBOR FOR UNCONFINED OPEN-WATER DISPOSAL AT THE COMMENCEMENT BAY DISPOSAL SITE OR FOR BENEFICIAL USE.

1. Introduction. This memorandum reflects the consensus advisory determination of the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, Washington State Department of Ecology, Washington State Department of Natural Resources, and the Environmental Protection Agency) regarding the potential suitability of up to 2.5 million cubic yards (cy) of dredged material from the Blair Waterway for open-water disposal at the Commencement Bay disposal site or for potential beneficial use.

   The DMMP agencies cooperatively manage eight open-water disposal sites in Puget Sound. The disposal site in closest proximity to Tacoma Harbor is the non-dispersive site located in Commencement Bay. Dredged material evaluation guidelines for disposal at the Commencement Bay site can be found in the DMMP Dredged Material Evaluation and Disposal Procedures User Manual (DMMP, 2018). These procedures are summarized in Exhibit A of this memorandum.

   Blair Waterway is an authorized federal navigation channel located in Tacoma, Washington. The existing authorized dimensions of the waterway are 520 ft wide from the mouth to 11th Street, 345 ft wide through the 11th Street reach, 520 ft from 11th Street to Lincoln Avenue, 330 ft from Lincoln Avenue to the turning basin, and a 1300 ft turning basin, all to a depth of -51 feet MLLW. During the last deepening event in 2000-2001, the waterway was dredged to -51 feet MLLW, plus 2 ft of overdepth. Due to minimal accumulation of sediments since then, mudline elevations within the existing navigation channel remain at -51 ft MLLW or deeper.

   The U.S. Army Corps of Engineers (USACE) and Port of Tacoma (POT) are conducting a feasibility study to investigate potential deepening and widening alternatives for the Blair Waterway (Figure 1). Depths up to -58 feet MLLW, plus 2 feet of overdepth, are being evaluated. This DMMP memorandum presents and evaluates sediment characterization data collected from Blair Waterway with the purpose of advising USACE and POT regarding the probable suitability of sediment from Blair Waterway for open-water disposal or beneficial use.

   Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the U.S. EPA designated the Commencement Bay Nearshore/Tideflats Superfund site in 1983. The site includes three main components: remediation of the sediments and source control for Commencement Bay waterways, remediation of Tacoma Tar Pits, and remediation of the Asarco Smelter Facility and surrounding impacted areas. Multiple waterways within Commencement Bay are covered under the sediment operable unit for the Superfund Site. Blair Waterway was originally included under the sediment and source control operable unit, but was delisted by the U.S. EPA in 1996 because it was

cleaned up under an agreement known as the Puyallup Land Claim Settlement between EPA, the Port of Tacoma, and the Puyallup Tribe. Another notable Superfund action in Blair Waterway included dredging of tributyltin (TBT) contaminated sediments at Pier 4 as part of a Time Critical Removal Action. This action was completed in 2016 under the regulatory authority of the U.S. EPA and included removal of 71,000 cubic yards of contaminated sediment in conjunction with the redevelopment of Pier 4.

Project summary and tracking information is shown in Table 1.

Table 1. Project Summary

Project ranking	Channel: Low-moderate
	Sideslopes: Moderate
Proposed dredging volume	2.5 million cy
Maximum proposed dredging depth	- 58 ft MLLW, plus 2 feet overdepth
Sampling Dates	February 18 – February 22, 2019
EIM Study ID	POTBD19

2. Sediment Evaluation Strategy for the Tacoma Harbor Feasibility Study. Several factors were taken into consideration in development of a sediment evaluation strategy for the Blair Waterway.

DMMP Recency Guidelines – The DMMP recency guidelines specify the length of time that sediment characterization data remain adequate and valid for decision-making without further testing. The length of the recency period is determined by the rank of a project, the rank being driven by the available information on chemical and biological-response characteristics of project sediments and the number, kinds, and proximity of chemical sources (existing and historical). Blair Waterway has a split ranking; the existing navigation channel is ranked low and areas outside the navigation channel have project-specific rankings based on site characteristics (DMMP, 2018). For the purpose of this advisory evaluation, the DMMP agencies agreed to consider the entire project area as having an overall rank of low-moderate. The recency period for low-moderate-ranked areas is six years. Since it was unlikely that construction would occur within six years following sediment sampling for the feasibility study, a decision was made to wait until the Preconstruction Engineering Design (PED) phase of the project to conduct a full DMMP characterization for final decision-making. More limited sediment characterization would be done during this feasibility study.

Level of Effort – Since full DMMP characterization will not be completed until PED, the study team needed to determine the level of effort that would be adequate to support the evaluation of alternatives during feasibility. In consultation with the DMMP agencies, the study team decided that a 20% level of effort would suffice. Additionally, bioassays and bioaccumulation testing were not conducted for this effort. This level of effort was selected to provide a meaningful representation of levels and patterns of contamination in Blair Waterway, without incurring the expense of a full characterization.

3. <u>DMMP Sampling and Testing Requirements</u>. DMMP sampling and testing requirements are dependent on the rank of the project. As indicated previously, Blair Waterway was ranked “low-moderate” for this evaluation in order to determine the appropriate level of sampling. For low-moderate-ranked projects, one field sample must be taken for every 8,000 cy of sediment.

   Typically the dredge prism would be divided up into dredged material management units (DMMUs) based on the design of the project. A DMMU is a volume of sediment that can be independently dredged from adjacent sediment and for which a separate disposal decision can be made. Allowed volumes per DMMU are based on rank, surface versus subsurface DMMUs, and homogeneity/heterogeneity of the sediments. However, since the study is in the feasibility phase a specific dredge design has not been developed. The dredged material volume and prism associated with the selected alternative will not be known until the feasibility study has been completed.

   For the purposes of sediment characterization conducted during feasibility, the dredged material volume associated with maximum proposed dredging was calculated, along with the number of field samples required for full DMMP characterization, see Table 2 below. The number of field samples required for full characterization was multiplied by 0.20 (for a 20% level of effort), resulting in a need for 63 field samples for the advisory-level characterization.

Table 2
Sampling Rationale

Waterway	Total Volume (cubic yards)[1]	Rank[2]	Total Number of Cores	Total Number of Samples Required for Full Characterization	20% of Total Number of Samples Required for Advisory-level Characterization
Blair Navigation Channel	2,247,500	Low-moderate: 8,000 cy/sample	20 (2 to 3 samples analyzed per core)	313	63
Side slopes	209,500		5 (2 to 3 samples analyzed per core)		

Notes:
1. The total estimated volume including navigation channel and side slopes is 2,457,000 cy.

To provide higher-resolution data for the feasibility study, a decision was made to not composite individual samples, as is often done in DMMP sediment characterization, but to instead analyze individual field samples. To get a good spatial distribution, 25 sampling locations were identified throughout the waterway (Figure 2). The location of the sampling stations was determined in coordination with the Port of Tacoma, the Port’s contractor, the DMMP agencies and the Puyallup Tribe. Due to elevated concern over the quality of the material in the sideslopes, 5 sampling locations were placed in the side slopes in to characterize these areas at a sampling intensity closer to a moderate-rank level. For a moderate-rank project one sample is required for every 4,000 cy of material. The estimated volume of the sideslopes is 209,500 cy – so 11 samples are needed to sample the sideslopes at 20% of the “moderate-ranked” intensity. Thus the 5 identified cores, with 2 to 3 samples each (a single core can provide multiple depth interval samples), was sufficient to meet the 20% level of effort for the side slopes. The additional samples collected in the side slopes were subtracted from the total number of samples needed in the rest of the waterway, so that the total number of samples analyzed equaled 63.

Native Material – An additional goal of sampling was to determine the elevation of the native horizon. Previous deepening of Blair Waterway was to -51 ft MLLW plus 2 ft of overdepth. The native horizon was expected to be around -53 ft MLLW.

The native horizon was identified based on evaluation of the core lithology by sampling personnel familiar with the characteristics of the native sediments in Tacoma Harbor. Based on review of uplands geotechnical boring and available sediment cores in the Blair Waterway, the native unit was expected to consist of moist, medium dense to dense, gray to grayish brown, fine to medium sand with various amounts of silt and trace shell hash and occasional interbeds of moist, medium stiff, light gray, clayey silt.

4. Sampling. Field sampling took place February 18-22, 2019 using a vibracore sampler. Cores were processed at the Port of Tacoma facility at the head of the Sitcum Waterway in Tacoma, WA and samples were then transported to ARI in Tukwila, WA and submitted for analysis. Figure 2 shows the target and actual coring locations and Table 3 gives the station coordinates and other core collection data. Samples were collected within 10 feet of the target location coordinates, with the following exceptions:
   - Location C-8 was moved 85 feet northeast due to core refusal on a hard, uneven bottom, likely riprap
   - Location C-13 was moved 41 feet to the southeast to avoid contact with buried sewer lines
   - Location C-25 was shifted 84 feet due to the presence of a cargo vessel for the extent of field sampling operations

   The approved sampling and analysis plan (Anchor QEA, 2019a) was followed to the maximum extent possible. Additional deviations from the SAP were reported in the final sediment characterization report (Anchor QEA, 2019b), including:
   - Holding cores overnight before processing, which was done to minimize the number of field sampling days. Cores held overnight were securely stored upright on the sampling vessel behind a locked gate. Ambient overnight temperatures during the sampling period ranged from 3.3 to 5 ºC, with an average of 4.3 ºC. These holding conditions are in accordance with standard custody and temperature requirements for holding sediment cores.
   - As a result of holding cores overnight, additional compaction of some cores occurred between the time they were collected and processed. This additional compaction was not accounted for in the core logs and depths reported in the data report and in this advisory memo.
   - Due to the difficulty of collecting cores in the sideslopes, only three cores were collected from sideslopes instead of the five that were originally planned. During SAP development C-1 was initially considered a sideslope sample, but during finalization of the sampling plan that location was moved to the edge of navigation channel and therefore was not considered a side slope sample. Location C-8 was moved out of the sideslopes during sampling due to difficulty coring. Nine samples were analyzed for the full DMMP list of chemicals from the three sideslope samples (C-12, C-13, and C-17) in Round 1, and an additional four samples were analyzed for conventionals and dioxins/furans in Round 2. In total, 13 sideslope samples were analyzed, sufficient to meet the sampling intensity for a moderate rank.

Core intervals collected for sampling were determined based on the core lithology to avoid excessive testing of the native material while simultaneously ensuring that the native material was adequately tested. The following guidelines were used:

- At least two samples (depth intervals) from each core were analyzed.
- Samples were analyzed from the top down, and no more than three samples per core were analyzed.
- Minimum sample size was a 2-foot interval, in order to have sufficient volume of sediment for all analyses.
- The length of the top non-native interval was determined by the depth of the native horizon. As many 2-foot intervals as could be delineated were collected and analyzed from the non-native layer.
- At a minimum the surface non-native or mixed interval and the top interval of native material were analyzed.
- In sideslope samples, the first interval of native material was analyzed as long as it was within the top three depth intervals of the core. If not, the native intervals were archived and analysis was only triggered if there were SL or BT exceedances in the shallower interval.

6. Chemical Analysis.

To avoid excessive testing of native sediments a tiered testing approach was used. Analysis by the analytical laboratory occurred in two rounds. Round 1 included 57 samples identified based on the core lithology. All Round 1 samples included testing of the full suite of DMMP COCs, including conventionals, metals, semivolatiles, pesticides, PCBs, bulk TBT and dioxins/furans. Table 4 lists the sediment samples that were analyzed in Round 1 and Round 2. Six analyses were triggered for Round 2 based on the results of Round 1, as described below:

- Location C-2: This location did not have any SL or BT exceedances, but TBT increased with depth from 7.35 µg/kg in the 0-2 ft sample to 17.3 µg/kg in the 2-4 ft sample. Based on proximity to historically elevated TBT concentrations at depth (2016 EPA TBT Time Critical Removal Action) and the observed increasing concentrations with depth, Round 2 chemistry results were triggered in the next two deeper samples to evaluate the chemical trend. Results were non-detect in both intervals.
- Location C-12: Dioxin/furan concentrations were above 10 pptr TEQ in the 0-2 ft, 2-4 ft, and 4-6 ft intervals (56.21, 54.47, and 17.74 pptr TEQ, respectively). Round 2 chemistry samples were triggered in the next two deeper samples and were below the SL of 4 pptr TEQ. Additionally, total PCBs were above the SL of 130 µg/kg in the 0-2 ft interval (173.3 µg/kg), but below the SL in the 2-4 ft interval.
- Location C-13: Dioxin/furan concentrations were above 4 pptr TEQ in the 0-2 and 2-4 ft intervals (5.34 and 7.73 pptr TEQ, respectively) and above 10 pptr TEQ in the 4-6 ft interval (11.88 pptr TEQ). Round 2 chemistry samples were triggered in the next two deeper samples. The 6-8 ft. interval was above 4 pptr TEQ (7.64 pptr TEQ), and the 8-10 interval was below 4 pptr TEQ.

Tables 5 and 6 present the sediment conventionals and chemistry results, respectively. Figure 3 shows boxplots of TOC, percent sand and percent fines for the project. Samples were grouped into one of three categories based on core lithology: 1) samples that were identified as native, 2) samples from cores where the native layer was undetermined and 3) samples identified as non-native material.

Samples identified as native have a higher percentage of sand and lower percentage of fines than the non-native and unidentified material, consistent with the expected characteristics of the native material. The depth (in ft MLLW) of the native layer as identified during core processing is shown in Figure 4.

A total of 8 cores out of the 25 collected contained one or more samples with at least one SL or BT exceedance. The other 17 cores did not contain any samples with SL or BT exceedances. Figure 5 provides a summary of all the detected and undetected SL exceedances from all analytical results. The non-native surface intervals of C-3 and C-11 had nondetected exceedances of the SL for total chlordane (when all five total chlordane constituents were reported at the lower method detection limit). There were three cores with detected exceedances of SLs: C-7 was above the SL for hexachlorobutadiene in the 2-4 foot (native) interval, C-10 was above the BT for TBT in the 2-4 foot (non-native) interval, and C-12 was above the SL for total PCBs in the non-native surface interval.

Dioxin/furan results are summarized in Table 7. Elevated dioxins/furans were found throughout the mouth and middle sections of the waterway. Dioxin concentrations above 4 pptr TEQ and less than 10 pptr TEQ were found in non-native samples in cores C-7, C-8, C-10, C-11 and C-12. Dioxin concentrations above the bioaccumulation trigger of 10 pptr TEQ were found in three cores: C-12, C-13 and C-15. As mentioned above, additional samples from C-12 and C-13 were triggered in Round 2 to identify the vertical extent of elevated dioxin/furan concentrations. In all cores, samples were analyzed at deeper intervals until dioxin/furan concentrations less than 4 pptr TEQ were found. All native samples contained dioxins/furans less than 4 pptr TEQ, and all samples (both non-native and native) from the head of the waterway had dioxin/furan concentrations less than 4 pptr TEQ.

7. <u>DMMP Advisory Suitability Evaluation</u>. A DMMP suitability determination is typically based solely on the evaluation guidelines found in the DMMP User Manual current at the time of testing. However, the dredged material evaluation guidelines used by the DMMP agencies are constantly evolving as technological and scientific advances are made. Those changes could include updates to the bioaccumulation triggers or testing guidelines. However, there are no such changes currently pending. Therefore the DMMP agencies used the current evaluation guidelines to determine the potential suitability of Blair Waterway sediments for open-water disposal.

Tables 8 and 9 present the results of the DMMP evaluation, along with the rationale for determining the potential suitability or unsuitability of each sample for open-water disposal. In these tables, samples were separated into those identified as native sediment (Table 9) and those identified as non-native or undetermined sediment (Table 8). Sample ID refers to the intervals of sediment core starting with A at the top of each core. For each station/interval tested, one of the following determinations was provided:

Suitable – No SL or BT exceedances; dioxins/furans below 4 pptr TEQ.

Likely Suitable – No SL or BT exceedances occurred; dioxins/furans below 10 pptr TEQ but above 4 pptr TEQ.

Possibly Suitable – Detected or undetected SL exceedances and dioxins/furans < 10 pptr TEQ.

Unsuitable – BT exceedance and/or dioxins/furans > 10 pptr TEQ, with or without other SL exceedance.

To facilitate the use of this information in the estimation of quantities of suitable and unsuitable dredged material for the Tacoma Harbor Deepening feasibility study, the DMMP agencies adopted a probability approach for the Blair Waterway. Sampling stations with similar suitability characteristics in the non-native intervals of sediment were grouped to form three distinct sections within the waterway (Table 8; Figure 6) regardless of whether they were on the sideslope or in the channel. To establish a logical segmentation of the waterway for planning purposes, numerical probabilities were assigned to each station and those probabilities averaged and rounded down to the nearest 5%. Numeric probabilities were assigned as follows:

- suitable = 100% probability of being suitable for open-water disposal
- likely suitable = 75%
- possibly suitable = 50%
- unsuitable = 0%

At the head of the waterway all samples in all cores were below SLs and dioxins/furans were less than 4 pptr TEQ. All of this material was classified as suitable and the average suitability probability was 100%.

The middle portion of the waterway had the lowest suitability probabilities. Three cores, C-12, C-13 and C-15 contained unsuitable material due to dioxins/furans above 10 pptr TEQ and one core, C-10, contained unsuitable material due to TBT. One sample in core C-11 contained possibly unsuitable material due to a non-detect exceedance of total chlordane and dioxins/furans between 4-10 pptr TEQ. In all of these cores, lower intervals of the core were analyzed until clean material was confirmed. Overall, the average suitability probability for surface non-native material in the middle portion of the waterway is 63.6%.

The mouth of the waterway was largely suitable, with only one sample (C-3) with a possibly suitable classification due to a single non-detect exceedance of total chlordane. The average suitability probability for surface non-native material in the mouth of the waterway is 92.9%.

The same probability approach was applied to the native sediments. Among all sediments throughout the waterway that were identified as native material, only one sample was classified as possibly suitable (due to a single exceedance of hexachlorobutadiene in C-7) and the rest were classified as suitable. Therefore, the average suitability probability of identified native sediments is 98.1%

The predictive ability of the feasibility-level sediment characterization completed for the deepening study does not match the mathematical precision of the calculated probability averages. Therefore, the calculated averages were rounded down to the nearest 5%. The rounded probability values are found in Tables 8 and 9 and illustrated in Figures 6 and 7.

In summary, the non-native sediments showed a range of contaminant concentrations. The probability of suitability for open-water disposal was estimated by the DMMP agencies in the non-native sediments to be 90% suitable in mouth, 60% suitable in the middle and 100% suitable in the head, as shown in

Figure 6. Nearly all identified native sediment is suitable for open-water disposal, with an average probability of being suitable for open-water disposal of 95%.

This advisory determination only applies to the areas identified and documented in this document. Additional areas not considered here, especially in the sideslopes and/or near outfalls, may have a different sediment contaminant profile. The results from the sideslope samples in this study as well as historical information from cutback projects throughout Blair Waterway give a strong indication that material outside of the navigation channel (i.e. closer to shore) considered in this advisory memo is more likely to be unsuitable. The DMMP agencies recommend a more conservative assumption of the probability of suitability for areas outside the areas evaluated in this advisory memo.

8. Suitability for Beneficial Use. The DMMP agencies do not determine the suitability of material for beneficial use projects. It is up to the project proponents, the site receiving the material, and other interested stakeholders including applicable resource agencies and Tribes to determine the physical and chemical suitability of dredged materials for a beneficial use site.

However, typically the first step taken to evaluate sediments for beneficial use is comparison against the State's Sediment Quality Standards (SQS), which has been done in Tables 10 and 11. Many of the SQS standards are in organic carbon normalized units. Ecology's recommendation for organic carbon normalizing is to only use this approach for sediments with TOC concentrations between 0.5 – 3.5% (Ecology, 2017). Samples were divided into two groups, those with TOC between 0.5 – 3.5% (12 samples) and those with TOC less than 0.5% (51 samples). There were no samples with TOC greater than 3.5%.

For the 12 samples with TOC greater than 0.5%, results are compared to SQS and are shown in Table 10. Non-detect results for two chemicals, 1,2,4-trichlorobenzene and hexachlorobenzene, were above the SQS as initially reported by the laboratory. As is typically done by the DMMP agencies when there is a non-detect exceedance, the results are re-evaluated by the analytical laboratory to see if there was any evidence that the compounds of interest were detected at levels between the method detection limit (MDL) and the method reporting limit (MRL). If there is no evidence, then the results are reported as non-detect at the lower MDL. For these samples (and all samples in the project) there was no evidence that 1,2,4-trichlorobenzene or hexachlorobenzene were detected above the MDL, so the results for these two compounds were reported at the lower level, as indicated in Table 10.

11 of the 12 samples in Table 10 were less than the SQS. Sample C-12-A exceeds the SQS for PCBs and is not suitable for beneficial use. All other samples are below SQS, indicating that they would likely be suitable for beneficial use.

For the 51 samples with TOC less than 0.5%, results are compared to the dry weight based SQS values and are shown in Table 11. The dry-weight SQS values are based on the same apparent effects thresholds (AET) as the DMMP SLs, and are the same for all but two chemicals. The dry-weight SQS for pentachlorophenol is 360 μg/kg, lower than the DMMP SL of 400 μg/kg, and the dry-weight SQS for acenaphthylene is 1300 μg/kg, higher than the DMMP SL of 560 μg/kg. With only one exception, all samples for all chemicals, including pentachlorophenol, are less than the dry-weight SQS, indicating these sediments would likely be suitable for beneficial use. Sample C-7-B had a

detected concentration of hexachlorobutadiene above the dry-weight SQS, indicating that this material is likely not suitable for beneficial use.

Comparison to SQS is not the only consideration in assessing beneficial use. Based on initial coordination with other resource agencies and the Puyallup Tribe, the following assumptions were also taken into consideration:

- If material is unsuitable for the Commencement Bay open-water disposal site then it is also unsuitable for beneficial use
- NMFS' proposed PAH level for the protection of fish of 2,000 µg/kg[1] is appropriate for aquatic beneficial use
- Only material with dioxin less than 4 pptr TEQ is appropriate for beneficial use

Table 12 shows the average percent likelihood of suitability for beneficial use of this material based on all these considerations. The results are summarized below:

Table 12. Summary of Beneficial Use Suitability for Tacoma Harbor

Area	Average percent likelihood of suitability for beneficial use
Mouth	85%
Middle	40%
Head	100%
Native	95%

9. Sediment Exposed by Dredging. The sediment to be exposed by dredging must either meet the State of Washington Sediment Quality Standards (SQS) or the State's Antidegradation standard (Ecology, 2013) as outlined by DMMP guidance (DMMP, 2008).

This sediment core characterization in the Blair Waterway clearly demonstrated that contamination decreases with depth. With the exception of cores C-7, C-10, and C-13, the highest COC concentrations were found at the top of the core with contamination decreasing with depth. For C-7, there was elevated hexachlorobutadiene in the 2-4 foot layer that was not observed at the surface, but the layer below, representing -54 to -56 ft MLLW, was less than SL and SQS. For C-10, TBT was elevated (but below screening levels) in the 2-4 foot layer but decreased with depth and was no longer detected at depths below -53 ft MLLW. For the sideslope sample C-13, dioxins appeared to be highest in the 4-6 foot layer (11.88 pptr TEQ), and was below 4 pptr TEQ in the 8-10 foot layer (-47 to -49 ft MLLW).

At the current level of sampling density and dredge design, it is difficult to determine antidegradation within the side slope regions, although the data gathered in this characterization indicates that antidegradation can be met without need for cover. This uncertainty is being addressed by new rankings for sideslopes during full characterization.

The available information indicates that it is highly likely that antidegradation will be met in the

[1] The National Marine Fisheries Service (NMFS) proposed a screening level of 2,000 µg/kg total PAH for the protection of fish at the Regional Sediment Evaluation Team annual meeting in November 2014.

navigation channel once native material is reached.

10. Underlying Assumptions. Several key assumptions were made by the DMMP agencies in conducting this advisory suitability evaluation. These assumptions are discussed in the following paragraphs.

Dioxins/Furans - Samples with concentrations of dioxins/furans at or below 4 pptr TEQ were deemed suitable for open-water disposal, as this concentration is the site management objective for nondispersive disposal sites. Concentrations of dioxins/furans between 4 and 10 pptr TEQ were considered likely to be eligible for open-water disposal because there is a large volume of clean native material that would be dredged during deepening, and this material can be used to bring the project volume-weighted average below the site management objective of 4 pptr TEQ. USACE planners will need to plan for the additional volume of clean sediment required to meet the volume-weighted average guidelines at the Commencement Bay disposal site. This will likely reduce the amount of material available for beneficial use. It was also assumed that dredging and disposal will be sequenced such that suitable dredged material with relatively higher concentrations of dioxins/furans will be placed first at the Commencement Bay site, followed by native material with very low concentrations, thereby leaving a surface layer of sediment at the disposal site with a low dioxin/furan concentration. Dioxin/furan concentrations above 10 pptr TEQ were determined to be unsuitable for open-water disposal. DMMUs with dioxin/furan concentrations above 10 pptr TEQ would need to pass bioaccumulation testing in order to qualify for open-water disposal. The DMMP agencies made the conservative assumption for the purpose of this evaluation that either bioaccumulation testing for dioxins/furans would not be conducted or, if tested, these samples would fail bioaccumulation testing.

Bioassays – Bioassay testing was not conducted for this advisory-level characterization due to schedule restrictions. Therefore the assignment of potential suitability of samples with SL exceedances was based on the experience and best professional judgment of the DMMP agencies assuming that bioassays would be conducted during full characterization. There were only two samples with SL exceedances with no other exceedances (i.e. they did not have dioxin above 4 pptr TEQ or other BT exceedance) – one detected exceedance of hexachlorobutadiene and one non-detect exceedance of total chlordane. Based on prior experience testing sediments with minor SL exceedances of these chemicals, the DMMP assigned both of these samples a 50% chance of being suitable for open-water disposal.

11. DMMP Guidance for Full Characterization and Dredging. As indicated previously, full characterization of potential dredged material from the Blair Waterway must be completed in order to complete a suitability determination for this project prior to dredging. The testing results from this feasibility study indicated that the appropriate ranking for full characterization is variable throughout the waterway. Therefore, unless new information becomes available in the interim, sampling requirements for full characterization will be based on rank according to the following chart:

Sediment Category	Waterway Area	Rank
Sideslopes	Head	Moderate to High
	Middle	High
	Mouth	Moderate to High
Surface material	Head	Low-Moderate
	Middle	Moderate to High
	Mouth	Low-Moderate to Moderate
Confirmed native material	Throughout waterway	No further testing, except for confirmatory testing around C-7 and where full characterization identifies SL/BT failures at the native/non-native boundary

Two of the three side slope cores (C12, C13) were determined to be unsuitable without further testing (bioaccumulation for dioxins for both; PCB toxicity for C12). Since most of the nearshore areas are not often dredged, and are closer to sources of contamination, DMMP is assigning ranks to the sideslopes that are higher than originally assigned for sampling for this advisory determination. For the full determination, it will be important to have sufficient dredge design details to inform where sideslopes will either be dredged or will slough due to dredging along the base of the slope, so that appropriate sediment locations and depths are characterized.

The concentrations of chemicals of concern in the identified native material were far below the DMMP SLs, with only one exception. There was a detected exceedance of SL for one chemical in a single sample in the middle section of the waterway (C-7). Therefore, throughout the project area, confirmed native sediment will be assumed to be suitable for open-water disposal by the DMMP agencies and will be exempt from analysis during full characterization with two exceptions: native material around C-7 which will require confirmatory testing to verify its suitability, and where full characterization identifies SL/BT failures at the native/non-native boundary. Samples from native material DMMUs will need to be collected and archived pending results of overlying DMMUs.

There is also a high probability of encountering BT exceedances for dioxin, and to a lesser extent TBT, during full characterization, particularly in the middle portion of the waterway and in sideslopes. Bioaccumulation testing requires large volumes of sediment and the testing is costly. Whether and when to collect adequate volumes of sediment to conduct this testing will be up to USACE and the Port of Tacoma.

DMMUs that are found unsuitable for open-water disposal will need to be disposed in an appropriate upland facility. To ensure that the unsuitable material is separated from the suitable material during dredging, a minimum one-foot vertical buffer and an appropriate horizontal buffer will need to be added to the unsuitable portions of the dredge prism. This means that in areas where the top four feet are found unsuitable for open-water disposal, at minimum the top five feet of sediment will need to be dredged and taken upland. The one-foot vertical buffer is not the same as the overdepth allowance. If the dredging contract includes one foot of overdepth, the dredge cut would be five feet, plus one foot of overdepth. USACE planners will need to include the horizontal and vertical buffers in volume calculations for upland disposal.

Since the last deepening of the Blair Waterway in 2000/2001, maintenance dredging has not occurred in the navigation channel, and has occurred in the berthing areas three times for different areas: at GP Gypsum, Husky Terminal and Washington United Terminal. Therefore, there is a good chance that debris will be encountered during dredging. This debris must be removed from sediment prior to disposal at the Commencement Bay open-water disposal site. The dredger will likely be required to screen the surface non-native sediments in areas with suitable material using a grid with a maximum opening size of 12 inches by 12 inches. Native material and material found unsuitable for open-water disposal will not need to be screened. However, if large (greater than 12 inches by 12 inches) woody debris or other large natural debris is found in native sediments, this debris will need to be removed from the dredged material prior to disposal at the Commencement Bay open-water disposal site.

The DMMP agencies are in the process of revising the disposal site monitoring program for all disposal sites in Puget Sound. The process is expected to be completed within a few years, but there are many unknowns at this time. Currently the following changes are reasonably likely to have an impact on future use of the disposal sites:

Disposal tipping fees - DNR is likely to pursue an increase in the disposal tipping fee within the next 5-10 years. The current tipping fee of $0.45/cy was last increased in 1994. It is premature to estimate what the increased fee might be.

Preventing off-site migration of dredged material - Off-site migration has historically been an issue at the Commencement Bay disposal site, even resulting in the need to temporarily shut down use of the site after significant off-site migration. For projects disposing of a large amount of material in a short period of time there is an increased concern over off-site migration.

In 2009 the DMMP agencies completed a supplemental EIS (SAIC, 2009) for reauthorization of the Commencement Bay open-water disposal site. The preferred alternative chosen for management of the disposal site, Alternative 2, included increasing the cumulative disposal volume of the site to 23 million cubic yards (mcy) with three coordinate shifts within the target area and consideration of the need to implement institutional controls on disposal to better manage the site. Institutional controls considered and studied included specific requirements for tug/barge orientation or direction during disposal and disposal during a specified portion of the tidal cycle.

Due to the potential large volume of material from this project that could be disposed at the Commencement Bay site, additional measures will need to be taken to ensure that the disposed material is not migrating off-site. The DMMP agencies recommend physical monitoring of the site before the start of the project to get a baseline and subsequent physical monitoring of the site after every 500,000 cy disposed or at the end of each dredging year, whichever is more frequent. Physical monitoring includes a multibeam bathymetric survey and SPI monitoring.

If results of the physical monitoring indicate that significant off-site migration is occurring, the DMMP agencies will consider implementation of institutional controls to better manage the site.

12. References.

Anchor, 2019a. *Sampling and Analysis Plan – Dredged Material Characterization – Tacoma Harbor Deepening Study.* Prepared by Anchor QEA, LLC for Port of Tacoma, February 2019

Anchor, 2019b. *Sediment Characterization Data Report – Dredged Material Characterization – Tacoma Harbor Deepening Study*. Prepared by Anchor QEA, LLC for Northwest Seaport Alliance, April 2019

DMMP, 2018. *Dredged Material Evaluation and Disposal Procedures (Users Manual)*. Prepared by the Seattle District Dredged Material Management Office for the Dredged Material Management Program, December 2018.

DMMP, 2011. *Marine Sediment Quality Screening Levels: Adopting RSET Marine SLs for Use in DMMP.* A Clarification Paper prepared by Laura Inouye (Ecology) and David Fox (USACE) for the Dredged Material Management Program, June 2011.

DMMP, 2010. *Dredged Material Management Program New Interim Guidelines for Dioxins*. December 6, 2010.

DMMP, 2008. *Quality of Post-Dredge Sediment Surfaces (Updated).* A Clarification Paper Prepared by David Fox (USACE), Erika Hoffman (EPA) and Tom Gries (Ecology) for the Dredged Material Management Program, June 2008.

Ecology, 2013. *Sediment Management Standards – Chapter 173-204 WAC*. Washington State Department of Ecology, February 2013.

Ecology, 2017. *Sediment Cleanup User's Manual II (SCUM II), Guidance for Implementing the Cleanup Provisions of the Sediment Management Standards, Chapter 173-204 WAC.* Prepared by the Toxics Cleanup Program, Department of Ecology. Final originally published March 2015, revised December 2017.

SAIC, 2009. *Reauthorization of Dredged Material Management Program Disposal Site at Commencement Bay, Supplemental Environmental Impact Statement.* Prepared by SAIC for the Dredged Material Management Program, August 2009.

10. Agency Signatures.

The signed copy is on file in the Dredged Material Management Office.

Concur:

Date — Kelsey van der Elst - Seattle District Corps of Engineers

Date — Justine Barton - Environmental Protection Agency

Date — Laura Inouye, Ph.D. - Washington Department of Ecology

Date — Abby Barnes - Washington Department of Natural Resources

Copies furnished:

DMMP signatories
Kristine Koch, EPA Superfund RPM
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Donald Kramer, USACE Planner
Kristen Kerns, USACE Risk Assessor
Daniel Bernal, USACE Coastal Engineer
Walker Messer, USACE Economist
Kaitlin Whitlock, USACE Biologist

Exhibit A – DMMP Evaluation Procedures

The DMMP evaluation procedures are fully described in DMMP (2018). This exhibit includes information about several key elements relevant for the Blair Waterway suitability evaluation.

Ranking:

For DMMP dredged material evaluations, dredging projects are assigned to one of four possible ranks: high, moderate, low-moderate, or low. These ranks reflect the potential for adverse biological effects or elevated concentrations of chemicals of concern. The higher the rank, the higher the concern, and the more intense the sampling and testing requirements needed to adequately characterize the dredged material. Project or area ranking is based on the available information on chemical and biological-response characteristics of the sediments, as well as the number, kinds, and proximity of chemical sources (existing and historical).

DMMUs:

Tiered testing is conducted for smaller units within the area to be dredged. These units are termed Dredged Material Management Units (DMMUs). A DMMU is the smallest volume of dredged material capable of being dredged independently from adjacent units and for which a separate disposal decision can be made.

Full Characterization:

Full DMMP characterization includes minimum sampling and testing requirements, which are typically based on the rank, volume and depth of the dredging project. For example, in a moderate-ranked area, field samples are restricted to representing no more than 4,000 cubic yards and each DMMU can represent no more than 16,000 cubic yards of dredged material in the surface layer (0-4 feet below mudline). In subsurface sediment (> 4 feet below mudline), field samples are restricted to representing no more than 4,000 cubic yards, but DMMUs can represent up to 24,000 cubic yards, depending on site-specific conditions. Best professional judgment may need to be applied in addressing certain scenarios, for example areas with increasing contamination with depth or adjacent to a cleanup site. Full characterization typically results in a DMMP suitability determination.

Tiered Testing:

The DMMP dredged material suitability determination process consists of four tiers of evaluation and testing. A brief discussion of these tiers follows.

Tier 1 analysis involves the review of existing sediment data and site history, including all potential sources (e.g., outfalls, spills, etc.) for sediment contamination. The Tier 1 evaluation informs the sediment evaluation process for the project.

Tier 2 analysis consists of chemical testing of sediment samples. Table 5 includes the chemicals of concern analyzed in DMMP projects at the time of the Blair Waterway sediment characterization

in 2019. This list includes metals, semivolatiles, pesticides and PCBs, which are all considered standard chemicals of concern. Certain other chemicals of concern, including dioxins/furans and tributyltin, are analyzed in areas that are of concern for these chemicals.

Tier 3 consists of biological testing. DMMUs with exceedances of the chemical screening levels (SLs) or bioaccumulation triggers (BTs) listed in Table 5 require biological testing in Tier 3 to determine their toxicity and/or bioaccumulation potential respectively.

If the Tier 2 analysis indicates that all chemical concentrations are below the SLs and BTs, then no biological testing is necessary. If there is one or more SL exceedance, the DMMU is subjected to a suite of Tier 3 bioassays, consisting of an amphipod mortality test, a larval development test, and the juvenile infaunal growth test. If one or more BT is exceeded, the DMMU is subjected to bioaccumulation testing for the chemical/s exceeding BT.

Tier 4 evaluations are conducted only if standard chemical and biological evaluations are insufficient to determine the suitability of dredged material for open-water disposal. A Tier 4 assessment is a special, non-routine evaluation which might include time-sequenced bioaccumulation or tissue analysis of organisms collected from the area to be dredged. Tier 4 could also include a risk assessment. Tier 4 assessments are rarely needed.

Dioxin Guidelines:

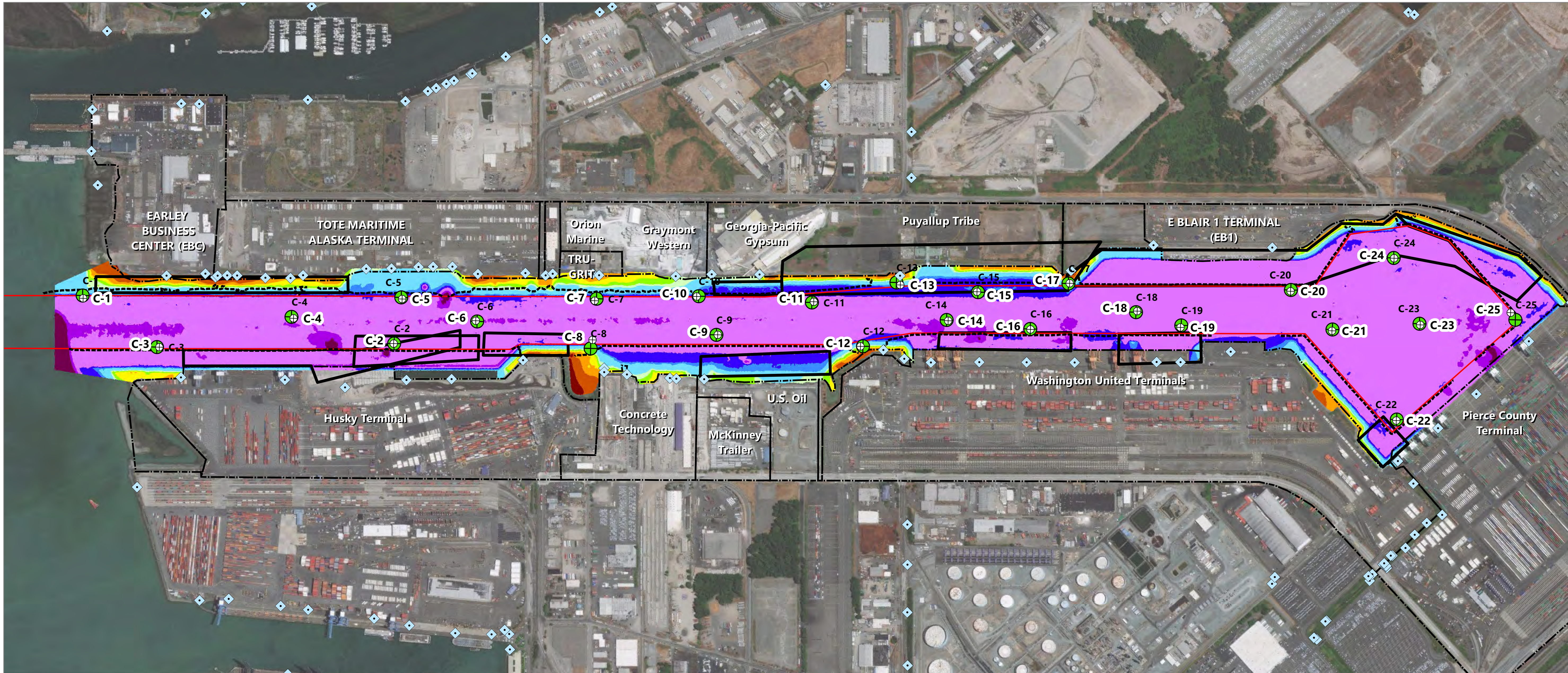
The DMMP agencies implemented revised dioxin/furan guidelines in 2010 for dredged material disposed at the eight multiuser open-water disposal sites in Puget Sound. Implementation of the revised guidelines followed a 3-year study, which included analysis of dioxins/furans in sediment and tissue samples collected from the five non-dispersive sites, as well as determination of background sediment concentrations of dioxins/furans at non-urban sites throughout the Sound (including Hood Canal, the San Juan Islands and the Strait of Juan de Fuca).

The background sediment concentration was determined to be 4 pptr TEQ. The TEQ is the summation of all 17 congeners of dioxins/furans having 2005 World Health Organization Toxic Equivalency Factors. The revised dioxin guidelines for Puget Sound disposal sites are based on this background concentration.

The non-dispersive site management objective is 4 pptr TEQ. DMMUs with dioxin/furan concentrations below 10 pptr TEQ are allowed for disposal as long as the volume-weighted average concentration of dioxins/furans in material from the entire dredging project does not exceed 4 pptr TEQ. DMMUs exceeding 10 pptr may still be placed at non-dispersive sites if they pass bioaccumulation testing that show that the dioxins/furans are not bioavailable. The dioxin concentrations of DMMUs passing bioaccumulation testing are not included in the volume-weighted average.

Figure 1
Site Map and Study Area

Tacoma Harbor Deepening Study



LEGEND:

- Outfall
- Actual Sampling Location
- Proposed Sampling Location
- Proposed Navigation Channel Boundary
- Property Boundary
- Historical Dredged Material Characterization Area
- Approximate 2H:1V Daylight Limits

MLLW Elevation (Feet)

- < -58
- -58 - -55
- -55 - -50
- -50 - -45
- -45 - -40
- -40 - -25
- -25 - -20
- -20 - -15
- -15 - -10
- -10 - -5
- -5 - 0
- 0 - 20

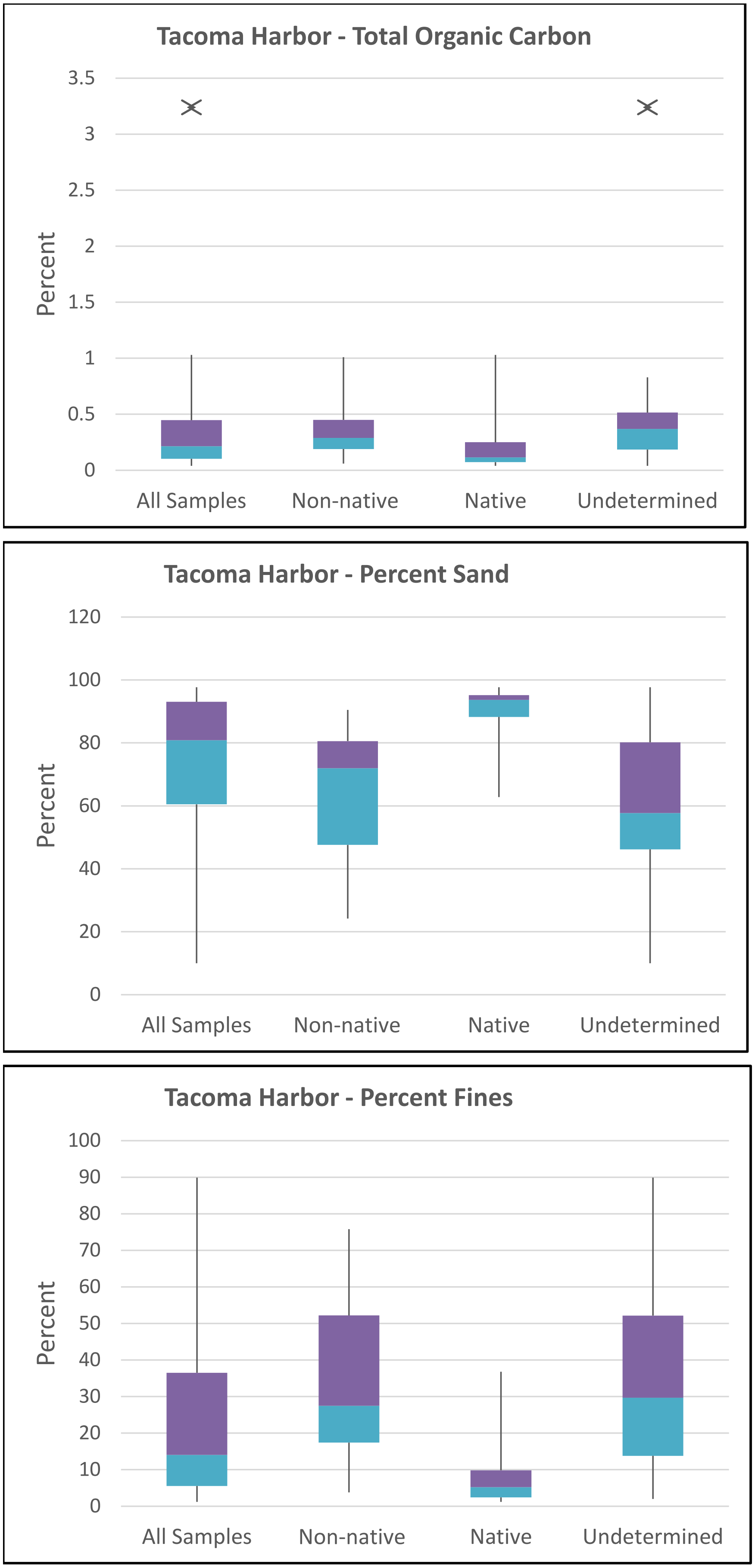
NOTES:
1. Bathymetry from November 2018.

Figure 2

Proposed and Actual Sampling Locations

Tacoma Harbor Deepening Study

Figure 3. Boxplots of conventionals results from Tacoma Harbor Deepening Study



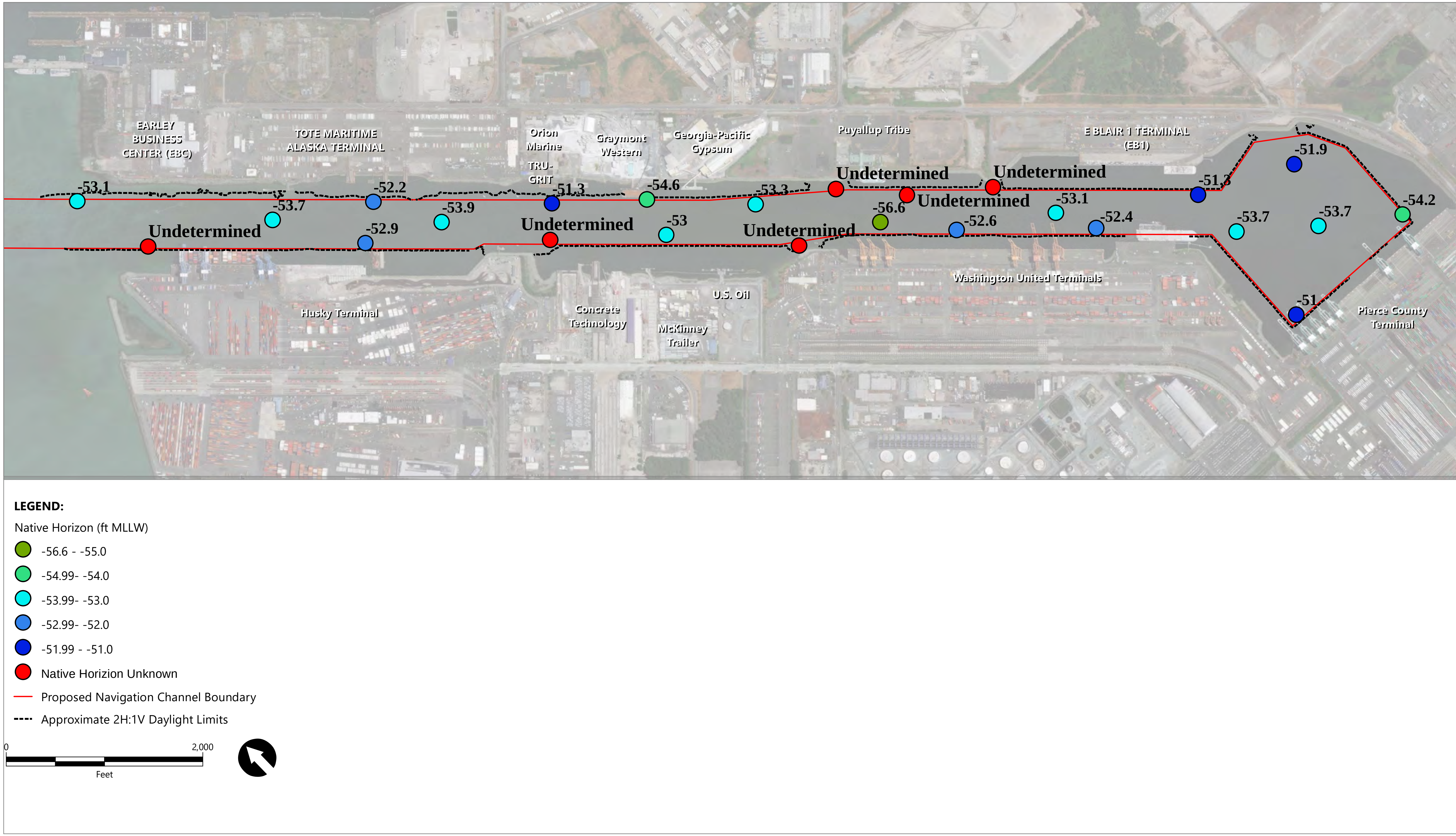
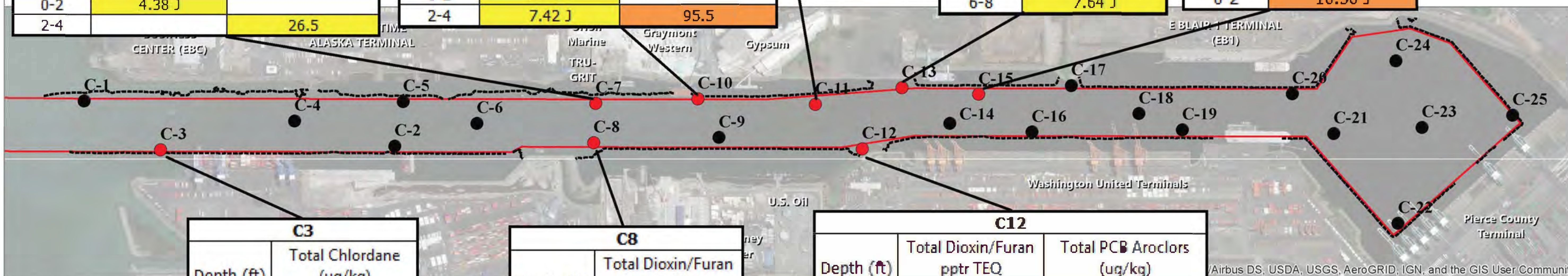


Figure 4
Depth of Native Horizon (ft MLLW)
Tacoma Harbor Deepening Study



C7

Depth (ft)	Total Dioxin/Furan pptr TEQ	Hexachlorobutadiene (ug/kg)
0-2	4.38 J	
2-4		26.5

C10

Depth (ft)	Total Dioxin/Furan pptr TEQ	TBT (ug/kg)
0-2	8.79 J	
2-4	7.42 J	95.5

C11

Depth (ft)	Total Dioxin/Furan pptr TEQ	Total Chlordane (ug/kg)
0-2	5.92 J	21.9 U

C13

Depth (ft)	Total Dioxin/Furan pptr TEQ
0-2	5.34 J
2-4	7.73 J
4-6	11.88 J
6-8	7.64 J

C15

Depth (ft)	Total Dioxin/Furan pptr TEQ
0-2	10.56 J

C3

Depth (ft)	Total Chlordane (ug/kg)
0-2.7	24.9 U

C8

Depth (ft)	Total Dioxin/Furan pptr TEQ
0-2	5.00 J

C12

Depth (ft)	Total Dioxin/Furan pptr TEQ	Total PCB Aroclors (ug/kg)
0-2	56.21 J	173.3 J
2-4	54.47 J	
4-6	17.74 J	

LEGEND:

- Suitable
- Unsuitable
- Proposed Navigation Channel Boundary
- Approximate 2H:1V Daylight Limits

NOTES:
1. Bathymetry from November 2018.

Yellow	Detected concentration is greater than DMMP SL screening level
Orange	Detected concentration is greater than DMMP bioaccumulation trigger(BT)
Blue	Non-detected concentration is above one or more identified screening levels

0 2,000
Feet

Figure 5
Summary of SL/BT Exceedances
Tacoma Harbor Deepening

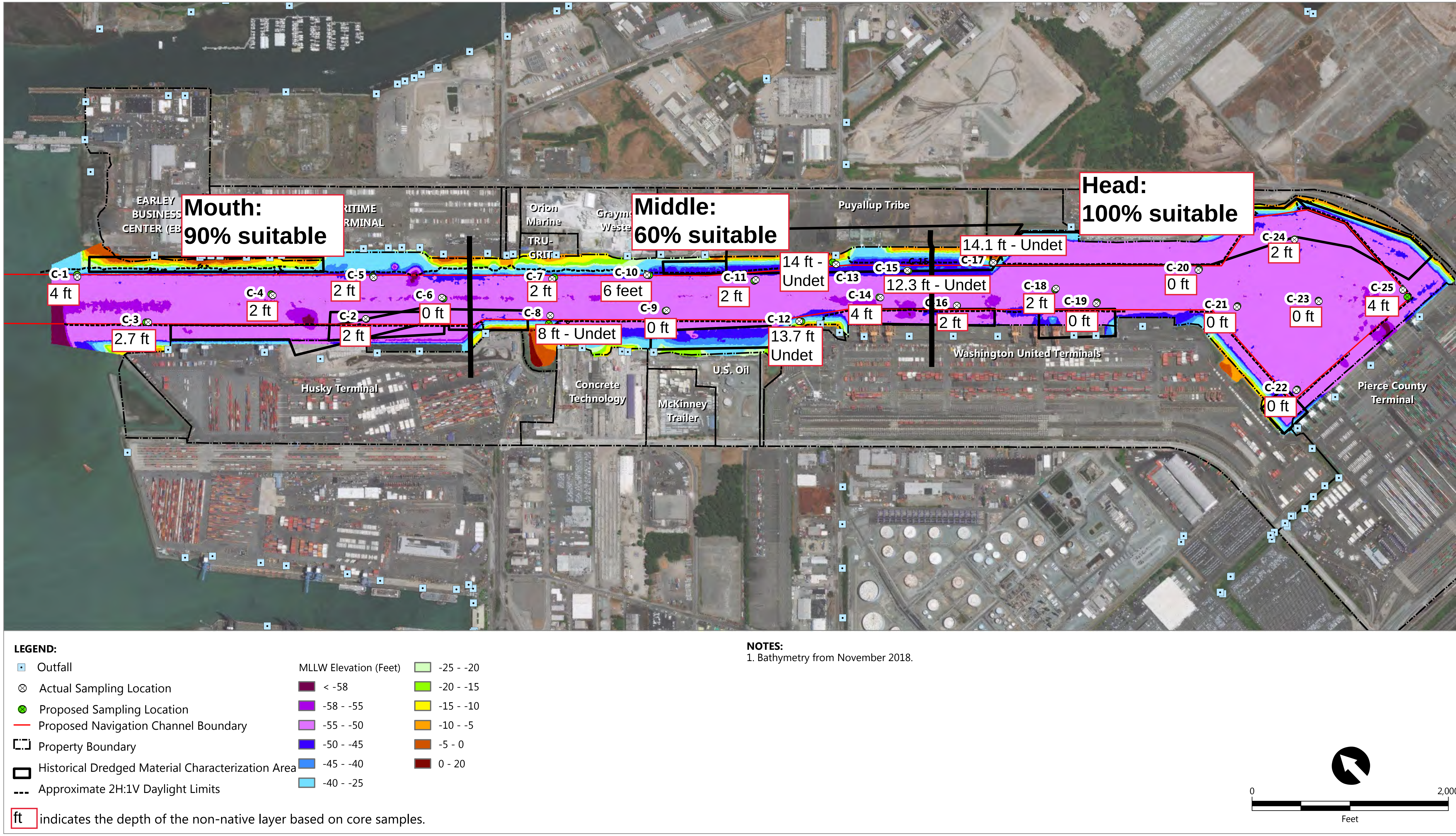
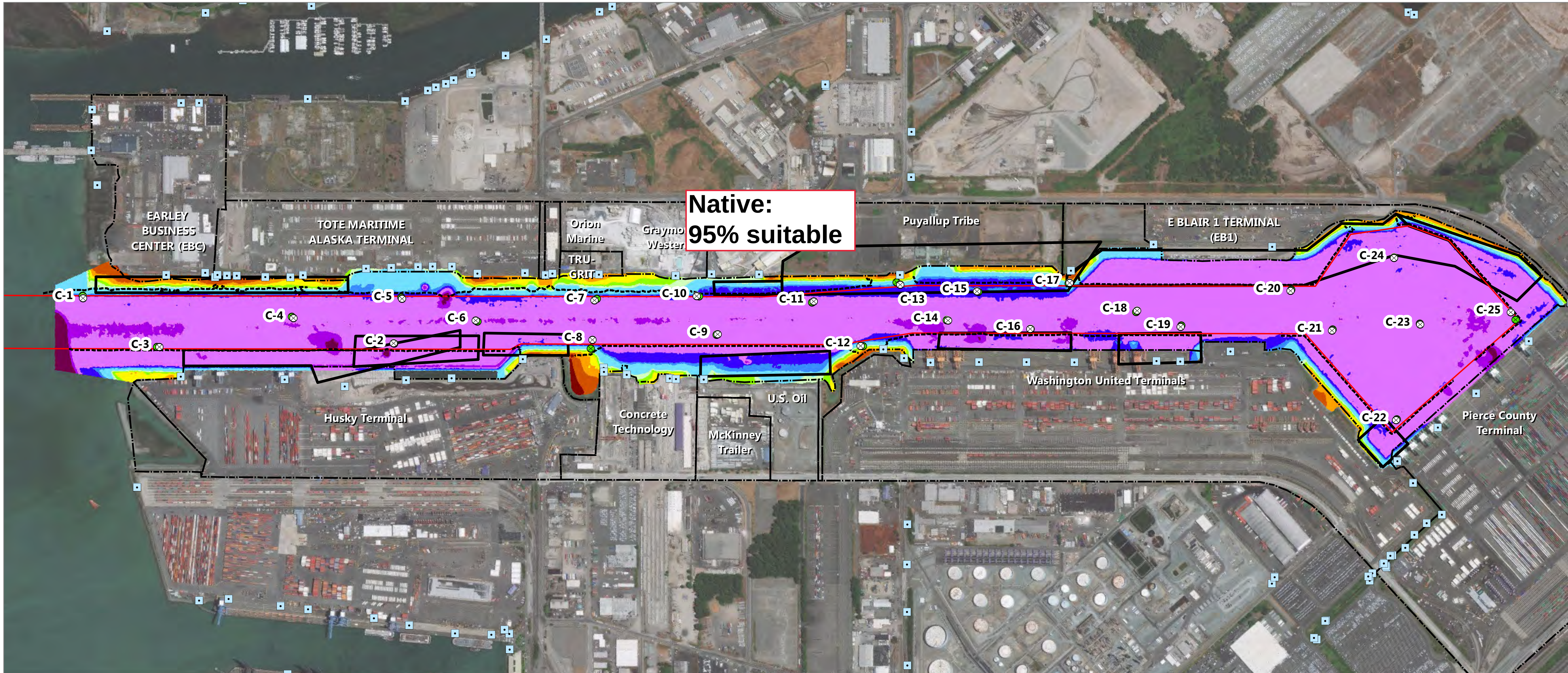


Figure 6

Probability of Suitability for Open-Water Disposal of Non-Native Material

Tacoma Harbor Deepening Study



LEGEND:

- Outfall
- Actual Sampling Location
- Proposed Sampling Location
- Proposed Navigation Channel Boundary
- Property Boundary
- Historical Dredged Material Characterization Area
- Approximate 2H:1V Daylight Limits

MLLW Elevation (Feet)

- < -58
- -58 - -55
- -55 - -50
- -50 - -45
- -45 - -40
- -40 - -25
- -25 - -20
- -20 - -15
- -15 - -10
- -10 - -5
- -5 - 0
- 0 - 20

NOTES:
1. Bathymetry from November 2018.
2. Native interval identified based on core lithology

0 2,000
Feet

Figure 7
Probability of Suitability for Open-Water Disposal for Native Material

Tacoma Harbor Deepening Study

Table 3
Sample Coordinates and Core Collection Data

Station	Date	Location[1]		Measured Water Depth (feet)	Water Level (ft MLLW)[2]	Mudline Elevation (feet MLLW)	Drive Penetration (feet)	Collection Recovery Measurement (feet)	Recovery[3] (%)	Native Horizon Elevation (feet MLLW)
		X Coordinate	Y Coordinate							
C-1	2/18/2019	1165157.4	715708.8	61.7	11.8	-49.9	13.5	13.1	97.0	-53.1
C-2	2/18/2019	1166970.1	713363.2	63.2	11.8	-51.4	11.0	9.7	88.2	-52.9
C-3	2/18/2019	1165354.3	714876.0	59.2	6.7	-52.5	12.0	11.9	99.2	Undetermined
C-4	2/18/2019	1166455.2	714192.3	61.5	7.8	-53.7	9.7	9.7	100.0	-53.7
C-5	2/20/2019	1167320.0	713610.6	58.5	7.0	-51.5	14.6	14.0	95.9	-52.2
C-6	2/18/2019	1167677.8	712979.4	65.6	11.7	-53.9	10.0	9.6	96.0	-53.9
C-7	2/20/2019	1168617.2	712335.3	59.2	8.8	-50.4	13.8	13.5	97.8	-51.3
C-8	2/21/2019	1168345.9	712082.2	55.8	3.8	-52.0	11.0	9.5	86.4	Undetermined
C-9	2/20/2019	1169230.3	711295.5	59.4	6.4	-53.0	9.7	9.5	97.9	-53.0
C-10	2/20/2019	1169339.5	711694.4	59.9	10.9	-49.0	13.5	13.4	99.3	-54.6
C-11	2/20/2019	1170100.3	710890.6	56.7	5.1	-51.6	13.9	13.0	93.5	-53.3
C-12	2/22/2019	1170124.7	710281.3	27.7	5.0	-22.7	14.7	14.7	100.0	Undetermined
C-13	2/22/2019	1170797.6	710436.2	48.4	9.4	-39.0	14.7	14.3	97.3	Undetermined
C-14	2/21/2019	1170888.7	709878.9	57.0	4.4	-52.6	9.6	9.2	95.8	-56.6
C-15	2/22/2019	1171275.8	709886.8	57.3	11.7	-45.6	14.7	12.6	85.7	Undetermined
C-16	2/22/2019	1171390.8	709280.6	62.2	11.6	-50.6	9.7	9.6	99.0	-52.6
C-17	2/22/2019	1171960.3	709337.6	31.2	9.5	-21.7	15.0	14.5	96.7	Undetermined
C-18	2/19/2019	1172236.9	708704.3	63.4	11.2	-52.2	9.0	7.1	78.9	-53.1
C-19	2/19/2019	1172424.4	708310.0	62.7	10.3	-52.4	9.6	8.0	83.3	-52.4
C-20	2/19/2019	1173409.8	707832.4	57.0	5.7	-51.3	13.8	13.6	98.6	-51.3
C-21	2/19/2019	1173431.1	707291.8	59.4	5.7	-53.7	9.6	8.6	89.6	-53.7
C-22	2/19/2019	1173278.7	706259.8	56.7	5.7	-51.0	13.2	13.0	98.5	-51.0
C-23	2/21/2019	1174069.4	706752.9	64.1	10.4	-53.7	8.5	7.5	88.2	-53.7
C-24	2/22/2019	1174329.1	707378.1	61.2	10.1	-51.1	9.7	9.3	95.9	-51.9
C-25	2/22/2019	1174764.8	706243.0	56.7	5.3	-51.4	9.7	9.6	99.0	-54.2

Notes

1. Coordinates are in North American Datum of 1983 Washington State Plane South, U.S. feet.

2. Water level obtained using real-time kinematic GPS.

3. Percent recovery calculated based on collection measurement.

MLLW: mean lower low water

Table 4
Core Sampling Intervals and Analysis

Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Round 1 Sampling Status[1]	Round 2 Analyses
C-1	C-1-A-190219	0 to 2	-49.9 to -51.9	Full Suite	
	C-1-B-190219	2 to 4	-51.9 to -53.9	Full Suite	
	C-1-C-190219	4 to 6	-53.9 to -55.9	Full Suite	
	C-1-D-190219	6 to 8	-55.9 to -57.9	Archive	
	C-1-E-190219	8 to 9.9	-57.9 to -59.8	Archive	
C-2	C-2-A-190219	0 to 2	-51.4 to -53.4	Full Suite	
	C-2-B-190219	2 to 4	-53.4 to -55.4	Full Suite	
	C-2-C-190219	4 to 6	-55.4 to -57.4	Archive	Conventionals and TBT
	C-2-D-190219	6 to 8.6	57.4 to -60.0	Archive	Conventionals and TBT
C-3	C-3-A-190218	0 to 2.7	-52.5 to -55.2	Full Suite	
	C-3-B-190218	2.7 to 5.8	-55.2 to -58.3	Full Suite	
	C-3-C-190218	5.8 to 7.5	-58.3 to -60.0	Archive	
	C-3-Z-190218	7.5 to 9.5	-60.0 to -62.0	Archive	
	C-3-Z2-190218	9.5 to 11.2	-62.0 to -63.7	Archive	
C-4	C-4-A-190218	0 to 2	-53.6 to -55.6	Full Suite	
	C-4-B-190218	2 to 4	-55.6 to -57.6	Full Suite	
	C-4-C-190218	4 to 6	-57.6 to -59.6	Archive	
	C-4-Z-190218	6 to 8.2	-59.6 to -61.8	Archive	
C-5	C-5-A-190221	0 to 2	-51.5 to -53.5	Full Suite	
	C-5-B-190221	2 to 4	-53.5 to -55.5	Full Suite	
	C-5-C-190221	4 to 6	-55.5 to -57.5	Archive	
	C-5-D-190221	6 to 8.5	-57.5 to -60.0	Archive	
	C-5-Z-190221	8.5 to 10.5	-60.0 to -62.0	Archive	
C-6	C-6-A-190219	0 to 2	-53.9 to -55.9	Full Suite	
	C-6-B-190219	2 to 4	-55.9 to -57.9	Full Suite	
	C-6-C-190219	4 to 6.1	-57.9 to -60.0	Archive	
	C-6-Z-190219	6.1 to 8.1	60.0 to -62.0	Archive	
C-7	C-7-A-190221	0 to 2	-50.4 to -52.4	Full Suite	
	C-7-B-190221	2 to 4	-52.4 to -54.4	Full Suite	
	C-7-C-190221	4 to 6	-54.4 to -56.4	Full Suite	
	C-7-D-190221	6 to 8	-56.4 to -58.4	Archive	

Table 4
Core Sampling Intervals and Analysis

Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Round 1 Sampling Status[1]	Round 2 Analyses
	C-7-E-190221	8 to 9.6	-58.4 to -60.0	Archive	
	C-7-Z-190221	9.6 to 11.6	-60.0 to -62.0	Archive	
C-8	C-8-A-190221	0 to 2	-52.0 to -54.0	Full Suite	
	C-8-B-190221	2 to 4	-54.0 to -56.0	Full Suite	
	C-8-C-190221	4 to 6	-56.0 to -58.0	Archive	
	C-8-D-190221	6 to 8	-58.0 to -60.0	Archive	
	C-8-Z-190221	8 to 8.3	-60.0 to -60.3	Archive	
C-9	C-9-A-190220	0 to 2	-53.0 to -55.0	Full Suite	
	C-9-B-190220	2 to 4	-55.0 to -57.0	Full Suite	
	C-9-C-190220	4 to 7	-57.0 to -60.0	Archive	
	C-9-Z-190220	7 to 9	-60.0 to -62.0	Archive	
C-10	C-10-A-190221	0 to 2	-49.0 to -51.0	Full Suite	
	C-10-B-190221	2 to 4	-51.0 to -53.0	Full Suite	
	C-10-C-190221	4 to 6	-53.0 to -55.0	Full Suite	
	C-10-D-190221	6 to 8	-55.0 to -57.0	Archive	
	C-10-E-190221	8 to 11	-57.0 to -60.0	Archive	
	C-10-Z-190221	11 to 13	-60.0 to -62.0	Archive	
C-11	C-11-A-190220	0 to 2	-51.6 to -53.6	Full Suite	
	C-11-B-190220	2 to 4	-53.6 to -55.6	Full Suite	
	C-11-C-190220	4 to 6.3	-55.6 to -57.9	Archive	
	C-11-D-190220	6.3 to 8.4	-57.9 to -60.0	Archive	
	C-11-Z-190220	8.4 to 10.4	-60.0 to -62.0	Archive	
C-12	C-12-A-190223	0 to 2	-22.7 to -24.7	Full Suite	
	C-12-B-190223	2 to 4	-24.7 to -26.7	Full Suite	
	C-12-C-190223	4 to 6	-26.7 to -28.7	Full Suite	
	C-12-D-190223	6 to 8	-28.7 to -30.7	Archive	conventionals and D/F
	C-12-E-190223	8 to 10	-30.7 to -32.7	Archive	conventionals and D/F
	C-12-F-190223	10 to 12	-32.7 to -34.7	Archive	
	C-12-G-190223	12 to 13.7	-34.7 to -36.4	Archive	
C-13	C-13-A-190223	0 to 2	-39.0 to -41	Full Suite	
	C-13-B-190223	2 to 4	-41.0 to -43.0	Full Suite	

Table 4
Core Sampling Intervals and Analysis

Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Round 1 Sampling Status[1]	Round 2 Analyses
	C-13-C-190223	4 to 6	-43.0 to -45.0	Full Suite	
	C-13-D-190223	6 to 8	-45.0 to -47.0	Archive	conventionals and D/F
	C-13-E-190223	8 to 10	-47.0 to -49.0	Archive	conventionals and D/F
	C-13-F-190223	10 to 12	-49.0 to -51.0	Archive	
	C-13-G-190223	12 to 14	-51.0 to -53.0	Archive	
C-14	C-14-A-190221	0 to 2	-52.6 to -54.6	Full Suite	
	C-14-B-190221	2 to 4	-54.6 to -56.6	Full Suite	
	C-14-C-190221	4 to 6	-56.6 to -58.6	Archive	
	C-14-C-190221	6 to 7.4	-58.6 to -60.0	Archive	
	C-14-Z-190221	7.4 to 7.6	-60.0 to -60.6	Archive	
C-15	C-15-A-190222	0 to 2	-45.6 to -47.6	Full Suite	
	C-15-B-190222	2 to 4	-47.6 to -49.6	Full Suite	
	C-15-C-190222	4 to 6	-49.6 to -51.6	Full Suite	
	C-15-D-190222	6 to 8	-51.6 to -53.6	Archive	
	C-15-E-190222	8 to 10	-53.6 to -55.6	Archive	
	C-15-F-190222	10 to 12.3	-55.6 to -57.9	Archive	
C-16	C-16-A-190223	0 to 2	-50.6 to -52.6	Full Suite	
	C-16-B-190223	2 to 4	-52.6 to -54.6	Full Suite	
	C-16-C-190223	4 to 6.5	-54.6 to -57.1	Archive	
C-17	C-17-A-190222	0 to 2	-19.7 to -21.7	Full Suite	
	C-17-B-190222	2 to 4	-21.7 to -23.7	Full Suite	
	C-17-C-190222	4 to 8	-23.7 to -25.7	Full Suite	
	C-17-D-190222	8 to 10	-25.7 to -27.7	Archive	
	C-17-E-190222	10 to 12	-27.7 to -29.7	Archive	
	C-17-F-190222	12 to 14.1	-29.7 to -31.8	Archive	
C-18	C-18-A1-190220	0 to 2.3	-52.2 to -54.5	Full Suite	
	C-18-B1-190220	3.9 to 6.3	-54.5 to -56.9	Full Suite	
C-19	C-19-A-190220	0 to 2	-52.4 to -54.4	Full Suite	
	C-19-B-190220	2 to 4	-54.4 to -56.4	Full Suite	
	C-19-C-190220	4 to 6	-56.4 to -58.4	Archive	
	C-19-D-190220	6 to 7.9	-58.4 to -60.3	Archive	

Table 4
Core Sampling Intervals and Analysis

Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Round 1 Sampling Status[1]	Round 2 Analyses
C-20	C-20-A-190219	0 to 2	-51.3 to -53.3	Full Suite	
	C-20-B-190219	2 to 4	-53.3 to -55.3	Full Suite	
	C-20-C-190219	4 to 6	-55.3 to -57.3	Archive	
	C-20-D-190219	6 to 8.7	-57.3 to -60.0	Archive	
	C-20-Z-190219	8.7 to 10.6	-60.0 to -61.9	Archive	
C-21	C-21-A-190219	0 to 2	-53.7 to -55.7	Full Suite	
	C-21-B-190219	2 to 4	-55.7 to -57.7	Full Suite	
	C-21-C-190219	4 to 6.3	-57.7 to -60.0	Archive	
	C-21-Z-190219	6.3 to 8.3	-60.0 to -62.0	Archive	
C-22	C-22-A-190219	0 to 2	-51.0 to -53.0	Full Suite	
	C-22-B-190219	2 to 4	-53.0 to -55.0	Full Suite	
	C-22-C-190219	4 to 6	-55.0 to -57.0	Archive	
	C-22-D-190219	6 to 9	-57.0 to -60.0	Archive	
	C-22-Z-190219	9 to 11	-60.0 to -62.0	Archive	
C-23	C-23-A1-190222	0 to 2	-53.7 to -55.7	Full Suite	
	C-23-B1-190222	2 to 4	-55.7 to -57.7	Full Suite	
C-24	C-24-A-190223	0 to 2	-51.1 to -53.1	Full Suite	
	C-24-B-190223	2 to 4	-53.1 to -55.1	Full Suite	
	C-24-C-190223	4 to 6.6	-55.1 to -57.7	Archive	
C-25	C-25-A-190222	0 to 2	-51.4 to -53.4	Full Suite	
	C-25-B-190222	2 to 4	-53.4 to -55.4	Full Suite	
	C-25-C-190222	4 to 6	-55.4 to -57.4	Archive	
	C-25-D-190222	6 to 8.6	-57.4 to -60.0	Archive	
	C-25-Z-190222	8.6 to 9.3	-60.0 to -60.7	Archive	

Notes:

1. The full suite of testing parameters include semivolatile organic compounds, polycyclic aromatic hydrocarbons, pesticides, polychlorinated biphenyls, metals, sulfide, ammonia, total organic carbon, grain size, total volatile solids, and total solids, dioxins and furans, and tributytin.

MLLW: mean lower low water

Table 5
Sample Results Summary - Conventionals and Physical Tests

Analyte	Method	C-1-A-190219 (0 - 2 ft)	C-1-B-190219 (2 - 4 ft)	C-1-C-190219 (4 - 6 ft)	C-2-A-190219 (0 - 2 ft)	C-2-B-190219 (2 - 4 ft)	C-2-C-190219 (4 - 6 ft)	C-2-D-190219 (6 - 8.6 ft)	C-3-A-190218 (0 - 2.7 ft)	C-3-B-190218 (2.7 - 5.8 ft)	C-4-A-190218 (0 - 2 ft)
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	SM4500NH3H	**2.09**	**0.81**	**0.68**	**2.64**	**2.24**	--	--	**3.01**	**8.74**	**0.63**
Sulfide	SM4500S2D	**388**	**104**	**93.3**	**117**	**1.89**	--	--	**529**	**115**	**29.6**
Conventional Parameters (%)											
Total organic carbon	SW9060A	**0.71**	**0.21**	**0.09**	**0.37**	**0.26**	**1.03**	**0.45**	**0.49**	**0.27**	**0.15**
Total solids	SM2540G	**71.88**	**80.16**	**78.63**	**74.57**	**78.53**	**73.42**	**80.56**	**68.43**	**77.92**	**78.72**
Total volatile solids	PSEP-TVS	**2.4**	**1.34**	**1.23**	**1.88**	**1.45**	--	--	**2.1**	**1.56**	**1.35**
Grain Size (%)											
Gravel	PSEP-PS	**0**	**0.3**	**0**	**0.5**	**0.1**	**0.4**	**0.5**	**0**	**0.1**	**0.1**
Sand, very coarse	PSEP-PS	**0.2**	**0.6**	**0.7**	**0.5**	**0.9**	**0.7**	**0.9**	**0.7**	**0.1**	**0.2**
Sand, coarse	PSEP-PS	**3.1**	**9.1**	**8.9**	**7**	**12.9**	**2.9**	**6.2**	**3.2**	**0.2**	**3.3**
Sand, medium	PSEP-PS	**12.5**	**33.4**	**38.9**	**28.6**	**38.4**	**17.6**	**32.3**	**8.3**	**1**	**25**
Sand, fine	PSEP-PS	**13.6**	**25.1**	**31.1**	**24.8**	**18.7**	**36.8**	**38.7**	**15.8**	**26.5**	**46**
Sand, very fine	PSEP-PS	**12.5**	**12.4**	**10.4**	**11.1**	**5.1**	**20.7**	**9.4**	**16**	**42.4**	**16**
Total Sand	PSEP-PS	**41.9**	**80.6**	**90**	**72**	**76**	**78.7**	**87.5**	**44**	**70.2**	**90.5**
Silt, coarse	PSEP-PS	**12.9**	**5.3**	**3.7**	**7.3**	**6.1**	**9.3**	**3.8**	**11.2**	**8**	**4.3**
Silt, medium	PSEP-PS	**14.3**	**4.6**	**1.8**	**6**	**6.7**	**4.5**	**2.5**	**12.9**	**8.6**	**1.3**
Silt, fine	PSEP-PS	**11**	**3.3**	**1.4**	**4.8**	**4.5**	**2.3**	**1.7**	**11.1**	**3.3**	**1**
Silt, very fine	PSEP-PS	**5.6**	**1.6**	**0.7**	**2.6**	**2.5**	**1.4**	**1.1**	**4.7**	**2.4**	**0.5**
Clay, coarse	PSEP-PS	**4.2**	**1.2**	**0.6**	**1.8**	**1.3**	**0.9**	**0.8**	**4.6**	**2**	**0.5**
Clay, medium	PSEP-PS	**3**	**0.9**	**0.4**	**1.5**	**0.8**	**0.7**	**0.5**	**3.6**	**1.6**	**0.4**
Clay, fine	PSEP-PS	**6.9**	**2.2**	**1.3**	**3.5**	**2**	**1.8**	**1.5**	**7.8**	**3.8**	**1.4**
Total Fines	PSEP-PS	**57.9**	**19.1**	**9.9**	**27.5**	**23.9**	**20.9**	**11.9**	**55.9**	**29.7**	**9.4**

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 5
Sample Results Summary - Conventionals and Physical Tests

Analyte / Sample ID / Depth	C-4-B-190218	C-5-A-190221	C-5-B-190221	C-6-A-190219	C-6-B-190219	C-7-A-190221	C-7-B-190221	C-7-C-190221	C-8-A-190221	C-8-B-190221	C-9-A-190220
Depth	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	4 - 6 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	0.5 U	**3.9**	**14.8**	0.41 U	**1.58**	**4.01**	**1.06**	**1.18**	**6.98**	**27.9**	**5.97**
Sulfide	**8.33**	**32.9**	**6.35**	**13.5**	1.11 U	**258**	**7.28**	0.887 U	**153**	**4.52**	0.984 U
Conventional Parameters (%)											
Total organic carbon	**0.12**	**0.28**	**0.74 J**	**0.22**	**0.71**	**0.55**	**0.44**	**0.2**	**0.54**	**0.39**	**0.11**
Total solids	**79.07**	**80.52**	**74.08**	**90.85**	**77.91**	**60.4**	**79.72**	**81.42**	**74.91**	**74.88**	**84.21**
Total volatile solids	**1.07**	**3.39**	**2.45**	**1.36**	**2.26**	**1.33**	**1.57**	**1.28**	**1.95**	**2.13**	**0.92**
Grain Size (%)											
Gravel	**0.3**	**0.1**	**0.5**	**1.1**	**0.5**	**0.4**	**0.3**	**0.2**	**3.6**	**0**	**0.1**
Sand, very coarse	**0.3**	**0.7**	**2.2**	**1**	**0.9**	**0.4**	**0.9**	**0.4**	**0.6**	**0.2**	**0.5**
Sand, coarse	**5.2**	**8.4**	**14.2**	**16.9**	**4.5**	**2.5**	**4.4**	**2.9**	**2**	**0.3**	**8.4**
Sand, medium	**34.2**	**28.9**	**19.1**	**51**	**34.4**	**21.9**	**36.5**	**26.4**	**7**	**0.4**	**35.9**
Sand, fine	**45.5**	**26.2**	**18.7**	**21.5**	**42.8**	**28**	**44.9**	**49.2**	**14.8**	**1.4**	**33**
Sand, very fine	**10.3**	**11.5**	**16.6**	**3.7**	**11.3**	**11.3**	**6.9**	**13.9**	**18.7**	**8.4**	**9.3**
Total Sand	**95.5**	**75.7**	**70.8**	**94.1**	**93.9**	**64.1**	**93.6**	**92.8**	**43.1**	**10.7**	**87.1**
Silt, coarse	4.1 U	**8.5**	**9.6**	**1.4**	**1.1**	**7.9**	**1.5**	**3.1**	**16.3**	**17.7**	**3.8**
Silt, medium	4.1 U	**5.4**	**8**	**1**	**1.2**	**8.4**	**1.1**	**1.1**	**11.7**	**24.6**	**3**
Silt, fine	4.1 U	**3.4**	**3.8**	**0.7**	**1**	**6.3**	**0.8**	**0.6**	**8.1**	**17.4**	**2.3**
Silt, very fine	4.1 U	**2.1**	**2**	**0.4**	**0.5**	**3.9**	**0.6**	**0.3**	**5**	**10.4**	**1.1**
Clay, coarse	4.1 U	**1.4**	**1.4**	**0.4**	**0.2**	**2.8**	**0.5**	**0.4**	**3.5**	**5.8**	**0.5**
Clay, medium	4.1 U	**0.9**	**1**	**0.3**	**0.3**	**1.8**	**0.3**	**0.2**	**2.4**	**4.1**	**0.4**
Clay, fine	4.1 U	**2.5**	**2.7**	**0.7**	**1.2**	**4.6**	**1.4**	**1.2**	**6.4**	**9.3**	**1.5**
Total Fines	4.1 U	**24.2**	**28.5**	**4.9**	**5.5**	**35.7**	**6.2**	**6.9**	**53.4**	**89.3**	**12.6**

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 5
Sample Results Summary - Conventionals and Physical Tests

Sample ID / Depth / Analyte	C-9-B-190220 2 - 4 ft	C-10-A-190221 0 - 2 ft	C-10-B-190221 2 - 4 ft	C-10-C-190221 4 - 6 ft	C-11-A-190220 0 - 2 ft	C-11-B-190220 2 - 4 ft	C-12-A-190223 0 - 2 ft	C-12-B-190223 2 - 4 ft	C-12-C-190223 4 - 6 ft	C-12-D-190223 6 - 8 ft	C-12-E-190223 8 - 10 ft
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	**36.4**	**8.44**	**8.05**	**11.9**	**4.27**	**0.95**	**3.31**	**4.36**	**12**	--	--
Sulfide	1.03 U	**627**	**592**	0.989 U	**605**	1.12 U	**57.1**	**104**	**113**	--	--
Conventional Parameters (%)											
Total organic carbon	**0.19**	**1.01**	**0.45**	**0.19**	**0.86**	**0.14**	**0.61 J**	**0.37 J**	**0.75 J**	**0.1**	**0.21**
Total solids	**78.65**	**66.64**	**73.29**	**99.27**	**68.52**	**80.63**	**72.61**	**74.39**	**75.94**	**82.52**	**81.81**
Total volatile solids	**1.34**	**2.88**	**1.92**	**1.67**	**2.45**	**1.06**	**2.13**	**2.08**	**1.86**	--	--
Grain Size (%)											
Gravel	**0.2**	**0.7**	**0.1**	**0.2**	**0.2**	**0.3**	**3.5**	**2.9**	**0.6**	**2.8**	**13.7**
Sand, very coarse	**0.3**	**0.2**	**0.2**	**0.5**	**0.4**	**0.3**	**2.5**	**1.8**	**0.5**	**4**	**13.9**
Sand, coarse	**2.7**	**0.9**	**2.1**	**6.5**	**2.5**	**3.9**	**14.5**	**8.5**	**3.5**	**34**	**26.5**
Sand, medium	**9.2**	**5**	**7.2**	**19.8**	**12.5**	**35.6**	**16.9**	**14.2**	**10.5**	**29.5**	**15.9**
Sand, fine	**22**	**12.9**	**15.5**	**20.1**	**20.1**	**43.9**	**13.1**	**17**	**18.8**	**11.8**	**10.6**
Sand, very fine	**28.6**	**12.9**	**19.7**	**12.8**	**12.1**	**9.4**	**10.7**	**12.9**	**15.1**	**4.6**	**8.8**
Total Sand	**62.8**	**31.9**	**44.7**	**59.7**	**47.6**	**93.1**	**57.7**	**54.4**	**48.4**	**83.9**	**75.7**
Silt, coarse	**9.3**	**13.8**	**14.3**	**9.7**	**10.7**	**2**	**9.7**	**9.2**	**10.5**	**3.2**	**3.5**
Silt, medium	**9.2**	**14.5**	**13.5**	**8.9**	**14.2**	**1.1**	**8.2**	**9.9**	**13.3**	**2.7**	**1.7**
Silt, fine	**7.6**	**13.4**	**9.9**	**7.1**	**11.9**	**0.7**	**6.2**	**7.4**	**8.7**	**2.2**	**1.5**
Silt, very fine	**3.5**	**7.5**	**5.1**	**4.1**	**5.8**	**0.6**	**3.9**	**4.6**	**5.5**	**1.5**	**1.2**
Clay, coarse	**2.4**	**5.7**	**3.7**	**3**	**3**	**0.4**	**2.9**	**3.3**	**3.6**	**1.1**	**0.9**
Clay, medium	**1.5**	**3.4**	**2.1**	**1.9**	**1.7**	**0.3**	**2.5**	**2.6**	**2.9**	**0.8**	**0.7**
Clay, fine	**3.3**	**9.2**	**6.7**	**5.5**	**4.9**	**1.5**	**5.4**	**5.7**	**6.4**	**1.8**	**1.1**
Total Fines	**36.8**	**67.5**	**55.3**	**40.2**	**52.2**	**6.6**	**38.8**	**42.7**	**50.9**	**13.3**	**10.6**

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 5

Sample Results Summary - Conventionals and Physical Tests

Sample ID / Depth / Analyte	C-13-A-190223 0 - 2 ft	C-13-B-190223 2 - 4 ft	C-13-C-190223 4 - 6 ft	C-13-D-190223 6 - 8 ft	C-13-E-190223 8 - 10 ft	C-14-A-190221 0 - 2 ft	C-14-B-190221 2 - 4 ft	C-15-A-190222 0 - 2 ft	C-15-B-190222 2 - 4 ft	C-15-C-190222 4 - 6 ft	C-16-A-190223 0 - 2 ft
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	**4.85**	**19.3**	**23.8**	--	--	**8.62**	**20.3**	**2.33**	**2.08**	**2.4**	**2.82**
Sulfide	**402**	**339**	**5.5**	--	--	**11.4**	1.1 U	**224**	1.12 U	1.07 U	**203**
Conventional Parameters (%)											
Total organic carbon	**0.59 J**	**0.39 J**	**0.18 J**	**0.19**	**0.04**	**0.09**	**0.15**	**0.25 J**	**0.1 J**	**0.17 J**	**0.25 J**
Total solids	**77.45**	**74.72**	**83.95**	**84.57**	**85.03**	**86.15**	**84.18**	**75.49**	**82.44**	**83.22**	**94.31**
Total volatile solids	**1.73**	**1.92**	**1.12**	--	--	**0.88**	**1.27**	**1.69**	**1.08**	**1.23**	**18.98**
Grain Size (%)											
Gravel	**24.4**	**0.9**	**4.4**	**7.9**	**0.2**	**10.8**	**1.2**	**4.3**	**6.5**	**1.1**	**1.4**
Sand, very coarse	**3.6**	**1.5**	**3.8**	**4**	**1.7**	**6.9**	**3.8**	**3**	**5.9**	**3.5**	**1.8**
Sand, coarse	**10.1**	**8.6**	**16.1**	**18.5**	**18.5**	**25.9**	**16.9**	**14.2**	**21.2**	**19.6**	**13.3**
Sand, medium	**19.6**	**18.8**	**33.2**	**35.9**	**56.2**	**34.3**	**34.1**	**31.2**	**37.9**	**38.7**	**40.7**
Sand, fine	**14.8**	**15.4**	**20**	**14.9**	**19.9**	**15.3**	**23.5**	**22.3**	**16.9**	**20.9**	**18.7**
Sand, very fine	**6.5**	**12.5**	**8.1**	**3.4**	**1.4**	**2.9**	**6.9**	**8.5**	**4.7**	**5.8**	**5.7**
Total Sand	**54.6**	**56.8**	**81.2**	**76.7**	**97.7**	**85.3**	**85.2**	**79.2**	**86.6**	**88.5**	**80.2**
Silt, coarse	**4.2**	**9.7**	**4.7**	**1.6**	2 U	**0.7**	**4.6**	**3.2**	**2.3**	**2.8**	**3.8**
Silt, medium	**4.3**	**9**	**2.6**	**3.6**	2 U	**0.5**	**2.5**	**3.6**	**1.1**	**1.9**	**3.4**
Silt, fine	**4.5**	**7.2**	**2.1**	**3.3**	2 U	**0.6**	**1.8**	**4.1**	**0.8**	**1.4**	**4.1**
Silt, very fine	**2**	**4.2**	**1.5**	**2.4**	2 U	**0.5**	**1.3**	**1.4**	**0.8**	**1.1**	**1.9**
Clay, coarse	**1.7**	**3.6**	**0.9**	**1.4**	2 U	**0.5**	**1**	**0.9**	**0.4**	**0.9**	**1.3**
Clay, medium	**1.5**	**2.7**	**0.7**	**1**	2 U	**0.3**	**0.8**	**0.8**	**0.4**	**0.6**	**1.2**
Clay, fine	**2.9**	**5.8**	**1.8**	**2**	2 U	**0.7**	**1.8**	**2.3**	**1.2**	**1.7**	**2.6**
Total Fines	**21.1**	**42.2**	**14.3**	**15.3**	2 U	**3.8**	**13.8**	**16.3**	**7**	**10.4**	**18.3**

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 5
Sample Results Summary - Conventionals and Physical Tests

Sample ID / Depth / Analyte	C-16-B-190223	C-17-A-190222	C-17-B-190222	C-17-C-190222	C-18-A1-190220	C-18-B1-190220	C-19-A-190220	C-19-B-190220	C-20-A-190219	C-20-B-190219	C-21-A-190219
Depth	2 - 4 ft	0 - 2 ft	2 - 4 ft	4 - 8 ft	0 - 2.3 ft	3.9 - 6.3 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	**1.8**	**9.64**	**24.6**	**21.8**	**1.73**	**0.88**	**0.41**	**0.62**	**3.61**	**3.17**	0.44 U
Sulfide	1.11 U	**491**	1.73 U	1.07 U	**98.7**	0.97 U	1.01 U	**4.57**	**27.1**	1.01 U	**7.09**
Conventional Parameters (%)											
Total organic carbon	**0.05 J**	**0.83 J**	**3.24 J**	**0.39 J**	**0.29 J**	**0.13 J**	**0.09**	**0.1**	**0.08**	**0.04**	**0.49**
Total solids	**82.56**	**66.23**	**52.51**	**72.42**	**79.18**	**89.34**	**96.68**	**84.76**	**83.46**	**88.17**	**86.32**
Total volatile solids	**0.98**	**3.54**	**9.48**	**6.55**	**1.34**	**1.55**	**0.85**	**1.11**	**0.96**	**0.96**	**1.72**
Grain Size (%)											
Gravel	**1.5**	**0**	**0.2**	**0**	**1.1**	**3.1**	**2.1**	**2.5**	**1.1**	**4.7**	**1.1**
Sand, very coarse	**4.1**	**0.8**	**3.1**	**0.1**	**3.7**	**9.1**	**8.8**	**7**	**7.2**	**9.7**	**4.1**
Sand, coarse	**20.2**	**1.3**	**1.7**	**0.4**	**21.6**	**33.5**	**40.9**	**25.7**	**31**	**46.7**	**17.2**
Sand, medium	**55.6**	**2.1**	**1.7**	**1.5**	**36.5**	**44.3**	**33.7**	**33.7**	**32.6**	**31.8**	**43.2**
Sand, fine	**14.1**	**2.5**	**2.4**	**5.6**	**14.9**	**7.3**	**10.4**	**17.7**	**15.4**	**5.5**	**31.1**
Sand, very fine	**1.6**	**3.3**	**5.2**	**21.7**	**4.8**	**0.6**	**1.6**	**3.6**	**6.1**	**0.5**	**2.1**
Total Sand	**95.6**	**10**	**14.1**	**29.3**	**81.5**	**94.8**	**95.4**	**87.7**	**92.3**	**94.2**	**97.7**
Silt, coarse	2.8 U	**5.5**	**6.8**	**20.2**	**3.8**	2 U	2.4 U	**2.3**	**2.5**	1.2 U	1.3 U
Silt, medium	2.8 U	**12.9**	**13.7**	**18.6**	**3.7**	2 U	2.4 U	**2.5**	**1.2**	1.2 U	1.3 U
Silt, fine	2.8 U	**18.7**	**18.5**	**11.3**	**3**	2 U	2.4 U	**1.8**	**0.8**	1.2 U	1.3 U
Silt, very fine	2.8 U	**19.4**	**17**	**7.2**	**2.3**	2 U	2.4 U	**0.9**	**0.5**	1.2 U	1.3 U
Clay, coarse	2.8 U	**13.6**	**10.9**	**4.5**	**1.4**	2 U	2.4 U	**0.5**	**0.4**	1.2 U	1.3 U
Clay, medium	2.8 U	**7.6**	**6.9**	**2.8**	**1.2**	2 U	2.4 U	**0.3**	**0.3**	1.2 U	1.3 U
Clay, fine	2.8 U	**12.2**	**12**	**6**	**2**	2 U	2.4 U	**1.4**	**1**	1.2 U	1.3 U
Total Fines	2.8 U	**89.9**	**85.8**	**70.6**	**17.4**	2 U	2.4 U	**9.7**	**6.7**	1.2 U	1.3 U

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 5
Sample Results Summary - Conventionals and Physical Tests

Sample ID / Depth / Analyte	C-21-B-190219	C-22-A-190219	C-22-B-190219	C-23-A1-190222	C-23-B1-190222	C-24-A-190223	C-24-B-190223	C-25-A-190222	C-25-B-190222
Depth	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Conventional Parameters (mg/kg)									
Ammonia as nitrogen	0.45 U	**1.95**	**2.19**	0.41 U	0.38 U	**1.68**	**1.79**	**36.7**	**41.9**
Sulfide	1.19 U	1.01 U	1.07 U	1.01 U	1.07 U	**1.76**	1 U	1.31 U	1.17 U
Conventional Parameters (%)									
Total organic carbon	**0.11**	**0.07**	**0.04**	**0.07**	**0.04**	**0.06 J**	**0.04 J**	**0.29 J**	**0.44 J**
Total solids	**87**	**91.38**	**90.92**	**91.48**	**90.58**	**84.92**	**90.11**	**77.35**	**75.07**
Total volatile solids	**1.1**	**0.83**	**0.93**	**1.01**	**0.83**	**1.05**	**0.98**	**1.66**	**2.67**
Grain Size (%)									
Gravel	**0.4**	**0.4**	**0.4**	**2.6**	**4.1**	**15.3**	**4.5**	**0.1**	**0.5**
Sand, very coarse	**4.2**	**2.2**	**2.4**	**11.4**	**13.8**	**13.7**	**18.3**	**0.4**	**0.5**
Sand, coarse	**17.3**	**19.9**	**22.9**	**42.4**	**48.7**	**26.9**	**33**	**2**	**2.8**
Sand, medium	**43.5**	**45.3**	**47.6**	**32.9**	**26.9**	**26.7**	**34.2**	**5.3**	**31.1**
Sand, fine	**30.5**	**25.3**	**22.5**	**5.4**	**3.7**	**9.5**	**7.9**	**6.9**	**24.2**
Sand, very fine	**1.6**	**2.6**	**2.1**	**0.8**	**0.6**	**2.4**	**0.6**	**9.6**	**5.9**
Total Sand	**97.1**	**95.3**	**97.5**	**92.9**	**93.7**	**79.2**	**94**	**24.2**	**64.5**
Silt, coarse	2.5 U	**1.4**	2 U	**0.9**	2.1 U	**1.1**	1.4 U	**19.7**	**6.2**
Silt, medium	2.5 U	**0.9**	2 U	**0.6**	2.1 U	**1**	1.4 U	**25.3**	**12.2**
Silt, fine	2.5 U	**0.8**	2 U	**0.9**	2.1 U	**0.9**	1.4 U	**13.8**	**6.9**
Silt, very fine	2.5 U	**0.3**	2 U	**0.7**	2.1 U	**0.7**	1.4 U	**6.4**	**3.6**
Clay, coarse	2.5 U	**0.2**	2 U	**0.5**	2.1 U	**0.5**	1.4 U	**3.1**	**1.9**
Clay, medium	2.5 U	**0.1**	2 U	**0.2**	2.1 U	**0.4**	1.4 U	**2.2**	**1.4**
Clay, fine	2.5 U	**0.6**	2 U	**0.5**	2.1 U	**1.1**	1.4 U	**5.3**	**2.9**
Total Fines	2.5 U	**4.3**	2 U	**4.3**	2.1 U	**5.7**	1.4 U	**75.8**	**35.1**

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	DMMP SL	DMMP BT	C-1-A-190219 0 - 2 ft	C-1-B-190219 2 - 4 ft	C-1-C-190219 4 - 6 ft	C-2-A-190219 0 - 2 ft	C-2-B-190219 2 - 4 ft	C-2-C-190219 4 - 6 ft	C-2-D-190219 6 - 8.6 ft
Metals (mg/kg)									
Antimony	150	--	0.28 UJ	0.23 UJ	0.23 UJ	0.25 UJ	0.24 UJ	--	--
Arsenic	57	507.1	**3.24**	**1.67**	**1.06**	**4.97**	**1.95**	--	--
Cadmium	5.1	--	**0.09 J**	0.11 U	0.12 U	**0.05 J**	**0.05 J**	--	--
Chromium	260	--	**14.7**	**11**	**9.49**	**12.5**	**12.7**	--	--
Copper	390	--	**26.7**	**13.7**	**10.3**	**18.3**	**16.6**	--	--
Lead	450	975	**6.01**	**2.33**	**1.33**	**3.46**	**2.15**	--	--
Mercury	0.41	1.5	**0.0423**	**0.025**	**0.0114 J**	**0.0249 J**	**0.0167 J**	--	--
Selenium	--	3	**0.97**	**0.72**	**0.69**	**0.95**	**1.11**	--	--
Silver	6.1	--	**0.12 J**	**0.06 J**	**0.03 J**	**0.08 J**	**0.05 J**	--	--
Zinc	410	--	**33.3**	**19.3**	**14.9**	**27**	**23.7**	--	--
Organometallic Compounds (µg/kg)									
Tributyltin (ion)	--	73	**0.913 J**	3.42 U	3.49 U	**7.35**	**17.3**	3.6 U	3.43 U
Semivolatile Organics (µg/kg)									
1,2,4-Trichlorobenzene	31	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
1,2-Dichlorobenzene	35	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
1,4-Dichlorobenzene	110	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
2,4-Dimethylphenol	29	--	24.9 UJ	24 UJ	24.1 UJ	24.4 UJ	24.3 UJ	--	--
2-Methylphenol (o-Cresol)	63	--	**3 J**	4.8 U	4.8 U	4.9 U	4.9 U	--	--
4-Methylphenol (p-Cresol)	670	--	**5**	4.8 U	4.8 U	**2.9 J**	4.9 U	--	--
Benzoic acid	650	--	**84.7 J**	95.9 UJ	96.3 UJ	97.5 UJ	97 UJ	--	--
Benzyl alcohol	57	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
bis(2-Ethylhexyl)phthalate	1300	--	49.8 U	47.9 U	48.2 U	48.8 U	48.5 U	--	--
Butylbenzyl phthalate	63	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Diethyl phthalate	200	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Dimethyl phthalate	71	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
Di-n-butyl phthalate	1400	--	**37.3**	**22.5**	**22.4**	**40.6**	**14.9 J**	--	--
Di-n-octyl phthalate	6200	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Hexachlorobenzene	22	168	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
Hexachlorobutadiene	11	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
n-Nitrosodiphenylamine	28	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
Pentachlorophenol	400	504	19.9 UJ	19.2 UJ	19.3 UJ	19.5 UJ	19.4 UJ	--	--
Phenol	420	--	13.5 U	4.8 U	4.8 U	7.8 U	4.9 U	--	--
Polycyclic Aromatic Hydrocarbons (µg/kg)									
2-Methylnaphthalene	670	--	**24.7**	**8.6 J**	19.3 U	19.5 U	**6.4 J**	--	--
Acenaphthene	500	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Acenaphthylene	560	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Anthracene	960	--	**14.8 J**	19.2 U	19.3 U	**7.7 J**	19.4 U	--	--
Benzo(a)anthracene	1300	--	**24.1**	**16.6 J**	19.3 U	**17.5 J**	**5.2 J**	--	--
Benzo(a)pyrene	1600	--	**20.3**	**16.7 J**	19.3 U	**16.3 J**	19.4 U	--	--
Benzo(b,j,k)fluoranthenes	--	--	**57.7**	**35.3 J**	38.5 U	**38.8 J**	38.8 U	--	--
Benzo(g,h,i)perylene	670	--	**14.6 J**	**8 J**	19.3 U	**10.1 J**	19.4 U	--	--
Chrysene	1400	--	**37.5**	**21.2**	19.3 U	**24**	**6.7 J**	--	--
Dibenzo(a,h)anthracene	230	--	**4.4 J**	**3.7 J**	4.8 U	**2.7 J**	4.9 U	--	--
Dibenzofuran	540	--	**8.7 J**	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Fluoranthene	1700	4600	**47.4**	**22**	19.3 U	**32.1**	**7.7 J**	--	--
Fluorene	540	--	**8.3 J**	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Indeno(1,2,3-c,d)pyrene	600	--	**13.4 J**	**7.4 J**	19.3 U	**8.3 J**	19.4 U	--	--
Naphthalene	2100	--	**21.5**	**8.7 J**	19.3 U	**11.7 J**	**5.3 J**	--	--
Phenanthrene	1500	--	**45.7**	**13.6 J**	19.3 U	**24.9**	**13 J**	--	--
Pyrene	2600	11980	**61.5**	**27.1**	19.3 U	**39.5**	**9.3 J**	--	--
Total Benzofluoranthenes (b,j,k) (U = 0)	3200	--	**57.7**	**35.3 J**	38.5 U	**38.8 J**	38.8 U	--	--
Total HPAH (DMMP) (U = 0)[1]	12000	--	**280.9 J**	**158 J**	38.5 U	**189.3 J**	**28.9 J**	--	--
Total LPAH (DMMP) (U = 0)[2]	5200	--	**90.3 J**	**22.3 J**	19.3 U	**44.3 J**	**18.3 J**	--	--
Total PAH (DMMP) (U = 0)	--	--	**371.2 J**	**180.3 J**	38.5 U	**233.6 J**	**47.2 J**	--	--
Pesticides (µg/kg)[3]									
4,4'-DDD (p,p'-DDD)	16	--	0.31 U	0.31 U	0.32 U	0.32 U	0.32 U	--	--
4,4'-DDE (p,p'-DDE)	9	--	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	--	--
4,4'-DDT (p,p'-DDT)	12	--	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	--	--
Aldrin	9.5	--	0.36 U	0.36 U	0.36 U	0.37 U	0.37 U	--	--
Chlordane, alpha- (Chlordane, cis-)	--	--	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	--	--
Chlordane, beta- (Chlordane, trans-)	--	--	2.04 U	0.97 U	0.32 U	0.33 U	0.32 U	--	--
Dieldrin	1.9	--	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	--	--
Heptachlor	1.5	--	0.05 U	0.04 U	0.05 U	0.05 U	0.05 U	--	--
Nonachlor, cis-	--	--	0.2 U	0.2 U	0.21 U	0.21 U	0.21 U	--	--
Nonachlor, trans-	--	--	0.22 U	0.22 U	0.22 U	0.23 U	0.23 U	--	--
Oxychlordane	--	--	0.12 U	0.12 U	0.13 U	0.13 U	0.13 U	--	--
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	--	50	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	--	--
Total DMMP Chlordane (U = 0)[5]	2.8	37	2.04 U	0.97 U	0.32 U	0.33 U	0.32 U	--	--
PCB Aroclors (µg/kg)									
Aroclor 1016	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1221	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1232	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1242	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1248	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1254	--	--	**3 J**	3.9 U	4 U	**2 J**	4 U	--	--
Aroclor 1260	--	--	**2.1 J**	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1262	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1268	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Total DMMP PCB Aroclors (U = 0)	130	--	**5.1 J**	3.9 U	4 U	**2 J**	4 U	--	--
PCB Aroclors (mg/kg-OC)[6]									
Total DMMP PCB Aroclors (U = 0)	--	38	**0.72 J**	1.86 U	4.44 U	**0.54 J**	1.54 U	--	--

Notes:

(yellow)	Detected concentration is greater than DMMP SL screening level
(orange)	Detected concentration is greater than DMMP BT screening level
(blue)	Non-detected concentration is above one or more identified screening levels
(gray)	TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	C-3-A-190218 0 - 2.7 ft	C-3-B-190218 2.7 - 5.8 ft	C-4-A-190218 0 - 2 ft	C-4-B-190218 2 - 4 ft	C-5-A-190221 0 - 2 ft	C-5-B-190221 2 - 4 ft	C-6-A-190219 0 - 2 ft	C-6-B-190219 2 - 4 ft
Metals (mg/kg)								
Antimony	0.29 UJ	0.25 UJ	0.25 UJ	0.24 UJ	0.23 UJ	0.25 UJ	0.21 UJ	0.26 UJ
Arsenic	**3.7**	**1.77**	**1.12**	**1.01**	**1.59**	**1.63**	**1.14**	**1.41**
Cadmium	**0.06 J**	0.12 U	0.12 U	0.12 U	**0.04 J**	**0.05 J**	**0.12**	0.13 U
Chromium	**12.3**	**10.9**	**11.8**	**10.8**	**11.3**	**12.7**	**9.11**	**11.1**
Copper	**25.5**	**14.9**	**11.9**	**10.8**	**14.4**	**16.9**	**10.3**	**15.6**
Lead	**6.26**	**1.55**	**1.26**	**1.21**	**2.25**	**1.86**	**1.42**	**1.46**
Mercury	**0.0599 J**	0.0231 UJ	0.026 UJ	0.0254 UJ	0.0269 U	0.0227 U	0.0241 U	**0.00982 J**
Selenium	**0.93**	**0.81**	0.61 U	**0.77**	**0.79**	**0.76**	**0.77**	**0.74**
Silver	**0.12 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.06 J**	**0.06 J**	**0.04 J**	**0.06 J**
Zinc	**34.4**	**19.9**	**20**	**19.4**	**21.1**	**24**	**17.9**	**18.8**
Organometallic Compounds (µg/kg)								
Tributyltin (ion)	**2.16 J**	3.54 UJ	3.49 UJ	3.79 UJ	**0.768 J**	3.48 U	**1.05 J**	**0.477 J**
Semivolatile Organics (µg/kg)								
1,2,4-Trichlorobenzene	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
1,2-Dichlorobenzene	4.8 U	4.9 U	4.9 U	4.7 U	5 U	**0.9 J**	5 U	4.9 U
1,4-Dichlorobenzene	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
2,4-Dimethylphenol	24.1 UJ	24.6 UJ	24.3 UJ	23.6 UJ	24.9 U	24.4 U	24.8 UJ	24.6 UJ
2-Methylphenol (o-Cresol)	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
4-Methylphenol (p-Cresol)	**5.4**	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
Benzoic acid	**85.1 J**	**15.8 J**	**16.8 J**	94.3 UJ	**21.2 J**	**56.2 J**	99.1 UJ	**37.8 J**
Benzyl alcohol	**13.4 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
bis(2-Ethylhexyl)phthalate	**29.5 J**	49.2 U	48.6 U	47.1 U	49.8 U	48.9 U	49.5 U	49.2 U
Butylbenzyl phthalate	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Diethyl phthalate	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Dimethyl phthalate	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
Di-n-butyl phthalate	**118**	**69.7**	**96.1**	**108**	19.9 U	23.3 U	**43.4**	**56.1**
Di-n-octyl phthalate	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Hexachlorobenzene	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
Hexachlorobutadiene	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
n-Nitrosodiphenylamine	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
Pentachlorophenol	19.3 UJ	19.7 UJ	19.4 UJ	18.9 UJ	**5.4 J**	**5.5 J**	19.8 UJ	19.7 UJ
Phenol	**30**	6.1 U	5.6 U	4.7 U	6.4 U	8.1 U	5 U	6.4 U
Polycyclic Aromatic Hydrocarbons (µg/kg)								
2-Methylnaphthalene	**18.4 J**	**8 J**	19.4 U	18.9 U	19.9 U	**17.2 J**	19.8 U	**21.3**
Acenaphthene	**7 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Acenaphthylene	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Anthracene	**13.9 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Benzo(a)anthracene	**20.7**	19.7 U	19.4 U	18.9 U	**7.4 J**	**5.2 J**	19.8 U	19.7 U
Benzo(a)pyrene	**26.8**	19.7 U	19.4 U	18.9 U	**8.5 J**	19.5 U	19.8 U	19.7 U
Benzo(b,j,k)fluoranthenes	**75.9**	39.4 U	38.9 U	37.7 U	**26.9 J**	39.1 U	39.6 U	39.3 U
Benzo(g,h,i)perylene	**20.1**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Chrysene	**34.4**	**5.3 J**	19.4 U	18.9 U	**11.7 J**	**7.1 J**	19.8 U	**7.4 J**
Dibenzo(a,h)anthracene	**7.6**	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
Dibenzofuran	**12 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	**5.4 J**
Fluoranthene	**38.3**	19.7 U	19.4 U	18.9 U	**11.9 J**	19.5 U	19.8 U	19.7 U
Fluorene	**11 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Indeno(1,2,3-c,d)pyrene	**16.7 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Naphthalene	**31**	19.7 U	19.4 U	18.9 U	19.9 U	**7.9 J**	19.8 U	**11.1 J**
Phenanthrene	**36.9**	**13 J**	**5.9 J**	18.9 U	**12.9 J**	**19.1 J**	19.8 U	**23.7**
Pyrene	**63.5**	19.7 U	19.4 U	18.9 U	**15.9 J**	19.5 U	**6.3 J**	19.7 U
Total Benzofluoranthenes (b,j,k) (U = 0)	**75.9**	39.4 U	38.9 U	37.7 U	**26.9 J**	39.1 U	39.6 U	39.3 U
Total HPAH (DMMP) (U = 0)[1]	**304 J**	**5.3 J**	38.9 U	37.7 U	**82.3 J**	**12.3 J**	**6.3 J**	**7.4 J**
Total LPAH (DMMP) (U = 0)[2]	**99.8 J**	**13 J**	**5.9 J**	18.9 U	**12.9 J**	**27 J**	19.8 U	**34.8 J**
Total PAH (DMMP) (U = 0)	**403.8 J**	**18.3 J**	**5.9 J**	37.7 U	**95.2 J**	**39.3 J**	**6.3 J**	**42.2 J**
Pesticides (µg/kg)[3]								
4,4'-DDD (p,p'-DDD)	1.59 U	0.32 U	1.58 UJ	1.54 U	0.32 U	0.32 U	0.32 U	0.32 U
4,4'-DDE (p,p'-DDE)	0.67 U	0.13 U	0.67 U	0.65 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	1.62 U	0.32 U	1.6 UJ	1.57 U	0.32 U	0.32 UJ	0.32 U	0.32 U
Aldrin	1.84 U	0.37 U	1.82 U	1.78 U	0.37 U	0.37 U	0.37 U	0.37 U
Chlordane, alpha- (Chlordane, cis-)	0.55 U	0.11 U	0.55 U	0.54 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	24.9 U	0.33 U	1.61 U	1.58 U	0.33 U	0.33 U	0.32 U	0.33 U
Dieldrin	0.57 U	0.11 U	0.57 U	0.55 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.23 U	0.05 U	0.23 U	0.22 U	0.05 U	0.05 U	0.05 U	0.05 U
Nonachlor, cis-	1.04 U	0.21 U	1.04 UJ	1.01 U	0.21 U	0.21 U	0.21 U	0.21 U
Nonachlor, trans-	1.13 U	0.23 U	1.13 UJ	1.1 U	0.23 U	0.23 U	0.23 U	0.23 U
Oxychlordane	0.64 U	0.13 U	0.63 UJ	0.62 U	0.13 U	0.13 U	0.13 U	0.13 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	1.62 U	0.32 U	1.6 UJ	1.57 U	0.32 U	0.32 UJ	0.32 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	24.9 U	0.33 U	1.61 UJ	1.58 U	0.33 U	0.33 U	0.32 U	0.33 U
PCB Aroclors (µg/kg)								
Aroclor 1016	4 U	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1221	4 U	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1232	4 U	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1242	4 U	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1248	4 U	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1254	4 U	4 U	4 U	3.9 U	3.8 U	4 U	**1.9 J**	4 U
Aroclor 1260	**3.8 J**	4 U	4 U	3.9 U	**0.8 J**	4 U	3.9 U	4 U
Aroclor 1262	4 UJ	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1268	4 UJ	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Total DMMP PCB Aroclors (U = 0)	**3.8 J**	4 U	4 U	3.9 U	**0.8 J**	4 U	**1.9 J**	4 U
PCB Aroclors (mg/kg-OC)[6]								
Total DMMP PCB Aroclors (U = 0)	**0.78 J**	1.48 U	2.67 U	3.25 U	**0.29 J**	0.54 U	**0.86 J**	0.56 U

Notes:

(yellow)	Detected concentration is greater than DMMP SL screening level
(orange)	Detected concentration is greater than DMMP BT screening level
(blue)	Non-detected concentration is above one or more identified screening levels
(gray)	TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	C-7-A-190221 0 - 2 ft	C-7-B-190221 2 - 4 ft	C-7-C-190221 4 - 6 ft	C-8-A-190221 0 - 2 ft	C-8-B-190221 2 - 4 ft	C-9-A-190220 0 - 2 ft	C-9-B-190220 2 - 4 ft
Metals (mg/kg)							
Antimony	0.32 UJ	0.23 UJ	0.24 UJ	0.26 UJ	0.25 UJ	0.23 UJ	0.24 UJ
Arsenic	**4.52**	**1.76**	**1.39**	**4.3**	**2.66**	**2.08**	**2.58**
Cadmium	**0.08 J**	0.12 U	0.12 U	**0.07 J**	**0.07 J**	0.11 U	**0.09 J**
Chromium	**16.3**	**8.75**	**9.6**	**13.6**	**16.8**	**11.3**	**11.8**
Copper	**25.2**	**10.1**	**9.06**	**24.4**	**28.3**	**10.7**	**14.4**
Lead	**6.14**	**1.11**	**1.06**	**5.97**	**3.39**	**1.25**	**1.61**
Mercury	**0.0278 J**	0.0266 U	0.0214 U	**0.0351 J**	**0.0183 J**	0.0217 U	**0.00517 J**
Selenium	**1.05**	**0.66**	**0.56 J**	**0.89**	**0.94**	**0.76**	**0.84**
Silver	**0.11 J**	**0.04 J**	**0.03 J**	**0.11 J**	**0.09 J**	**0.04 J**	**0.06 J**
Zinc	**37.2**	**16.4**	**16.7**	**34.1**	**32.1**	**18**	**19.7**
Organometallic Compounds (µg/kg)							
Tributyltin (ion)	**2.55 J**	3.45 U	3.76 U	**3.45 J**	3.65 U	3.85 UJ	3.79 UJ
Semivolatile Organics (µg/kg)							
1,2,4-Trichlorobenzene	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
1,2-Dichlorobenzene	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
1,4-Dichlorobenzene	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
2,4-Dimethylphenol	24.8 U	24.3 U	24.7 U	24.4 U	24.9 U	24.8 UJ	23.8 UJ
2-Methylphenol (o-Cresol)	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
4-Methylphenol (p-Cresol)	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
Benzoic acid	**26.5 J**	97.1 U	98.8 U	**37.1 J**	99.5 U	99.1 UJ	95.3 UJ
Benzyl alcohol	19.9 U	19.4 U	19.8 U	19.5 U	19.9 U	**10.1 J**	**9.7 J**
bis(2-Ethylhexyl)phthalate	**29.9 J**	48.6 U	49.4 U	48.8 U	49.8 U	49.5 U	47.7 U
Butylbenzyl phthalate	19.9 U	19.4 U	19.8 U	19.5 U	19.9 U	19.8 U	19.1 U
Diethyl phthalate	19.9 U	19.4 U	25.5 U	67 U	27.7 U	19.8 U	19.1 U
Dimethyl phthalate	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
Di-n-butyl phthalate	48.3 U	19.4 U	30.6 U	19.5 U	19.9 U	**23.4**	**40.5**
Di-n-octyl phthalate	19.9 U	19.4 U	19.8 U	19.5 U	19.9 U	19.8 U	19.1 U
Hexachlorobenzene	5 U	**3 J**	4.9 U	4.9 U	5 U	5 U	4.8 U
Hexachlorobutadiene	5 U	**26.5**	4.9 U	4.9 U	5 U	5 U	4.8 U
n-Nitrosodiphenylamine	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
Pentachlorophenol	19.9 UJ	19.4 UJ	19.8 UJ	19.5 UJ	19.9 UJ	19.8 UJ	19.1 UJ
Phenol	6.2 U	5.4 U	4.9 U	4.9 U	5 U	5 U	5.3 U
Polycyclic Aromatic Hydrocarbons (µg/kg)							
2-Methylnaphthalene	19.9 U	**7.8 J**	**9.8 J**	**35.1**	**9.8 J**	19.8 U	19.1 U
Acenaphthene	19.9 U	19.4 U	19.8 U	**7.7 J**	19.9 U	19.8 U	19.1 U
Acenaphthylene	19.9 U	19.4 U	19.8 U	**6.4 J**	19.9 U	19.8 U	19.1 U
Anthracene	**13.2 J**	19.4 U	19.8 U	**20.1**	19.9 U	19.8 U	19.1 U
Benzo(a)anthracene	**29.8**	19.4 U	19.8 U	**38.4**	**5.4 J**	19.8 U	19.1 U
Benzo(a)pyrene	**37.8**	19.4 U	19.8 U	**41.8**	19.9 U	19.8 U	19.1 U
Benzo(b,j,k)fluoranthenes	**121**	38.8 U	39.5 U	**98.7**	39.8 U	39.6 U	38.1 U
Benzo(g,h,i)perylene	**29.3**	19.4 U	19.8 U	**27.1**	19.9 U	19.8 U	19.1 U
Chrysene	**50.8**	19.4 U	19.8 U	**71.7**	**17.6 J**	19.8 U	19.1 U
Dibenzo(a,h)anthracene	**8.8**	4.9 U	4.9 U	**11.8**	5 U	5 U	4.8 U
Dibenzofuran	19.9 U	19.4 U	19.8 U	**12.3 J**	19.9 U	19.8 U	19.1 U
Fluoranthene	**47.3**	19.4 U	19.8 U	**64.5**	19.9 U	19.8 U	19.1 U
Fluorene	**5.8 J**	19.4 U	19.8 U	**10.3 J**	19.9 U	19.8 U	19.1 U
Indeno(1,2,3-c,d)pyrene	**27.7**	19.4 U	19.8 U	**25.1**	19.9 U	19.8 U	19.1 U
Naphthalene	**17 J**	19.4 U	**8.5 J**	**26**	19.9 U	19.8 U	19.1 U
Phenanthrene	**33.8**	**14.7 J**	19.8 U	**59.9**	**22.6**	19.8 U	**14.7 J**
Pyrene	**65.8**	19.4 U	19.8 U	**81.6**	19.9 U	19.8 U	19.1 U
Total Benzofluoranthenes (b,j,k) (U = 0)	**121**	38.8 U	39.5 U	**98.7**	39.8 U	39.6 U	38.1 U
Total HPAH (DMMP) (U = 0)[1]	**418.3**	38.8 U	39.5 U	**460.7**	**23 J**	39.6 U	38.1 U
Total LPAH (DMMP) (U = 0)[2]	**69.8 J**	**14.7 J**	**8.5 J**	**130.4 J**	**22.6**	19.8 U	**14.7 J**
Total PAH (DMMP) (U = 0)	**488.1 J**	**14.7 J**	**8.5 J**	**591.1 J**	**45.6 J**	39.6 U	**14.7 J**
Pesticides (µg/kg)[3]							
4,4'-DDD (p,p'-DDD)	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.31 U
4,4'-DDE (p,p'-DDE)	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
Aldrin	0.37 U	0.36 U	0.37 U	0.37 U	0.37 U	0.37 U	0.36 U
Chlordane, alpha- (Chlordane, cis-)	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	0.32 U	0.32 U	0.32 U	0.33 U	0.33 U	0.33 U	0.32 U
Dieldrin	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Nonachlor, cis-	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Nonachlor, trans-	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.22 U
Oxychlordane	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	0.32 U	0.32 U	0.32 U	0.33 U	0.33 U	0.33 U	0.32 U
PCB Aroclors (µg/kg)							
Aroclor 1016	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Aroclor 1221	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Aroclor 1232	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Aroclor 1242	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Aroclor 1248	**3.4 J**	4 U	4 U	**3.8 J**	3.9 U	4 U	3.9 U
Aroclor 1254	**3.9 J**	4 U	4 U	**5**	3.9 U	4 U	3.9 U
Aroclor 1260	**2.1 J**	4 U	4 U	**3 J**	3.9 U	4 U	3.9 U
Aroclor 1262	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Aroclor 1268	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Total DMMP PCB Aroclors (U = 0)	**9.4 J**	4 U	4 U	**11.8 J**	3.9 U	4 U	3.9 U
PCB Aroclors (mg/kg-OC)[6]							
Total DMMP PCB Aroclors (U = 0)	**1.71 J**	0.91 U	2 U	**2.19 J**	1 U	3.64 U	2.05 U

Notes:

Yellow	Detected concentration is greater than DMMP SL screening level
Orange	Detected concentration is greater than DMMP BT screening level
Blue	Non-detected concentration is above one or more identified screening levels
Grey	TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	C-10-A-190221 0 - 2 ft	C-10-B-190221 2 - 4 ft	C-10-C-190221 4 - 6 ft	C-11-A-190220 0 - 2 ft	C-11-B-190220 2 - 4 ft	C-12-A-190223 0 - 2 ft	C-12-B-190223 2 - 4 ft	C-12-C-190223 4 - 6 ft
Metals (mg/kg)								
Antimony	0.28 UJ	0.25 UJ	0.2 UJ	0.28 UJ	0.25 UJ	0.27 UJ	0.25 UJ	0.25 UJ
Arsenic	**5.95**	**3.4**	**1.88**	**4.8**	**1.3**	**6.8**	**5.07**	**5.07**
Cadmium	**0.13 J**	**0.12 J**	**0.1**	**0.09 J**	0.12 U	**0.14**	**0.13**	**0.14**
Chromium	**15.6**	**11.3**	**8.23**	**14.3**	**10.7**	**16.3**	**16.2**	**16.7**
Copper	**31.8**	**19.1**	**11.8**	**27.3**	**11.1**	**29.2**	**23.8**	**24.7**
Lead	**8.1**	**4.2**	**1.46**	**6.34**	**1.33**	**14.8**	**6.32**	**5.11**
Mercury	**0.0428 J**	**0.0271 J**	**0.00691 J**	**0.0352**	0.0241 U	**0.0703**	**0.0607**	**0.0549**
Selenium	**1**	**0.74**	**0.61**	**1.04**	**0.61 J**	**0.79**	**1.03**	**0.73**
Silver	**0.16 J**	**0.09 J**	**0.04 J**	**0.13 J**	**0.04 J**	**0.14 J**	**0.09 J**	**0.09 J**
Zinc	**43.4**	**25.5**	**15.8**	**36.7**	**18.7**	**43.7**	**30.4**	**29.8**
Organometallic Compounds (µg/kg)								
Tributyltin (ion)	**5.67**	**95.5**	3.81 U	**2.8 J**	3.79 UJ	**13.4**	**0.525 J**	3.65 U
Semivolatile Organics (µg/kg)								
1,2,4-Trichlorobenzene	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	4.8 U	5 U	5 U
1,2-Dichlorobenzene	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	**6.1**	5 U	5 U
1,4-Dichlorobenzene	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	**3.7 J**	5 U	5 U
2,4-Dimethylphenol	**3.4 J**	23.8 U	24 U	**3.1 J**	23.5 UJ	**10.6 J**	**2.8 J**	24.9 U
2-Methylphenol (o-Cresol)	4.9 U	4.8 U	4.8 U	**2.2 J**	4.7 U	4.8 U	5 U	5 U
4-Methylphenol (p-Cresol)	**6.4**	**2.7 J**	4.8 U	**6.8**	4.7 U	**14.4**	**5.1**	**2.8 J**
Benzoic acid	**146**	**43.3 J**	96 U	**93.3 J**	94 UJ	**228 J**	**77 J**	**46.1 J**
Benzyl alcohol	19.7 U	19.1 U	19.2 U	**17.9 J**	18.8 U	19 U	19.8 U	19.9 U
bis(2-Ethylhexyl)phthalate	**56.7**	**32.8 J**	48 U	**30.2 J**	47 U	**106**	**32.9 J**	49.8 U
Butylbenzyl phthalate	19.7 U	19.1 U	19.2 U	19 U	18.8 U	19 U	19.8 U	19.9 U
Diethyl phthalate	19.7 U	19.1 U	24.5 U	--	18.8 U	19 U	38.2 U	19.9 U
Dimethyl phthalate	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	**3.1 J**	5 U	5 U
Di-n-butyl phthalate	41.4 U	20.6 U	30.4 U	**72.2**	**17.7 J**	19 U	**6 J**	19.9 U
Di-n-octyl phthalate	19.7 U	19.1 U	19.2 U	19 U	18.8 U	19 U	19.8 U	19.9 U
Hexachlorobenzene	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	4.8 U	5 U	5 U
Hexachlorobutadiene	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	4.8 U	5 U	5 U
n-Nitrosodiphenylamine	**3.4 J**	4.8 U	4.8 U	4.7 U	4.7 U	4.8 U	5 U	5 U
Pentachlorophenol	**9.3 J**	19.1 UJ	19.2 UJ	**4.1 J**	18.8 UJ	**11.2 J**	**10.1 J**	19.9 UJ
Phenol	15 U	9.7 U	4.8 U	**20.3**	4.7 U	53 U	23.1 U	17.5 U
Polycyclic Aromatic Hydrocarbons (µg/kg)								
2-Methylnaphthalene	**28.6**	**10.6 J**	19.2 U	**17.7 J**	18.8 U	**21.5**	19.8 U	19.9 U
Acenaphthene	**7.5 J**	19.1 U	19.2 U	19 U	18.8 U	**21.1**	**8.2 J**	19.9 U
Acenaphthylene	**11 J**	19.1 U	19.2 U	19 U	18.8 U	**10.9 J**	19.8 U	19.9 U
Anthracene	**28.7**	**16.1 J**	19.2 U	**18.6 J**	18.8 U	**26.6 J**	**14.4 J**	**8.5 J**
Benzo(a)anthracene	**56.2**	**33.6**	19.2 U	**42.5**	18.8 U	**25.1**	**13.1 J**	**8 J**
Benzo(a)pyrene	**67.2**	**45.7**	19.2 U	**46.1**	18.8 U	**40.3**	**18.8 J**	**9.7 J**
Benzo(b,j,k)fluoranthenes	**205**	**115**	38.4 U	**118**	37.6 U	**114**	**49.2**	**22.5 J**
Benzo(g,h,i)perylene	**48.5**	**30.3**	19.2 U	**33.1**	18.8 U	**30.8**	**17.2 J**	**9.7 J**
Chrysene	**82.7**	**53.7**	19.2 U	**61.4**	18.8 U	**51.1**	**23.4**	**11.8 J**
Dibenzo(a,h)anthracene	**18.8**	**12.4**	4.8 U	**9.2**	4.7 U	**11**	**6**	**2.7 J**
Dibenzofuran	**16.6 J**	**7.2 J**	19.2 U	**9 J**	18.8 U	**23.9**	**9.6 J**	19.9 U
Fluoranthene	**110**	**52**	19.2 U	**52.1**	18.8 U	**90.9**	**36**	**18.5 J**
Fluorene	**15.7 J**	**7.3 J**	19.2 U	**8 J**	18.8 U	**28**	**12.5 J**	19.9 U
Indeno(1,2,3-c,d)pyrene	**43.9**	**28.7**	19.2 U	**29.5**	18.8 U	**25.4**	**14.6 J**	**7.3 J**
Naphthalene	**27.7**	**15.9 J**	19.2 U	**20.1**	18.8 U	**60.2**	**27.9**	**16.9 J**
Phenanthrene	**53.3**	**43**	**7.7 J**	**39.2**	18.8 U	**78.3**	**38.5**	**24.2**
Pyrene	**174**	**79.1**	**6.6 J**	**76**	18.8 U	**215**	**71.1**	**40.1**
Total Benzofluoranthenes (b,j,k) (U = 0)	**205**	**115**	38.4 U	**118**	37.6 U	**114**	**49.2**	**22.5 J**
Total HPAH (DMMP) (U = 0)[1]	**806.3**	**450.5**	**6.6 J**	**467.9**	37.6 U	**603.6**	**249.4 J**	**130.3 J**
Total LPAH (DMMP) (U = 0)[2]	**143.9 J**	**82.3 J**	**7.7 J**	**85.9 J**	18.8 U	**225.1 J**	**101.5 J**	**49.6 J**
Total PAH (DMMP) (U = 0)	**950.2 J**	**532.8 J**	**14.3 J**	**553.8 J**	37.6 U	**828.7 J**	**350.9 J**	**179.9 J**
Pesticides (µg/kg)[3]								
4,4'-DDD (p,p'-DDD)	1.59 U	0.32 U	0.32 U	0.32 U	0.31 U	0.32 U	0.31 U	1.93 U
4,4'-DDE (p,p'-DDE)	0.67 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	1.61 U	0.32 U	0.32 U	0.32 U	0.31 U	3.96 U	3.39 U	2.42 U
Aldrin	1.83 U	0.37 U	0.36 U	0.37 U	0.35 U	0.37 U	0.36 U	0.36 U
Chlordane, alpha- (Chlordane, cis-)	0.55 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	1.62 U	0.32 U	0.32 U	14.9 U	0.31 U	0.32 U	0.32 U	0.32 U
Dieldrin	0.57 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.23 U	0.05 U	0.05 U	1.49 U	0.04 U	0.05 U	0.04 U	0.04 U
Nonachlor, cis-	1.04 U	0.21 U	0.21 U	0.21 U	0.2 U	0.21 U	0.2 U	0.2 U
Nonachlor, trans-	1.13 U	0.23 U	0.22 U	0.23 U	0.22 U	0.23 U	0.22 U	0.22 U
Oxychlordane	0.64 U	0.13 U	0.13 U	21.9 U	0.12 U	0.13 U	0.12 U	0.12 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	1.61 U	0.32 U	0.32 U	0.32 U	0.31 U	3.96 U	3.39 U	2.42 U
Total DMMP Chlordane (U = 0)[5]	1.62 U	0.32 U	0.32 U	21.9 U	0.31 U	0.32 U	0.32 U	0.32 U
PCB Aroclors (µg/kg)								
Aroclor 1016	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	3.9 U	3.8 U
Aroclor 1221	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	3.9 U	3.8 U
Aroclor 1232	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	3.9 U	3.8 U
Aroclor 1242	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	3.9 U	3.8 U
Aroclor 1248	**5.8**	**4.1**	3.9 U	4 U	3.8 U	**52.7**	**44.9**	**11**
Aroclor 1254	**9**	**5 J**	3.9 U	**3.4 J**	3.8 U	**94.3 J**	**33.5 J**	**7.8**
Aroclor 1260	**5.5 J**	**2.1 J**	3.9 U	**2.6 J**	3.8 U	**26.3 J**	**11.7 J**	**5.7 J**
Aroclor 1262	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 UJ	3.9 UJ	3.8 UJ
Aroclor 1268	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 UJ	3.9 UJ	3.8 UJ
Total DMMP PCB Aroclors (U = 0)	**20.3 J**	**11.2 J**	3.9 U	**6 J**	3.8 U	**173.3 J**	**90.1 J**	**24.5 J**
PCB Aroclors (mg/kg-OC)[6]								
Total DMMP PCB Aroclors (U = 0)	**2.01 J**	**2.49 J**	2.05 U	**0.70 J**	2.71 U	**28.41 J**	**24.35 J**	**3.27 J**

Notes:

(yellow)	Detected concentration is greater than DMMP SL screening level
(orange)	Detected concentration is greater than DMMP BT screening level
(blue)	Non-detected concentration is above one or more identified screening levels
(gray)	TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID Depth Analyte	C-13-A-190223 0 - 2 ft	C-13-B-190223 2 - 4 ft	C-13-C-190223 4 - 6 ft	C-14-A-190221 0 - 2 ft	C-14-B-190221 2 - 4 ft	C-15-A-190222 0 - 2 ft	C-15-B-190222 2 - 4 ft	C-15-C-190222 4 - 6 ft
Metals (mg/kg)								
Antimony	0.24 UJ	0.25 UJ	0.22 UJ	0.23 UJ	0.23 UJ	0.25 UJ	0.22 UJ	0.22 UJ
Arsenic	**6.08**	**6.67**	**3.88**	**4.18**	**5.08**	**6.4**	**2.74**	**4.28**
Cadmium	**0.11 J**	**0.11 J**	**0.05 J**	0.11 U	**0.06 J**	**0.05 J**	0.11 U	**0.04 J**
Chromium	**13**	**13.5**	**12**	**11.3**	**13**	**12.4**	**9.38**	**11.5**
Copper	**66.1**	**22.7**	**14.1**	**12.3**	**14.6**	**21.3**	**11.5**	**14.3**
Lead	**4.5**	**5.04**	**1.67**	**1.54**	**1.8**	**5.36**	**1.36**	**1.74**
Mercury	**0.0252**	**0.0381**	**0.011 J**	0.0216 U	0.0216 U	**0.027 J**	**0.0142 J**	**0.0148 J**
Selenium	**0.77**	**0.89**	**0.73**	**0.95**	**0.78**	**0.77**	**0.62**	**0.66**
Silver	**0.08 J**	**0.11 J**	**0.05 J**	**0.04 J**	**0.05 J**	**0.09 J**	**0.04 J**	**0.05 J**
Zinc	**43.1**	**34.2**	**22.2**	**21.7**	**22.2**	**30**	**18**	**22.5**
Organometallic Compounds (µg/kg)								
Tributyltin (ion)	**1.68 J**	**3.69**	3.81 U	3.74 U	3.82 U	**1.99 J**	3.77 U	3.84 U
Semivolatile Organics (µg/kg)								
1,2,4-Trichlorobenzene	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
1,2-Dichlorobenzene	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
1,4-Dichlorobenzene	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 UJ	5 UJ	5 UJ
2,4-Dimethylphenol	24.5 U	24.8 U	24.5 U	24.3 U	24.7 U	23.6 UJ	24.8 UJ	24.8 UJ
2-Methylphenol (o-Cresol)	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
4-Methylphenol (p-Cresol)	4.9 U	**3.1 J**	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Benzoic acid	**71.1 J**	**76.3 J**	**22.3 J**	97.1 U	98.6 U	**79.4 J**	99 U	99 UJ
Benzyl alcohol	19.6 U	**3.4 J**	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
bis(2-Ethylhexyl)phthalate	**30.4 J**	**41.7 J**	49 U	**54.7**	49.3 U	**61.8**	49.5 U	49.5 U
Butylbenzyl phthalate	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	**7.8 J**	19.8 U	19.8 U
Diethyl phthalate	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	31.9 U
Dimethyl phthalate	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Di-n-butyl phthalate	19.6 U	19.9 U	19.6 U	34.4 U	39.9 U	121 U	81.4 U	38.6 U
Di-n-octyl phthalate	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Hexachlorobenzene	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Hexachlorobutadiene	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
n-Nitrosodiphenylamine	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Pentachlorophenol	19.6 UJ	19.9 UJ	19.6 UJ	19.4 UJ	**7.7 J**	18.9 UJ	19.8 UJ	19.8 UJ
Phenol	23.7 U	31.6 U	8.2 U	4.9 U	4.9 U	13.7 U	5.9 U	7 U
Polycyclic Aromatic Hydrocarbons (µg/kg)								
2-Methylnaphthalene	**7.1 J**	**7 J**	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Acenaphthene	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Acenaphthylene	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Anthracene	**6.9 J**	**10.6 J**	19.6 UJ	19.4 U	19.7 U	**6.1 J**	19.8 UJ	19.8 UJ
Benzo(a)anthracene	**17.1 J**	**19.2 J**	19.6 U	19.4 U	19.7 U	**10.2 J**	19.8 U	19.8 U
Benzo(a)pyrene	**23.1**	**29.4**	19.6 U	19.4 U	19.7 U	**18.9**	19.8 U	19.8 U
Benzo(b,j,k)fluoranthenes	**62.9**	**85.1**	39.2 U	38.8 U	39.4 U	**54.5**	39.6 U	39.6 U
Benzo(g,h,i)perylene	**20.8**	**26.9**	19.6 U	19.4 U	19.7 U	**10.9 J**	19.8 U	19.8 U
Chrysene	**27.8**	**32.4**	19.6 U	19.4 U	19.7 U	**17 J**	19.8 U	19.8 U
Dibenzo(a,h)anthracene	**6.6**	**8.6**	4.9 U	4.9 U	4.9 U	**4.8**	5 U	5 U
Dibenzofuran	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Fluoranthene	**25.5**	**25.2**	19.6 U	19.4 U	19.7 U	**16.5 J**	19.8 U	19.8 U
Fluorene	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Indeno(1,2,3-c,d)pyrene	**15.9 J**	**21.9**	19.6 U	19.4 U	19.7 U	**10.6 J**	19.8 U	19.8 U
Naphthalene	**7.9 J**	**9 J**	19.6 U	19.4 U	19.7 U	**8.9 J**	19.8 UJ	19.8 UJ
Phenanthrene	**16.3 J**	**21.4**	**5.8 J**	19.4 U	19.7 U	**15.8 J**	**6.1 J**	19.8 U
Pyrene	**48.8**	**68.5**	19.6 U	19.4 U	19.7 U	**27.5**	19.8 U	19.8 U
Total Benzofluoranthenes (b,j,k) (U = 0)	**62.9**	**85.1**	39.2 U	38.8 U	39.4 U	**54.5**	39.6 U	39.6 U
Total HPAH (DMMP) (U = 0)[1]	**248.5 J**	**317.2 J**	39.2 U	38.8 U	39.4 U	**170.9 J**	39.6 U	39.6 U
Total LPAH (DMMP) (U = 0)[2]	**31.1 J**	**41 J**	**5.8 J**	19.4 U	19.7 U	**30.8 J**	**6.1 J**	19.8 UJ
Total PAH (DMMP) (U = 0)	**279.6 J**	**358.2 J**	**5.8 J**	38.8 U	39.4 U	**201.7 J**	**6.1 J**	39.6 UJ
Pesticides (µg/kg)[3]								
4,4'-DDD (p,p'-DDD)	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U	0.31 U	0.32 U	0.32 U
4,4'-DDE (p,p'-DDE)	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.31 U	0.32 U	0.32 U
Aldrin	0.37 U	0.36 U	0.36 U	0.37 U	0.37 U	0.35 U	0.37 U	0.37 U
Chlordane, alpha- (Chlordane, cis-)	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	0.32 U	1.94 U	0.32 U	0.32 U	0.33 U	0.31 U	0.32 U	0.32 U
Dieldrin	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.04 U	0.05 U	0.05 U
Nonachlor, cis-	0.21 U	0.2 U	0.21 U	0.21 U	0.21 U	0.2 U	0.21 U	0.21 U
Nonachlor, trans-	0.23 U	0.22 U	0.23 U	0.23 U	0.23 U	0.22 U	0.23 U	0.23 U
Oxychlordane	0.13 U	0.12 U	0.13 U	0.13 U	0.13 U	0.12 U	0.13 U	0.13 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.31 U	0.32 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	0.32 U	1.94 U	0.32 U	0.32 U	0.33 U	0.31 U	0.32 U	0.32 U
PCB Aroclors (µg/kg)								
Aroclor 1016	4 U	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Aroclor 1221	4 U	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Aroclor 1232	4 U	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Aroclor 1242	4 U	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Aroclor 1248	**6.5**	**8**	**3.7 J**	3.9 U	4 U	**8.2**	4 U	4 U
Aroclor 1254	**3.3 J**	**5.9**	3.9 U	3.9 U	4 U	**8.1 J**	4 U	4 U
Aroclor 1260	**1.9 J**	**9.2 J**	3.9 U	3.9 U	4 U	**3.1 J**	4 U	4 U
Aroclor 1262	4 UJ	3.9 UJ	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Aroclor 1268	4 UJ	3.9 UJ	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Total DMMP PCB Aroclors (U = 0)	**11.7 J**	**23.1 J**	**3.7 J**	3.9 U	4 U	**19.4 J**	4 U	4 U
PCB Aroclors (mg/kg-OC)[6]								
Total DMMP PCB Aroclors (U = 0)	**1.98 J**	**5.92 J**	**2.06 J**	4.33 U	2.67 U	**7.76 J**	4 U	2.35 U

Notes:

Detected concentration is greater than DMMP SL screening level

Detected concentration is greater than DMMP BT screening level

Non-detected concentration is above one or more identified screening levels

TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	C-16-A-190223 0 - 2 ft	C-16-B-190223 2 - 4 ft	C-17-A-190222 0 - 2 ft	C-17-B-190222 2 - 4 ft	C-17-C-190222 4 - 8 ft	C-18-A1-190220 0 - 2.3 ft	C-18-B1-190220 3.9 - 6.3 ft
Metals (mg/kg)							
Antimony	0.2 UJ	0.23 UJ	0.28 UJ	0.37 UJ	0.25 UJ	0.24 U	0.22 U
Arsenic	**3.82**	**2.21**	**3.74**	**3.44**	**2.15**	**3.2**	**3.89**
Cadmium	**0.07 J**	0.11 U	**0.05 J**	**0.21**	**0.04 J**	**0.05 J**	0.11 U
Chromium	**10.2**	**10.6**	**16.3**	**16.4**	**14.4**	**11.5**	**10.1**
Copper	**14.9**	**10.5**	**32.6**	**30.7**	**21.2**	**16.1**	**13**
Lead	**2.82**	**1.29**	**3.94**	**3.12**	**2.07**	**2.81**	**1.51**
Mercury	**0.0195 J**	**0.00813 J**	**0.0296**	**0.0373**	**0.0201 J**	0.0291 U	0.021 U
Selenium	**0.67**	**0.69**	**1.11**	**1.22**	**0.98**	**0.7**	**0.88**
Silver	**0.08 J**	**0.04 J**	**0.1 J**	**0.1 J**	**0.07 J**	**0.05 J**	**0.04 J**
Zinc	**22.5**	**19.7**	**30.4**	**25.3**	**23.9**	**25.6**	**29.6**
Organometallic Compounds (µg/kg)							
Tributyltin (ion)	**15.8**	**0.895 J**	3.61 U	3.84 U	3.69 U	**2.31 J**	3.64 UJ
Semivolatile Organics (µg/kg)							
1,2,4-Trichlorobenzene	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
1,2-Dichlorobenzene	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
1,4-Dichlorobenzene	4.8 U	4.9 U	5 UJ	4.9 UJ	4.8 UJ	4.8 U	4.7 U
2,4-Dimethylphenol	23.9 U	24.6 U	24.8 UJ	**2.6 J**	23.9 UJ	24.2 U	23.6 U
2-Methylphenol (o-Cresol)	4.8 U	4.9 U	**2.7 J**	**3.1 J**	4.8 U	4.8 U	4.7 U
4-Methylphenol (p-Cresol)	4.8 U	4.9 U	**4.7 J**	**7.6**	**2 J**	**3.1 J**	4.7 U
Benzoic acid	**68.4 J**	98.6 UJ	**310**	**164**	**32.9 J**	**214 J**	**60.2 J**
Benzyl alcohol	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
bis(2-Ethylhexyl)phthalate	47.8 U	49.3 U	49.7 U	48.7 U	**29.6 J**	48.4 U	47.2 U
Butylbenzyl phthalate	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Diethyl phthalate	23.2 U	19.7 U	19.9 U	19.5 U	24.6 U	**7.2 J**	**9.2 J**
Dimethyl phthalate	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
Di-n-butyl phthalate	19.1 U	19.7 U	97.9 U	99.9 U	91.1 U	19.4 U	18.9 U
Di-n-octyl phthalate	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Hexachlorobenzene	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
Hexachlorobutadiene	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
n-Nitrosodiphenylamine	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
Pentachlorophenol	19.1 UJ	19.7 UJ	**4.5 J**	19.5 UJ	19.2 UJ	19.4 UJ	18.9 UJ
Phenol	18.3 U	8.1 U	**41**	**34.7**	7.3 U	**38.7**	13.4 U
Polycyclic Aromatic Hydrocarbons (µg/kg)							
2-Methylnaphthalene	19.1 U	19.7 U	**11.7 J**	**7.1 J**	**6.2 J**	19.4 U	**7.5 J**
Acenaphthene	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Acenaphthylene	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Anthracene	**8.8 J**	19.7 UJ	19.9 UJ	19.5 UJ	19.2 UJ	**5.9 J**	18.9 U
Benzo(a)anthracene	**11.9 J**	19.7 U	**6.5 J**	19.5 U	19.2 U	**9 J**	18.9 U
Benzo(a)pyrene	**10.8 J**	19.7 U	19.9 U	19.5 U	19.2 U	**16.4 J**	18.9 U
Benzo(b,j,k)fluoranthenes	38.2 U	39.4 U	**22.7 J**	39 U	38.3 U	**42.2**	37.8 U
Benzo(g,h,i)perylene	**7.7 J**	19.7 U	19.9 U	19.5 U	19.2 U	**9.7 J**	18.9 U
Chrysene	**28.8**	19.7 U	**14.7 J**	**8.8 J**	**5.9 J**	**18.2 J**	18.9 U
Dibenzo(a,h)anthracene	**2.7 J**	4.9 U	**2.6 J**	4.9 U	4.8 U	**3.8 J**	4.7 U
Dibenzofuran	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Fluoranthene	**12.3 J**	19.7 U	**8 J**	19.5 U	**4.9 J**	**13.9 J**	18.9 U
Fluorene	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Indeno(1,2,3-c,d)pyrene	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	**8.2 J**	18.9 U
Naphthalene	19.1 U	19.7 U	**6.3 J**	**6.8 J**	**8.1 J**	**7.9 J**	**5.4 J**
Phenanthrene	**15.8 J**	19.7 U	**25.2**	**13.7 J**	**14.6 J**	**11.9 J**	**6.3 J**
Pyrene	**23.5**	19.7 U	**21.3**	19.5 U	**6.2 J**	**48.3**	18.9 U
Total Benzofluoranthenes (b,j,k) (U = 0)	38.2 U	39.4 U	**22.7 J**	39 U	38.3 U	**42.2**	37.8 U
Total HPAH (DMMP) (U = 0)[1]	**97.7 J**	39.4 U	**75.8 J**	**8.8 J**	**17 J**	**169.7 J**	37.8 U
Total LPAH (DMMP) (U = 0)[2]	**24.6 J**	19.7 UJ	**31.5 J**	**20.5 J**	**22.7 J**	**25.7 J**	**11.7 J**
Total PAH (DMMP) (U = 0)	**122.3 J**	39.4 UJ	**107.3 J**	**29.3 J**	**39.7 J**	**195.4 J**	**11.7 J**
Pesticides (µg/kg)[3]							
4,4'-DDD (p,p'-DDD)	0.31 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
4,4'-DDE (p,p'-DDE)	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
Aldrin	0.36 U	0.37 U	0.37 U	0.37 U	0.36 U	0.36 U	0.37 U
Chlordane, alpha- (Chlordane, cis-)	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	0.32 U	0.33 U	0.33 U	0.33 U	0.32 U	0.99 U	0.32 U
Dieldrin	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Nonachlor, cis-	0.2 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Nonachlor, trans-	0.22 U	0.23 U	0.23 U	0.23 U	0.22 U	0.22 U	0.23 U
Oxychlordane	0.12 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	0.32 U	0.33 U	0.33 U	0.33 U	0.32 U	0.99 U	0.32 U
PCB Aroclors (µg/kg)							
Aroclor 1016	4 U	4 U	4 U	4 U	4 U	3.9 U	4 U
Aroclor 1221	4 U	4 U	4 U	4 U	4 U	3.9 U	4 U
Aroclor 1232	4 U	4 U	4 U	4 U	4 U	3.9 U	4 U
Aroclor 1242	4 U	4 U	4 U	4 U	4 U	3.9 U	4 U
Aroclor 1248	**2 J**	4 U	**2.5 J**	4 U	4 U	3.9 U	4 U
Aroclor 1254	**2.2 J**	4 U	**2.4 J**	4 U	4 U	3.9 U	4 U
Aroclor 1260	**1.1 J**	4 U	**1.1 J**	4 U	4 U	3.9 UJ	4 U
Aroclor 1262	4 U	4 U	4 U	4 U	4 U	3.9 UJ	4 U
Aroclor 1268	4 U	4 U	4 U	4 U	4 U	3.9 UJ	4 U
Total DMMP PCB Aroclors (U = 0)	**5.3 J**	4 U	**6 J**	4 U	4 U	3.9 UJ	4 U
PCB Aroclors (mg/kg-OC)[6]							
Total DMMP PCB Aroclors (U = 0)	**2.12 J**	8 U	**0.72 J**	0.12 U	1.03 U	1.34 UJ	3.08 U

Notes:

(yellow)	Detected concentration is greater than DMMP SL screening level
(orange)	Detected concentration is greater than DMMP BT screening level
(blue)	Non-detected concentration is above one or more identified screening levels
(gray)	TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	C-19-A-190220 0 - 2 ft	C-19-B-190220 2 - 4 ft	C-20-A-190219 0 - 2 ft	C-20-B-190219 2 - 4 ft	C-21-A-190219 0 - 2 ft	C-21-B-190219 2 - 4 ft	C-22-A-190219 0 - 2 ft	C-22-B-190219 2 - 4 ft
Metals (mg/kg)								
Antimony	0.19 UJ	0.23 UJ	0.23 UJ	0.21 UJ	0.23 UJ	0.21 UJ	0.2 UJ	0.2 UJ
Arsenic	**1.89**	**2.53**	**1.28**	**1.1**	**4.41**	**2.26**	**1.59**	**1.31**
Cadmium	0.1 U	0.12 U	**0.05 J**	**0.03 J**	0.11 U	**0.05 J**	0.1 U	0.1 U
Chromium	**9.73**	**10.3**	**9.69**	**10.4**	**7.99**	**8.59**	**11.3**	**9.53**
Copper	**12.7**	**15.2**	**13.9**	**14**	**14.9**	**14.9**	**12.7**	**10.9**
Lead	**1.54**	**1.84**	**1.41**	**1.5**	**1.43**	**1.49**	**1.36**	**1.41**
Mercury	0.0187 U	0.0204 U	**0.00698 J**	**0.00973 J**	**0.0112 J**	**0.0134 J**	**0.00859 J**	**0.00788 J**
Selenium	**0.62**	**0.77**	**0.51 J**	**0.82**	**0.82**	**0.82**	**0.72**	**0.84**
Silver	**0.04 J**	**0.05 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.03 J**	**0.03 J**	**0.03 J**
Zinc	**20.9**	**21.3**	**18.7**	**20.1**	**18**	**20.1**	**19.2**	**17.6**
Organometallic Compounds (µg/kg)								
Tributyltin (ion)	**0.417 J**	**1.07 J**	3.79 U	3.76 U	3.63 U	3.76 U	3.53 U	3.57 U
Semivolatile Organics (µg/kg)								
1,2,4-Trichlorobenzene	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
1,2-Dichlorobenzene	4.9 U	4.9 U	5 U	**0.8 J**	4.8 U	4.8 U	4.9 U	4.9 U
1,4-Dichlorobenzene	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
2,4-Dimethylphenol	24.4 UJ	24.6 UJ	24.8 UJ	24.3 UJ	23.9 UJ	24.2 UJ	24.7 UJ	24.7 UJ
2-Methylphenol (o-Cresol)	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
4-Methylphenol (p-Cresol)	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Benzoic acid	97.7 UJ	**19.6 J**	99.1 UJ	97.1 UJ	95.7 UJ	96.7 UJ	98.7 UJ	98.6 UJ
Benzyl alcohol	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
bis(2-Ethylhexyl)phthalate	48.9 U	49.2 U	49.5 U	48.6 U	47.9 U	48.3 U	49.4 U	49.3 U
Butylbenzyl phthalate	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Diethyl phthalate	19.5 U	19.7 U	35.8 U	28.9 U	19.1 U	19.3 U	19.7 U	21.9 U
Dimethyl phthalate	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Di-n-butyl phthalate	**161**	**133**	**36.8**	**22.6**	**17.2 J**	**39.8**	**18.8 J**	19.7 U
Di-n-octyl phthalate	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Hexachlorobenzene	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Hexachlorobutadiene	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
n-Nitrosodiphenylamine	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Pentachlorophenol	19.5 UJ	19.7 UJ	19.8 UJ	19.4 UJ	19.1 UJ	19.3 UJ	19.7 UJ	19.7 UJ
Phenol	4.9 U	5.3 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Polycyclic Aromatic Hydrocarbons (µg/kg)								
2-Methylnaphthalene	19.5 U	19.7 U	19.8 U	19.4 U	**7.3 J**	19.3 U	19.7 U	19.7 U
Acenaphthene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Acenaphthylene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Anthracene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Benzo(a)anthracene	19.5 U	19.7 U	19.8 U	19.4 U	**7 J**	19.3 U	19.7 U	19.7 U
Benzo(a)pyrene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Benzo(b,j,k)fluoranthenes	39.1 U	39.3 U	39.6 U	38.9 U	38.3 U	38.7 U	39.5 U	39.5 U
Benzo(g,h,i)perylene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Chrysene	19.5 U	19.7 U	19.8 U	19.4 U	**14.3 J**	19.3 U	19.7 U	19.7 U
Dibenzo(a,h)anthracene	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Dibenzofuran	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Fluoranthene	19.5 U	19.7 U	19.8 U	19.4 U	**5.8 J**	19.3 U	19.7 U	19.7 U
Fluorene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Indeno(1,2,3-c,d)pyrene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Naphthalene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Phenanthrene	19.5 U	19.7 U	19.8 U	19.4 U	**38.1**	19.3 U	19.7 U	19.7 U
Pyrene	19.5 U	**5.5 J**	**5.9 J**	19.4 U	**8.1 J**	19.3 U	19.7 U	19.7 U
Total Benzofluoranthenes (b,j,k) (U = 0)	39.1 U	39.3 U	39.6 U	38.9 U	38.3 U	38.7 U	39.5 U	39.5 U
Total HPAH (DMMP) (U = 0)[1]	39.1 U	**5.5 J**	**5.9 J**	38.9 U	**35.2 J**	38.7 U	39.5 U	39.5 U
Total LPAH (DMMP) (U = 0)[2]	19.5 U	19.7 U	19.8 U	19.4 U	**38.1**	19.3 U	19.7 U	19.7 U
Total PAH (DMMP) (U = 0)	39.1 U	**5.5 J**	**5.9 J**	38.9 U	**73.3 J**	38.7 U	39.5 U	39.5 U
Pesticides (µg/kg)[3]								
4,4'-DDD (p,p'-DDD)	0.31 U	0.31 U	0.3 U	0.31 U	0.31 U	0.31 U	0.31 U	0.32 U
4,4'-DDE (p,p'-DDE)	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	0.31 U	0.32 U	0.31 U	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U
Aldrin	0.36 U	0.36 U	0.35 U	0.36 U	0.35 U	0.36 U	0.36 U	0.36 U
Chlordane, alpha- (Chlordane, cis-)	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	0.32 U	0.32 U	0.31 U	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U
Dieldrin	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.04 U	0.05 U	0.04 U	0.05 U	0.04 U	0.05 U	0.05 U	0.05 U
Nonachlor, cis-	0.2 U	0.21 U	0.2 U	0.21 U	0.2 U	0.2 U	0.21 U	0.21 U
Nonachlor, trans-	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U
Oxychlordane	0.12 U	0.12 U	0.12 U	0.13 U	0.12 U	0.12 U	0.13 U	0.13 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	0.31 U	0.32 U	0.31 U	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	0.32 U	0.32 U	0.31 U	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U
PCB Aroclors (µg/kg)								
Aroclor 1016	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1221	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1232	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1242	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1248	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1254	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1260	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1262	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1268	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Total DMMP PCB Aroclors (U = 0)	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
PCB Aroclors (mg/kg-OC)[6]								
Total DMMP PCB Aroclors (U = 0)	4.22 U	3.9 U	4.75 U	9.75 U	0.78 U	3.55 U	5.57 U	10 U

Notes:

(yellow)	Detected concentration is greater than DMMP SL screening level
(orange)	Detected concentration is greater than DMMP BT screening level
(blue)	Non-detected concentration is above one or more identified screening levels
(gray)	TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	C-23-A1-190222 0 - 2 ft	C-23-B1-190222 2 - 4 ft	C-24-A-190223 0 - 2 ft	C-24-B-190223 2 - 4 ft	C-25-A-190222 0 - 2 ft	C-25-B-190222 2 - 4 ft
Metals (mg/kg)						
Antimony	0.21 UJ	0.21 UJ	0.22 UJ	0.21 UJ	0.24 UJ	0.24 UJ
Arsenic	**2.41**	**2**	**1.99**	**1.16**	**2.79**	**2.59**
Cadmium	**0.04 J**	**0.04 J**	0.11 U	0.1 U	**0.05 J**	0.12 U
Chromium	**10.1**	**9.02**	**11.3**	**9.86**	**15.5**	**13.2**
Copper	**15.1**	**12.8**	**13.4**	**11.2**	**27.7**	**19.4**
Lead	**1.84**	**1.45**	**1.64**	**1.6**	**2.42**	**1.79**
Mercury	0.0232 U	**0.0101 J**	**0.0112 J**	**0.00818 J**	**0.0219 J**	**0.0191 J**
Selenium	**0.66**	**0.84**	**0.62**	**0.64**	**0.85**	**0.73**
Silver	**0.04 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.07 J**	**0.05 J**
Zinc	**23.8**	**21.2**	**23**	**22.4**	**73.9**	**20.1**
Organometallic Compounds (µg/kg)						
Tributyltin (ion)	3.51 U	3.46 U	3.78 U	3.53 U	3.6 U	3.77 U
Semivolatile Organics (µg/kg)						
1,2,4-Trichlorobenzene	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
1,2-Dichlorobenzene	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
1,4-Dichlorobenzene	5 UJ	4.9 UJ	4.9 U	4.9 U	4.9 UJ	4.8 UJ
2,4-Dimethylphenol	24.9 UJ	24.6 UJ	24.5 U	24.7 U	24.7 UJ	24.2 UJ
2-Methylphenol (o-Cresol)	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
4-Methylphenol (p-Cresol)	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Benzoic acid	**15.4 J**	98.6 U	**43.9 J**	**25.5 J**	**33.6 J**	**84.3 J**
Benzyl alcohol	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
bis(2-Ethylhexyl)phthalate	49.9 U	49.3 U	49.1 U	49.4 U	**30.4 J**	**31.4 J**
Butylbenzyl phthalate	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Diethyl phthalate	30.9 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Dimethyl phthalate	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Di-n-butyl phthalate	87.1 U	142 U	19.6 U	19.8 U	140 U	171 U
Di-n-octyl phthalate	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Hexachlorobenzene	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Hexachlorobutadiene	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
n-Nitrosodiphenylamine	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Pentachlorophenol	20 UJ	19.7 UJ	19.6 UJ	19.8 UJ	19.8 UJ	19.3 UJ
Phenol	6.8 U	6.5 U	10 U	7.9 U	14.8 U	19.5 U
Polycyclic Aromatic Hydrocarbons (µg/kg)						
2-Methylnaphthalene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	**17.9 J**
Acenaphthene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Acenaphthylene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Anthracene	20 UJ	19.7 UJ	19.6 UJ	19.8 UJ	19.8 UJ	19.3 UJ
Benzo(a)anthracene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Benzo(a)pyrene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Benzo(b,j,k)fluoranthenes	39.9 U	39.4 U	39.3 U	39.6 U	39.5 U	38.7 U
Benzo(g,h,i)perylene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Chrysene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Dibenzo(a,h)anthracene	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Dibenzofuran	20 U	19.7 U	19.6 U	19.8 U	19.8 U	**5.9 J**
Fluoranthene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Fluorene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Indeno(1,2,3-c,d)pyrene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Naphthalene	20 UJ	19.7 UJ	19.6 U	19.8 U	19.8 UJ	**5.8 J**
Phenanthrene	20 U	19.7 U	19.6 U	19.8 U	**6.7 J**	**15 J**
Pyrene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Total Benzofluoranthenes (b,j,k) (U = 0)	39.9 U	39.4 U	39.3 U	39.6 U	39.5 U	38.7 U
Total HPAH (DMMP) (U = 0)[1]	39.9 U	39.4 U	39.3 U	39.6 U	39.5 U	38.7 U
Total LPAH (DMMP) (U = 0)[2]	20 UJ	19.7 UJ	19.6 UJ	19.8 UJ	**6.7 J**	**20.8 J**
Total PAH (DMMP) (U = 0)	39.9 UJ	39.4 UJ	39.3 UJ	39.6 UJ	**6.7 J**	**20.8 J**
Pesticides (µg/kg)[3]						
4,4'-DDD (p,p'-DDD)	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U
4,4'-DDE (p,p'-DDE)	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	0.32 U	0.31 U	0.32 U	0.32 U	0.31 U	0.32 U
Aldrin	0.36 U	0.36 U	0.36 U	0.36 U	0.35 U	0.36 U
Chlordane, alpha- (Chlordane, cis-)	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	0.32 U	0.31 U	0.32 U	0.32 U	0.31 U	0.32 U
Dieldrin	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.05 U	0.04 U	0.05 U	0.05 U	0.04 U	0.05 U
Nonachlor, cis-	0.2 U	0.2 U	0.21 U	0.21 U	0.2 U	0.2 U
Nonachlor, trans-	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U
Oxychlordane	0.12 U	0.12 U	0.13 U	0.13 U	0.12 U	0.12 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	0.32 U	0.31 U	0.32 U	0.32 U	0.31 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	0.32 U	0.31 U	0.32 U	0.32 U	0.31 U	0.32 U
PCB Aroclors (µg/kg)						
Aroclor 1016	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1221	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1232	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1242	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1248	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1254	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1260	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1262	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1268	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Total DMMP PCB Aroclors (U = 0)	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
PCB Aroclors (mg/kg-OC)[6]						
Total DMMP PCB Aroclors (U = 0)	5.57 U	9.75 U	6.5 U	10 U	1.31 U	0.89 U

Notes:

Detected concentration is greater than DMMP SL screening level

Detected concentration is greater than DMMP BT screening level

Non-detected concentration is above one or more identified screening levels

TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 7

Summary of Dioxin/Furan Results

Sample ID	C-1-A-190219	C-1-B-190219	C-1-C-190219	C-2-A-190219	C-2-B-190219	C-3-A-190218	C-3-B-190218	C-4-A-190218	C-4-B-190218	C-5-A-190221	C-5-B-190221
Depth	0 - 2 ft	2 - 4 ft	4 - 6 ft	0 - 2 ft	2 - 4 ft	0 - 2.7 ft	2.7 - 5.8 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Analyte											
Dioxin Furans (ng/kg)											
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**1.87 J**	**0.51 J**	**0.08 J**	**1.23 J**	**0.26 J**	**2.53 J**	**0.08 J**	0.05 UJ	0.05 UJ	**0.59 J**	**0.67 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**1.78 J**	**0.32 J**	**0.03 J**	**0.96 J**	**0.19 J**	**2.42 J**	**0.02 J**	0.05 UJ	0.05 UJ	**0.36 J**	**0.01 J**

Sample ID	C-6-A-190219	C-6-B-190219	C-7-A-190221	C-7-B-190221	C-7-C-190221	C-8-A-190221	C-8-B-190221	C-9-A-190220	C-9-B-190220	C-10-A-190221	C-10-B-190221
Depth	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	4 - 6 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Analyte											
Dioxin Furans (ng/kg)											
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**0.74 J**	**0.05 J**	**4.38 J**	**0.53 J**	**0.68 J**	**5.00 J**	**0.60 J**	**0.06 J**	**0.06 J**	**8.79 J**	**7.42 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**0.57 J**	**5.60E-04 J**	**4.21 J**	**0.02 J**	**2.97E-05 J**	**4.88 J**	**0.07 J**	**0.01 J**	**2.88E-03 J**	**8.40 J**	**7.29 J**

Sample ID	C-10-C-190221	C-11-A-190220	C-11-B-190220	C-12-A-190223	C-12-B-190223	C-12-C-190223	C-12-D-190223	C-12-E-190223	C-13-A-190223	C-13-B-190223	C-13-C-190223
Depth	4 - 6 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	4 - 6 ft	6 - 8 ft	8 - 10 ft	0 - 2 ft	2 - 4 ft	4 - 6 ft
Analyte											
Dioxin Furans (ng/kg)											
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**0.61 J**	**5.92 J**	**0.18 J**	**56.21 J**	**54.47 J**	**17.74 J**	**0.63 J**	**0.07 J**	**5.34 J**	**7.73 J**	**11.88 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**0.42 J**	**5.76 J**	**0.09 J**	**56.21 J**	**54.01 J**	**17.55 J**	**0.51 J**	**2.76E-03 J**	**5.06 J**	**7.55 J**	**11.73 J**

Notes:

Detected concentration is greater than DMMP SL screening level (4 ng/kg TEQ)

Detected concentration is greater than DMMP BT screening level (10 ng/kg TEQ)

Bold: Detected result

*: EMPC value reported by laboratory; treated as non-detect (U) in the TEQ calculation

BT: Bioaccumulation Trigger

D/F: dioxins/furans

DMMP: Dredged Material Management Program

J: Estimated value

ML: Maximum Level

ng/kg: nanogram per kilogram

SL: Screening Level

TEF: toxic equivalence factor

TEQ: toxic equivalent

U: Compound analyzed, but not detected above detection limit

Table 7
Summary of Dioxin/Furan Results

Analyte	C-13-D-190223	C-13-E-190223	C-14-A-190221	C-14-B-190221	C-15-A-190222	C-15-B-190222	C-15-C-190222	C-16-A-190223	C-16-B-190223	C-17-A-190222	C-17-B-190222
Depth	6 - 8 ft	8 - 10 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	4 - 6 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Dioxin Furans (ng/kg)											
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**7.64 J**	**0.07 J**	**0.68 J**	**0.56 J**	**10.56 J**	**0.15 J**	**0.07 J**	**2.75 J**	**0.18 J**	**1.86 J**	**0.19 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**7.29 J**	**0.01 J**	**6.68E-03 J**	**0.07 J**	**9.37 J**	**0.08 J**	**0.01 J**	**2.66 J**	**0.11 J**	**1.81 J**	**0.11 J**

Analyte	C-17-C-190222	C-18-A1-190220	C-18-B1-190220	C-19-A-190220	C-19-B-190220	C-20-A-190219	C-20-B-190219	C-21-A-190219	C-21-B-190219	C-22-A-190219	C-22-B-190219
Depth	4 - 8 ft	0 - 2.3 ft	3.9 - 6.3 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Dioxin Furans (ng/kg)											
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**0.10 J**	**2.99 J**	**0.08 J**	**0.27 J**	**0.39 J**	**0.50 J**	**0.04 J**	**0.08 J**	**0.06 J**	**0.15 J**	**0.13 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**0.02 J**	**2.93 J**	**0.03 J**	**0.14 J**	**0.27 J**	**0.42 J**	**4.80E-04 J**	**0.02 J**	**0.02 J**	**0.09 J**	**0.06 J**

Analyte	C-23-A1-190222	C-23-B1-190222	C-24-A-190223	C-24-B-190223	C-25-A-190222	C-25-B-190222
Depth	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Dioxin Furans (ng/kg)						
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**0.35 J**	**0.08 J**	**0.63 J**	**0.05 J**	**0.07 J**	**0.07 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**0.27 J**	**0.01 J**	**0.48 J**	**5.5E-03 J**	**0.02 J**	**0.01 J**

Notes:

Detected concentration is greater than DMMP SL screening level (4 ng/kg TEQ)

Detected concentration is greater than DMMP BT screening level (10 ng/kg TEQ)

Bold: Detected result

*: EMPC value reported by laboratory; treated as non-detect (U) in the TEQ calculation

BT: Bioaccumulation Trigger

D/F: dioxins/furans

DMMP: Dredged Material Management Program

J: Estimated value

ML: Maximum Level

ng/kg: nanogram per kilogram

SL: Screening Level

TEF: toxic equivalence factor

TEQ: toxic equivalent

U: Compound analyzed, but not detected above detection limit

Table 8

Suitability Probabilities for Open-Water Disposal of Non-Native Material

Area	Station	sediment category	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Analyses[1]	Detected SL/BT Exceedance	Dioxins/furans above 4/10 pptr TEQ	Suitable/Unsuitable	Suitability Probablility	Average suitability probability	Rounded Suitability Probability
Mouth	C-1	surf	A	0 to 2	-49.9 to -51.9	Full Suite	no	no	suitable	100	92.86	**90**
	C-1	surf	B	2 to 4	-51.9 to -53.9	Full Suite	no	no	suitable	100		
	C-2	surf	A	0 to 2	-51.4 to -53.4	Full Suite	no	no	suitable	100		
	C-3	undetermined	A	0 to 2.7	-52.5 to -55.2	Full Suite	Total Chlordane non-detect	no	possibly suitable	50		
	C-3	undetermined	B	2.7 to 5.8	-55.2 to -58.3	Full Suite	no	no	suitable	100		
	C-4	surf	A	0 to 2	-53.6 to -55.6	Full Suite	no	no	suitable	100		
	C-5	surf	A	0 to 2	-51.5 to -53.5	Full Suite	no	no	suitable	100		
Middle	C-7	surf	A	0 to 2	-50.4 to -52.4	Full Suite	no	4.38	likely suitable	75	63.63636364	**60**
	C-8	undetermined	A	0 to 2	-52.0 to -54.0	Full Suite	no	5.00	likely suitable	75		
	C-8	undetermined	B	2 to 4	-54.0 to -56.0	Full Suite	no	no	suitable	100		
	C-10	surf	A	0 to 2	-49.0 to -51.0	Full Suite	no	8.79	likely suitable	75		
	C-10	surf	B	2 to 4	-51.0 to -53.0	Full Suite	Tributyltin	7.42	unsuitable	0		
	C-10	surf	C	4 to 6	-53.0 to -55.0	Full Suite	no	no	suitable	100		
	C-11	surf	A	0 to 2	-51.6 to -53.6	Full Suite	Total Chlordane non-detect	5.92	possibly suitable	50		
	C-12	undetermined	A	0 to 2	-22.7 to -24.7	Full Suite	Total PCB Aroclors	56.2	unsuitable	0		
	C-12	undetermined	B	2 to 4	-24.7 to -26.7	Full Suite	no	54.5	unsuitable	0		
	C-12	undetermined	C	4 to 6	-26.7 to -28.7	Full Suite	no	17.7	unsuitable	0		
	C-12	undetermined	D	6 to 8	-28.7 to -30.7	D/F	no	no	suitable	100		
	C-12	undetermined	E	8 to 10	-30.7 to -32.7	D/F	no	no	suitable	100		
	C-13	undetermined	A	0 to 2	-39.0 to -41	Full Suite	no	5.34	likely suitable	75		
	C-13	undetermined	B	2 to 4	-41.0 to -43.0	Full Suite	no	7.73	likely suitbble	75		
	C-13	undetermined	C	4 to 6	-43.0 to -45.0	Full Suite	no	11.88	unsuitable	0		
	C-13	undetermined	D	6 to 8	-45.0 to -47.0	D/F	no	7.64	likely suitable	75		
	C-13	undetermined	E	8 to 10	-47.0 to -49.0	D/F	no	no	suitable	100		
	C-14	surf	A	0 to 2	-52.6 to -54.6	Full Suite	no	no	suitable	100		
	C-14	surf	B	2 to 4	-54.6 to -56.6	Full Suite	no	no	suitable	100		
	C-15	undetermined	A	0 to 2	-45.6 to -47.6	Full Suite	no	10.6	unsuitable	0		
	C-15	undetermined	B	2 to 4	-47.6 to -49.6	Full Suite	no	no	suitable	100		
	C-15	undetermined	C	4 to 6	-49.6 to -51.6	Full Suite	no	no	suitable	100		
Head	C-16	surf	A	0 to 2	-50.6 to -52.6	Full Suite	no	no	suitable	100	100	**100**
	C-17	undetermined	A	0 to 2	-19.7 to -21.7	Full Suite	no	no	suitable	100		
	C-17	undetermined	B	2 to 4	-21.7 to -23.7	Full Suite	no	no	suitable	100		
	C-17	undetermined	C	4 to 8	-23.7 to -25.7	Full Suite	no	no	suitable	100		
	C-18	surf	A	0 to 2.3	-52.2 to -54.5	Full Suite	no	no	suitable	100		
	C-24	surf	A	0 to 2	-51.1 to -53.1	Full Suite	no	no	suitable	100		
	C-25	surf	A	0 to 2	-51.4 to -53.4	Full Suite	no	no	suitable	100		
	C-25	surf	B	2 to 4	-53.4 to -55.4	Full Suite	no	no	suitable	100		

Legend

	Probability of being suitable during full characterization
suitable	100
likely suitable	75
possibly suitable	50
unsuitable	0

above SL, BT or dioxin above 4 pptr TEQ

dioxin above 10 pptr TEQ

all less than SLs/BTs

Table 9
Suitability Probabilities for Open-Water Disposal of Native Material

Station		Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Analyses[1]	Detected SL/BT Exceedance	Dioxins/furans above 4 pptr TEQ	Suitable/Unsuitable	Suitability Probablility	Average suitability probability	Rounded Suitability Probability
C-1	native	C	4 to 6	-53.9 to -55.9	Full Suite	no	no	suitable	100		
C-2	native	B	2 to 4	-53.4 to -55.4	Full Suite	no	no	suitable	100		
C-2	native	C	4 to 6	-55.4 to -57.4	TBT	no	no	suitable	100		
C-2	native	D	6 to 8.6	57.4 to -60.0	TBT	no	no	suitable	100		
C-4	native	B	2 to 4	-55.6 to -57.6	Full Suite	no	no	suitable	100		
C-5	native	B	2 to 4	-53.5 to -55.5	Full Suite	no	no	suitable	100		
C-6	native	A	0 to 2	-53.9 to -55.9	Full Suite	no	no	suitable	100		
C-6	native	B	2 to 4	-55.9 to -57.9	Full Suite	no	no	suitable	100		
C-7	native	B	2 to 4	-52.4 to -54.4	Full Suite	Hexachlorobutadiene	no	possibly suitable	50		
C-7	native	C	4 to 6	-54.4 to -56.4	Full Suite	no	no	suitable	100	98.07692308	
C-9	native	A	0 to 2	-53.0 to -55.0	Full Suite	no	no	suitable	100		
C-9	native	B	2 to 4	-55.0 to -57.0	Full Suite	no	no	suitable	100		
C-11	native	B	2 to 4	-53.6 to -55.6	Full Suite	no	no	suitable	100		**95**
C-16	native	B	2 to 4	-52.6 to -54.6	Full Suite	no	no	suitable	100		
C-18	native	B	3.9 to 6.3	-54.5 to -56.9	Full Suite	no	no	suitable	100		
C-19	native	A	0 to 2	-52.4 to -54.4	Full Suite	no	no	suitable	100		
C-19	native	B	2 to 4	-54.4 to -56.4	Full Suite	no	no	suitable	100		
C-20	native	A	0 to 2	-51.3 to -53.3	Full Suite	no	no	suitable	100		
C-20	native	B	2 to 4	-53.3 to -55.3	Full Suite	no	no	suitable	100		
C-21	native	A	0 to 2	-53.7 to -55.7	Full Suite	no	no	suitable	100		
C-21	native	B	2 to 4	-55.7 to -57.7	Full Suite	no	no	suitable	100		
C-22	native	A	0 to 2	-51.0 to -53.0	Full Suite	no	no	suitable	100		
C-22	native	B	2 to 4	-53.0 to -55.0	Full Suite	no	no	suitable	100		
C-23	native	A	0 to 2	-53.7 to -55.7	Full Suite	no	no	suitable	100		
C-23	native	B	2 to 4	-55.7 to -57.7	Full Suite	no	no	suitable	100		
C-24	native	B	2 to 4	-53.1 to -55.1	Full Suite	no	no	suitable	100		

Legend

	Probability of being suitable during full characterization
suitable	100
likely suitable	75
possibly suitable	50
unsuitable	0

above SL, BT or dioxin above 4 pptr TEQ

dioxin above 10 pptr TEQ

all less than SLs/BTs

Table 10
SMS Comparison for Samples with TOC above 0.5%

Sample ID		C-1-A-190219	C-5-B-190221	C-6-B-190219	C-7-A-190221	C-8-A-190221	C-10-A-190221	C-11-A-190220	C-12-A-190223	C-12-C-190223	C-13-A-190223	C-17-A-190222	C-17-B-190222
Sample Date		2/19/2019	2/21/2019	2/19/2019	2/21/2019	2/21/2019	2/21/2019	2/20/2019	2/23/2019	2/23/2019	2/23/2019	2/22/2019	2/22/2019
Depth		0 - 2 ft	2 - 4 ft	2 - 4 ft	0 - 2 ft	0 - 2 ft	0 - 2 ft	0 - 2 ft	0 - 2 ft	4 - 6 ft	0 - 2 ft	0 - 2 ft	2 - 4 ft
Analyte	SQS	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ
Conventional Parameters (%)													
Total organic carbon		0.71	0.74	0.71	0.55	0.54	1.01	0.86	0.61	0.75	0.59	0.83	3.24
Metals (mg/kg)													
Arsenic	57	3.24	1.63	1.41	4.52	4.3	5.95	4.8	6.8	5.07	6.08	3.74	3.44
Cadmium	5.1	0.09 J	0.05 J	0.13 U	0.08 J	0.07 J	0.13 J	0.09 J	0.14	0.14	0.11 J	0.05 J	0.21
Chromium	260	14.7	12.7	11.1	16.3	13.6	15.6	14.3	16.3	16.7	13	16.3	16.4
Copper	390	26.7	16.9	15.6	25.2	24.4	31.8	27.3	29.2	24.7	66.1	32.6	30.7
Lead	450	6.01	1.86	1.46	6.14	5.97	8.1	6.34	14.8	5.11	4.5	3.94	3.12
Mercury	0.41	0.0423	0.0227 U	0.00982 J	0.0278 J	0.0351 J	0.0428 J	0.0352	0.0703	0.0549	0.0252	0.0296	0.0373
Silver	6.1	0.12 J	0.06 J	0.06 J	0.11 J	0.11 J	0.16 J	0.13 J	0.14 J	0.09 J	0.08 J	0.1 J	0.1 J
Zinc	410	33.3	24	18.8	37.2	34.1	43.4	36.7	43.7	29.8	43.1	30.4	25.3
Semivolatile Organics (ug/kg)													
Benzoic acid	650	84.7 J	56.2 J	37.8 J	26.5 J	37.1 J	146	93.3 J	228 J	46.1 J	71.1 J	310	164
Benzyl alcohol	57	19.9 U	19.5 U	19.7 U	19.9 U	19.5 U	19.7 U	17.9 J	19 U	19.9 U	19.6 U	19.9 U	19.5 U
2,4-Dimethylphenol	29	24.9 UJ	24.4 U	24.6 UJ	24.8 U	24.4 U	3.4 J	3.1 J	10.6 J	24.9 U	24.5 U	24.8 UJ	2.6 J
2-Methylphenol (o-Cresol)	63	3 J	4.9 U	4.9 U	5 U	4.9 U	4.9 U	2.2 J	4.8 U	5 U	4.9 U	2.7 J	3.1 J
4-Methylphenol (p-Cresol)	670	5	4.9 U	4.9 U	5 U	4.9 U	6.4	6.8	14.4	2.8 J	4.9 U	4.7 J	7.6
Pentachlorophenol	360	19.9 UJ	5.5 J	19.7 UJ	19.9 UJ	19.5 UJ	9.3 J	4.1 J	11.2 J	19.9 UJ	19.6 UJ	4.5 J	19.5 UJ
Phenol	420	13.5 U	8.1 U	6.4 U	6.2 U	4.9 U	15 U	20.3	53 U	17.5 U	23.7 U	41	34.7
Semivolatile Organics (mg/kg OC)													
1,2,4-Trichlorobenzene	0.81	0.38 U	0.35 U	0.37 U	0.49 U	0.48 U	0.26 U	0.29 U	0.41 U	0.36 U	0.44 U	0.33 U	0.08 U
1,2-Dichlorobenzene	2.3	0.70 U	0.13 J	0.69 U	0.70 U	0.69 U	0.69 U	0.66 U	0.86	0.70 U	0.69 U	0.70 U	0.69 U
1,4-Dichlorobenzene	3.1	0.70 U	0.69 U	0.69 U	0.70 U	0.69 U	0.69 U	0.66 U	0.52 J	0.70 U	0.69 U	0.70 UJ	0.69 UJ
Hexachlorobenzene	0.38	0.10 U	0.09 U	0.10 U	0.13 U	0.13 U	0.07 U	0.08 U	0.11 U	0.09 U	0.12 U	0.08 U	0.02 U
bis(2-Ethylhexyl)phthalate	47	7.01 U	6.89 U	6.93 U	4.21 J	6.87 U	7.99	4.25 J	14.93	7.01 U	4.28 J	7.00 U	6.86 U
Butylbenzyl phthalate	4.9	2.80 U	2.75 U	2.77 U	2.80 U	2.75 U	2.77 U	2.68 U	2.68 U	2.80 U	2.76 U	2.80 U	2.75 U
Diethyl phthalate	61	2.80 U	2.75 U	2.77 U	2.80 U	9.44 U	2.77 U	--	2.68 U	2.80 U	2.76 U	2.80 U	2.75 U
Dimethyl phthalate	53	0.70 U	0.69 U	0.69 U	0.70 U	0.69 U	0.69 U	0.66 U	0.44 J	0.70 U	0.69 U	0.70 U	0.69 U
Di-n-butyl phthalate	220	5.25	3.28 U	7.90	6.80 U	2.75 U	5.83 U	10.17	2.68 U	2.80 U	2.76 U	13.79 U	14.07 U
Di-n-octyl phthalate	58	2.80 U	2.75 U	2.77 U	2.80 U	2.75 U	2.77 U	2.68 U	2.68 U	2.80 U	2.76 U	2.80 U	2.75 U
Hexachlorobutadiene	3.9	0.70 U	0.66 U	0.69 U	0.91 U	0.91 U	0.49 U	0.55 U	0.79 U	0.67 U	0.83 U	0.60 U	0.15 U
Dibenzofuran	15	1.23 J	2.75 U	0.76 J	2.80 U	1.73 J	2.34 J	1.27 J	3.37	2.80 U	2.76 U	2.80 U	2.75 U
n-Nitrosodiphenylamine	11	0.70 U	0.69 U	0.69 U	0.70 U	0.69 U	0.48 J	0.66 U	0.68 U	0.70 U	0.69 U	0.70 U	0.69 U
Polycyclic Aromatic Hydrocarbons (mg/kg OC)													
2-Methylnaphthalene	38	3.48	2.42 J	3.00	2.80 U	4.94	4.03	2.49 J	3.03	2.80 U	1.00 J	1.65 J	1.00 J
Acenaphthene	16	2.80 U	2.75 U	2.77 U	2.80 U	1.08 J	1.06 J	2.68 U	2.97	2.80 U	2.76 U	2.80 U	2.75 U
Acenaphthylene	66	2.80 U	2.75 U	2.77 U	2.80 U	0.90 J	1.55 J	2.68 U	1.54 J	2.80 U	2.76 U	2.80 U	2.75 U
Anthracene	220	2.08 J	2.75 U	2.77 U	1.86 J	2.83	4.04	2.62 J	3.75 J	1.20 J	0.97 J	2.80 UJ	2.75 UJ
Benzo(a)anthracene	110	3.39	0.73 J	2.77 U	4.20	5.41	7.92	5.99	3.54	1.13 J	2.41 J	0.92 J	2.75 U
Benzo(a)pyrene	99	2.86	2.75 U	2.77 U	5.32	5.89	9.46	6.49	5.68	1.37 J	3.25	2.80 U	2.75 U
Benzo(b,j,k)fluoranthenes	230	8.13	5.51 U	5.54 U	17.04	13.90	28.87	16.62	16.06	3.17 J	8.86	3.20 J	5.49 U
Benzo(g,h,i)perylene	31	2.06 J	2.75 U	2.77 U	4.13	3.82	6.83	4.66	4.34	1.37 J	2.93	2.80 U	2.75 U
Chrysene	110	5.28	1.00 J	1.04 J	7.15	10.10	11.65	8.65	7.20	1.66 J	3.92	2.07 J	1.24 J
Dibenzo(a,h)anthracene	12	0.62 J	0.69 U	0.69 U	1.24	1.66	2.65	1.30	1.55	0.38 J	0.93	0.37 J	0.69 U
Fluoranthene	160	6.68	2.75 U	2.77 U	6.66	9.08	15.49	7.34	12.80	2.61 J	3.59	1.13 J	2.75 U
Fluorene	23	1.17 J	2.75 U	2.77 U	0.82 J	1.45 J	2.21 J	1.13 J	3.94	2.80 U	2.76 U	2.80 U	2.75 U
Indeno(1,2,3-c,d)pyrene	34	1.89 J	2.75 U	2.77 U	3.90	3.54	6.18	4.15	3.58	1.03 J	2.24 J	2.80 U	2.75 U
Naphthalene	99	3.03	1.11 J	1.56 J	2.39 J	3.66	3.90	2.83	8.48	2.38 J	1.11 J	0.89 J	0.96 J
Phenanthrene	100	6.44	2.69 J	3.34	4.76	8.44	7.51	5.52	11.03	3.41	2.30 J	3.55	1.93 J
Pyrene	1000	8.66	2.75 U	2.77 U	9.27	11.49	24.51	10.70	30.28	5.65	6.87	3.00	2.75 U
PCB Aroclors (mg/kg-OC)[6]													
Total DMMP PCB Aroclors (U = 0)	12	0.72 J	0.54 U	0.56 U	1.71 J	2.19 J	2.01 J	0.7 J	28.41 J	3.27 J	1.98 J	0.72 J	0.12 U

non-detect reported at MDL
non-detect exceedance
detected exceedance

Table 11

SMS Comparison for Samples with TOC less than 0.5%

Analyte	SQS	C-1-B-190219 2 - 4 ft	C-1-C-190219 4 - 6 ft	C-2-A-190219 0 - 2 ft	C-2-B-190219 2 - 4 ft	C-3-A-190218 0 - 2.7 ft	C-3-B-190218 2.7 - 5.8 ft	C-4-A-190218 0 - 2 ft	C-4-B-190218 2 - 4 ft	C-5-A-190221 0 - 2 ft	C-6-A-190219 0 - 2 ft	C-7-B-190221 2 - 4 ft	C-7-C-190221 4 - 6 ft	C-8-B-190221 2 - 4 ft
Conventional Parameters (%)														
Total organic carbon		**0.21**	**0.09**	**0.37**	**0.26**	**0.49**	**0.27**	**0.15**	**0.12**	**0.28**	**0.22**	**0.44**	**0.2**	**0.39**
Metals (mg/kg)														
Arsenic	57	**1.67**	**1.06**	**4.97**	**1.95**	**3.7**	**1.77**	**1.12**	**1.01**	**1.59**	**1.14**	**1.76**	**1.39**	**2.66**
Cadmium	5.1	0.11 U	0.12 U	**0.05 J**	**0.05 J**	**0.06 J**	0.12 U	0.12 U	0.12 U	**0.04 J**	**0.12**	0.12 U	0.12 U	**0.07 J**
Chromium	260	**11**	**9.49**	**12.5**	**12.7**	**12.3**	**10.9**	**11.8**	**10.8**	**11.3**	**9.11**	**8.75**	**9.6**	**16.8**
Copper	390	**13.7**	**10.3**	**18.3**	**16.6**	**25.5**	**14.9**	**11.9**	**10.8**	**14.4**	**10.3**	**10.1**	**9.06**	**28.3**
Lead	450	**2.33**	**1.33**	**3.46**	**2.15**	**6.26**	**1.55**	**1.26**	**1.21**	**2.25**	**1.42**	**1.11**	**1.06**	**3.39**
Mercury	0.41	**0.025**	**0.0114 J**	**0.0249 J**	**0.0167 J**	**0.0599 J**	0.0231 UJ	0.026 UJ	0.0254 UJ	0.0269 U	0.0241 U	0.0266 U	0.0214 U	**0.0183 J**
Silver	6.1	**0.06 J**	**0.03 J**	**0.08 J**	**0.05 J**	**0.12 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.06 J**	**0.04 J**	**0.04 J**	**0.03 J**	**0.09 J**
Zinc	410	**19.3**	**14.9**	**27**	**23.7**	**34.4**	**19.9**	**20**	**19.4**	**21.1**	**17.9**	**16.4**	**16.7**	**32.1**
Semivolatile Organics (ug/kg)														
Benzoic acid	650	95.9 UJ	96.3 UJ	97.5 UJ	97 UJ	**85.1 J**	**15.8 J**	**16.8 J**	94.3 UJ	**21.2 J**	99.1 UJ	97.1 U	98.8 U	99.5 U
Benzyl alcohol	57	19.2 U	19.3 U	19.5 U	19.4 U	**13.4 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Hexachlorobutadiene	11	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	**26.5**	4.9 U	5 U
2,4-Dimethylphenol	29	24 UJ	24.1 UJ	24.4 UJ	24.3 UJ	24.1 UJ	24.6 UJ	24.3 UJ	23.6 UJ	24.9 U	24.8 UJ	24.3 U	24.7 U	24.9 U
2-Methylphenol (o-Cresol)	63	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
4-Methylphenol (p-Cresol)	670	4.8 U	4.8 U	**2.9 J**	4.9 U	**5.4**	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
Pentachlorophenol	360	19.2 UJ	19.3 UJ	19.5 UJ	19.4 UJ	19.3 UJ	19.7 UJ	19.4 UJ	18.9 UJ	**5.4 J**	19.8 UJ	19.4 UJ	19.8 UJ	19.9 UJ
Phenol	420	4.8 U	4.8 U	7.8 U	4.9 U	**30**	6.1 U	5.6 U	4.7 U	6.4 U	5 U	5.4 U	4.9 U	5 U
Semivolatile Organics (ug/kg)														
1,2,4-Trichlorobenzene	31	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
1,2-Dichlorobenzene	35	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
1,4-Dichlorobenzene	110	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
Hexachlorobenzene	22	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	**3 J**	4.9 U	5 U
bis(2-Ethylhexyl)phthalate	1300	47.9 U	48.2 U	48.8 U	48.5 U	**29.5 J**	49.2 U	48.6 U	47.1 U	49.8 U	49.5 U	48.6 U	49.4 U	49.8 U
Butylbenzyl phthalate	63	19.2 U	19.3 U	19.5 U	19.4 U	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Diethyl phthalate	200	19.2 U	19.3 U	19.5 U	19.4 U	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	25.5 U	27.7 U
Dimethyl phthalate	71	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
Di-n-butyl phthalate	1400	**22.5**	**22.4**	**40.6**	**14.9 J**	**118**	**69.7**	**96.1**	**108**	19.9 U	**43.4**	19.4 U	30.6 U	19.9 U
Di-n-octyl phthalate	6200	19.2 U	19.3 U	19.5 U	19.4 U	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Dibenzofuran	540	19.2 U	19.3 U	19.5 U	19.4 U	**12 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
n-Nitrosodiphenylamine	28	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
Polycyclic Aromatic Hydrocarbons (ug/kg)														
2-Methylnaphthalene	670	**8.6 J**	19.3 U	19.5 U	**6.4 J**	**18.4 J**	**8 J**	19.4 U	18.9 U	19.9 U	19.8 U	**7.8 J**	**9.8 J**	**9.8 J**
Acenaphthene	500	19.2 U	19.3 U	19.5 U	19.4 U	**7 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Acenaphthylene	1300	19.2 U	19.3 U	19.5 U	19.4 U	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Anthracene	960	19.2 U	19.3 U	**7.7 J**	19.4 U	**13.9 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Benzo(a)anthracene	1300	**16.6 J**	19.3 U	**17.5 J**	**5.2 J**	**20.7**	19.7 U	19.4 U	18.9 U	**7.4 J**	19.8 U	19.4 U	19.8 U	**5.4 J**
Benzo(a)pyrene	1600	**16.7 J**	19.3 U	**16.3 J**	19.4 U	**26.8**	19.7 U	19.4 U	18.9 U	**8.5 J**	19.8 U	19.4 U	19.8 U	19.9 U
Benzo(b,j,k)fluoranthenes	3200	**35.3 J**	38.5 U	**38.8 J**	38.8 U	**75.9**	39.4 U	38.9 U	37.7 U	**26.9 J**	39.6 U	38.8 U	39.5 U	39.8 U
Benzo(g,h,i)perylene	670	**8 J**	19.3 U	**10.1 J**	19.4 U	**20.1**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Chrysene	1400	**21.2**	19.3 U	**24**	**6.7 J**	**34.4**	**5.3 J**	19.4 U	18.9 U	**11.7 J**	19.8 U	19.4 U	19.8 U	**17.6 J**
Dibenzo(a,h)anthracene	230	**3.7 J**	4.8 U	**2.7 J**	4.9 U	**7.6**	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
Fluoranthene	1700	**22**	19.3 U	**32.1**	**7.7 J**	**38.3**	19.7 U	19.4 U	18.9 U	**11.9 J**	19.8 U	19.4 U	19.8 U	19.9 U
Fluorene	540	19.2 U	19.3 U	19.5 U	19.4 U	**11 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Indeno(1,2,3-c,d)pyrene	600	**7.4 J**	19.3 U	**8.3 J**	19.4 U	**16.7 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Naphthalene	2100	**8.7 J**	19.3 U	**11.7 J**	**5.3 J**	**31**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	**8.5 J**	19.9 U
Phenanthrene	1500	**13.6 J**	19.3 U	**24.9**	**13 J**	**36.9**	**13 J**	**5.9 J**	18.9 U	**12.9 J**	19.8 U	**14.7 J**	19.8 U	**22.6**
Pyrene	2600	**27.1**	19.3 U	**39.5**	**9.3 J**	**63.5**	19.7 U	19.4 U	18.9 U	**15.9 J**	**6.3 J**	19.4 U	19.8 U	19.9 U
PCB Aroclors (µg/kg)														
Total DMMP PCB Aroclors (U = 0)	130	3.9 U	4 U	**2 J**	4 U	**3.8 J**	4 U	4 U	3.9 U	**0.8 J**	**1.9 J**	4 U	4 U	3.9 U

non-detect exceedance
detected exceedance
AET-based SQS different from DMMP SL

Table 11
SMS Comparison for Samples with TOC less than 0.5%

Sample ID / Depth / Analyte	SQS	C-9-A-190220 0 - 2 ft	C-9-B-190220 2 - 4 ft	C-10-B-190221 2 - 4 ft	C-10-C-190221 4 - 6 ft	C-11-B-190220 2 - 4 ft	C-12-B-190223 2 - 4 ft	C-13-B-190223 2 - 4 ft	C-13-C-190223 4 - 6 ft	C-14-A-190221 0 - 2 ft	C-14-B-190221 2 - 4 ft	C-15-A-190222 0 - 2 ft	C-15-B-190222 2 - 4 ft	C-15-C-190222 4 - 6 ft
Conventional Parameters (%)														
Total organic carbon		**0.11**	**0.19**	**0.45**	**0.19**	**0.14**	**0.37**	**0.39**	**0.18**	**0.09**	**0.15**	**0.25**	**0.1**	**0.17**
Metals (mg/kg)														
Arsenic	57	**2.08**	**2.58**	**3.4**	**1.88**	**1.3**	**5.07**	**6.67**	**3.88**	**4.18**	**5.08**	**6.4**	**2.74**	**4.28**
Cadmium	5.1	0.11 U	**0.09 J**	**0.12 J**	**0.1**	0.12 U	**0.13**	**0.11 J**	**0.05 J**	0.11 U	**0.06 J**	**0.05 J**	0.11 U	**0.04 J**
Chromium	260	**11.3**	**11.8**	**11.3**	**8.23**	**10.7**	**16.2**	**13.5**	**12**	**11.3**	**13**	**12.4**	**9.38**	**11.5**
Copper	390	**10.7**	**14.4**	**19.1**	**11.8**	**11.1**	**23.8**	**22.7**	**14.1**	**12.3**	**14.6**	**21.3**	**11.5**	**14.3**
Lead	450	**1.25**	**1.61**	**4.2**	**1.46**	**1.33**	**6.32**	**5.04**	**1.67**	**1.54**	**1.8**	**5.36**	**1.36**	**1.74**
Mercury	0.41	0.0217 U	**0.00517 J**	**0.0271 J**	**0.00691 J**	0.0241 U	**0.0607**	**0.0381**	**0.011 J**	0.0216 U	0.0216 U	**0.027 J**	**0.0142 J**	**0.0148 J**
Silver	6.1	**0.04 J**	**0.06 J**	**0.09 J**	**0.04 J**	**0.04 J**	**0.09 J**	**0.11 J**	**0.05 J**	**0.04 J**	**0.05 J**	**0.09 J**	**0.04 J**	**0.05 J**
Zinc	410	**18**	**19.7**	**25.5**	**15.8**	**18.7**	**30.4**	**34.2**	**22.2**	**21.7**	**22.2**	**30**	**18**	**22.5**
Semivolatile Organics (ug/kg)														
Benzoic acid	650	99.1 UJ	95.3 UJ	**43.3 J**	96 U	94 UJ	**77 J**	**76.3 J**	**22.3 J**	97.1 U	98.6 U	**79.4 J**	99 U	99 UJ
Benzyl alcohol	57	**10.1 J**	**9.7 J**	19.1 U	19.2 U	18.8 U	19.8 U	**3.4 J**	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Hexachlorobutadiene	11	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
2,4-Dimethylphenol	29	24.8 UJ	23.8 UJ	23.8 U	24 U	23.5 UJ	**2.8 J**	24.8 U	24.5 U	24.3 U	24.7 U	23.6 UJ	24.8 UJ	24.8 UJ
2-Methylphenol (o-Cresol)	63	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
4-Methylphenol (p-Cresol)	670	5 U	4.8 U	**2.7 J**	4.8 U	4.7 U	**5.1**	**3.1 J**	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Pentachlorophenol	360	19.8 UJ	19.1 UJ	19.1 UJ	19.2 UJ	18.8 UJ	**10.1 J**	19.9 UJ	19.6 UJ	19.4 UJ	**7.7 J**	18.9 UJ	19.8 UJ	19.8 UJ
Phenol	420	5 U	5.3 U	9.7 U	4.8 U	4.7 U	23.1 U	31.6 U	8.2 U	4.9 U	4.9 U	13.7 U	5.9 U	7 U
Semivolatile Organics (ug/kg)														
1,2,4-Trichlorobenzene	31	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
1,2-Dichlorobenzene	35	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
1,4-Dichlorobenzene	110	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 UJ	5 UJ	5 UJ
Hexachlorobenzene	22	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
bis(2-Ethylhexyl)phthalate	1300	49.5 U	47.7 U	**32.8 J**	48 U	47 U	**32.9 J**	**41.7 J**	49 U	**54.7**	49.3 U	**61.8**	49.5 U	49.5 U
Butylbenzyl phthalate	63	19.8 U	19.1 U	19.1 U	19.2 U	18.8 U	19.8 U	19.9 U	19.6 U	19.4 U	19.7 U	**7.8 J**	19.8 U	19.8 U
Diethyl phthalate	200	19.8 U	19.1 U	19.1 U	24.5 U	18.8 U	38.2 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	31.9 U
Dimethyl phthalate	71	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Di-n-butyl phthalate	1400	**23.4**	**40.5**	20.6 U	30.4 U	**17.7 J**	**6 J**	19.9 U	19.6 U	34.4 U	39.9 U	121 U	81.4 U	38.6 U
Di-n-octyl phthalate	6200	19.8 U	19.1 U	19.1 U	19.2 U	18.8 U	19.8 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Dibenzofuran	540	19.8 U	19.1 U	**7.2 J**	19.2 U	18.8 U	**9.6 J**	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
n-Nitrosodiphenylamine	28	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Polycyclic Aromatic Hydrocarbons (ug/kg)														
2-Methylnaphthalene	670	19.8 U	19.1 U	**10.6 J**	19.2 U	18.8 U	19.8 U	**7 J**	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Acenaphthene	500	19.8 U	19.1 U	19.1 U	19.2 U	18.8 U	**8.2 J**	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Acenaphthylene	1300	19.8 U	19.1 U	19.1 U	19.2 U	18.8 U	19.8 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Anthracene	960	19.8 U	19.1 U	**16.1 J**	19.2 U	18.8 U	**14.4 J**	**10.6 J**	19.6 UJ	19.4 U	19.7 U	**6.1 J**	19.8 UJ	19.8 UJ
Benzo(a)anthracene	1300	19.8 U	19.1 U	**33.6**	19.2 U	18.8 U	**13.1 J**	**19.2 J**	19.6 U	19.4 U	19.7 U	**10.2 J**	19.8 U	19.8 U
Benzo(a)pyrene	1600	19.8 U	19.1 U	**45.7**	19.2 U	18.8 U	**18.8 J**	**29.4**	19.6 U	19.4 U	19.7 U	**18.9**	19.8 U	19.8 U
Benzo(b,j,k)fluoranthenes	3200	39.6 U	38.1 U	**115**	38.4 U	37.6 U	**49.2**	**85.1**	39.2 U	38.8 U	39.4 U	**54.5**	39.6 U	39.6 U
Benzo(g,h,i)perylene	670	19.8 U	19.1 U	**30.3**	19.2 U	18.8 U	**17.2 J**	**26.9**	19.6 U	19.4 U	19.7 U	**10.9 J**	19.8 U	19.8 U
Chrysene	1400	19.8 U	19.1 U	**53.7**	19.2 U	18.8 U	**23.4**	**32.4**	19.6 U	19.4 U	19.7 U	**17 J**	19.8 U	19.8 U
Dibenzo(a,h)anthracene	230	5 U	4.8 U	**12.4**	4.8 U	4.7 U	**6**	**8.6**	4.9 U	4.9 U	4.9 U	**4.8**	5 U	5 U
Fluoranthene	1700	19.8 U	19.1 U	**52**	19.2 U	18.8 U	**36**	**25.2**	19.6 U	19.4 U	19.7 U	**16.5 J**	19.8 U	19.8 U
Fluorene	540	19.8 U	19.1 U	**7.3 J**	19.2 U	18.8 U	**12.5 J**	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Indeno(1,2,3-c,d)pyrene	600	19.8 U	19.1 U	**28.7**	19.2 U	18.8 U	**14.6 J**	**21.9**	19.6 U	19.4 U	19.7 U	**10.6 J**	19.8 U	19.8 U
Naphthalene	2100	19.8 U	19.1 U	**15.9 J**	19.2 U	18.8 U	**27.9**	**9 J**	19.6 U	19.4 U	19.7 U	**8.9 J**	19.8 UJ	19.8 UJ
Phenanthrene	1500	19.8 U	**14.7 J**	**43**	**7.7 J**	18.8 U	**38.5**	**21.4**	**5.8 J**	19.4 U	19.7 U	**15.8 J**	**6.1 J**	19.8 U
Pyrene	2600	19.8 U	19.1 U	**79.1**	**6.6 J**	18.8 U	**71.1**	**68.5**	19.6 U	19.4 U	19.7 U	**27.5**	19.8 U	19.8 U
PCB Aroclors (µg/kg)														
Total DMMP PCB Aroclors (U = 0)	130	4 U	3.9 U	**11.2 J**	3.9 U	3.8 U	**90.1 J**	**23.1 J**	**3.7 J**	3.9 U	4 U	**19.4 J**	4 U	4 U

non-detect exceedance
detected exceedance
AET-based SQS different from DMMP SL

Table 11

SMS Comparison for Samples with TOC less than 0.5%

Analyte	SQS	C-16-A-190223 0 - 2 ft	C-16-B-190223 2 - 4 ft	C-17-C-190222 4 - 8 ft	C-18-A1-190220 0 - 2.3 ft	C-18-B1-190220 3.9 - 6.3 ft	C-19-A-190220 0 - 2 ft	C-19-B-190220 2 - 4 ft	C-20-A-190219 0 - 2 ft	C-20-B-190219 2 - 4 ft	C-21-A-190219 0 - 2 ft	C-21-B-190219 2 - 4 ft	C-22-A-190219 0 - 2 ft	C-22-B-190219 2 - 4 ft
Conventional Parameters (%)														
Total organic carbon		**0.25**	**0.05**	**0.39**	**0.29**	**0.13**	**0.09**	**0.1**	**0.08**	**0.04**	**0.49**	**0.11**	**0.07**	**0.04**
Metals (mg/kg)														
Arsenic	57	**3.82**	**2.21**	**2.15**	**3.2**	**3.89**	**1.89**	**2.53**	**1.28**	**1.1**	**4.41**	**2.26**	**1.59**	**1.31**
Cadmium	5.1	**0.07 J**	0.11 U	**0.04 J**	**0.05 J**	0.11 U	0.1 U	0.12 U	**0.05 J**	**0.03 J**	0.11 U	**0.05 J**	0.1 U	0.1 U
Chromium	260	**10.2**	**10.6**	**14.4**	**11.5**	**10.1**	**9.73**	**10.3**	**9.69**	**10.4**	**7.99**	**8.59**	**11.3**	**9.53**
Copper	390	**14.9**	**10.5**	**21.2**	**16.1**	**13**	**12.7**	**15.2**	**13.9**	**14**	**14.9**	**14.9**	**12.7**	**10.9**
Lead	450	**2.82**	**1.29**	**2.07**	**2.81**	**1.51**	**1.54**	**1.84**	**1.41**	**1.5**	**1.43**	**1.49**	**1.36**	**1.41**
Mercury	0.41	**0.0195 J**	**0.00813 J**	**0.0201 J**	0.0291 U	0.021 U	0.0187 U	0.0204 U	**0.00698 J**	**0.00973 J**	**0.0112 J**	**0.0134 J**	**0.00859 J**	**0.00788 J**
Silver	6.1	**0.08 J**	**0.04 J**	**0.07 J**	**0.05 J**	**0.04 J**	**0.04 J**	**0.05 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.03 J**	**0.03 J**	**0.03 J**
Zinc	410	**22.5**	**19.7**	**23.9**	**25.6**	**29.6**	**20.9**	**21.3**	**18.7**	**20.1**	**18**	**20.1**	**19.2**	**17.6**
Semivolatile Organics (ug/kg)														
Benzoic acid	650	**68.4 J**	98.6 UJ	**32.9 J**	**214 J**	**60.2 J**	97.7 UJ	**19.6 J**	99.1 UJ	97.1 UJ	95.7 UJ	96.7 UJ	98.7 UJ	98.6 UJ
Benzyl alcohol	57	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Hexachlorobutadiene	11	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
2,4-Dimethylphenol	29	23.9 U	24.6 U	23.9 UJ	24.2 U	23.6 U	24.4 UJ	24.6 UJ	24.8 UJ	24.3 UJ	23.9 UJ	24.2 UJ	24.7 UJ	24.7 UJ
2-Methylphenol (o-Cresol)	63	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
4-Methylphenol (p-Cresol)	670	4.8 U	4.9 U	**2 J**	**3.1 J**	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Pentachlorophenol	360	19.1 UJ	19.7 UJ	19.2 UJ	19.4 UJ	18.9 UJ	19.5 UJ	19.7 UJ	19.8 UJ	19.4 UJ	19.1 UJ	19.3 UJ	19.7 UJ	19.7 UJ
Phenol	420	18.3 U	8.1 U	7.3 U	**38.7**	13.4 U	4.9 U	5.3 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Semivolatile Organics (ug/kg)														
1,2,4-Trichlorobenzene	31	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
1,2-Dichlorobenzene	35	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	**0.8 J**	4.8 U	4.8 U	4.9 U	4.9 U
1,4-Dichlorobenzene	110	4.8 U	4.9 U	4.8 UJ	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Hexachlorobenzene	22	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
bis(2-Ethylhexyl)phthalate	1300	47.8 U	49.3 U	**29.6 J**	48.4 U	47.2 U	48.9 U	49.2 U	49.5 U	48.6 U	47.9 U	48.3 U	49.4 U	49.3 U
Butylbenzyl phthalate	63	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Diethyl phthalate	200	23.2 U	19.7 U	24.6 U	**7.2 J**	**9.2 J**	19.5 U	19.7 U	35.8 U	28.9 U	19.1 U	19.3 U	19.7 U	21.9 U
Dimethyl phthalate	71	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Di-n-butyl phthalate	1400	19.1 U	19.7 U	91.1 U	19.4 U	18.9 U	**161**	**133**	**36.8**	**22.6**	**17.2 J**	**39.8**	**18.8 J**	19.7 U
Di-n-octyl phthalate	6200	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Dibenzofuran	540	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
n-Nitrosodiphenylamine	28	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Polycyclic Aromatic Hydrocarbons (ug/kg)														
2-Methylnaphthalene	670	19.1 U	19.7 U	**6.2 J**	19.4 U	**7.5 J**	19.5 U	19.7 U	19.8 U	19.4 U	**7.3 J**	19.3 U	19.7 U	19.7 U
Acenaphthene	500	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Acenaphthylene	1300	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Anthracene	960	**8.8 J**	19.7 UJ	19.2 UJ	**5.9 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Benzo(a)anthracene	1300	**11.9 J**	19.7 U	19.2 U	**9 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	**7 J**	19.3 U	19.7 U	19.7 U
Benzo(a)pyrene	1600	**10.8 J**	19.7 U	19.2 U	**16.4 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Benzo(b,j,k)fluoranthenes	3200	38.2 U	39.4 U	38.3 U	**42.2**	37.8 U	39.1 U	39.3 U	39.6 U	38.9 U	38.3 U	38.7 U	39.5 U	39.5 U
Benzo(g,h,i)perylene	670	**7.7 J**	19.7 U	19.2 U	**9.7 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Chrysene	1400	**28.8**	19.7 U	**5.9 J**	**18.2 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	**14.3 J**	19.3 U	19.7 U	19.7 U
Dibenzo(a,h)anthracene	230	**2.7 J**	4.9 U	4.8 U	**3.8 J**	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Fluoranthene	1700	**12.3 J**	19.7 U	**4.9 J**	**13.9 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	**5.8 J**	19.3 U	19.7 U	19.7 U
Fluorene	540	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Indeno(1,2,3-c,d)pyrene	600	19.1 U	19.7 U	19.2 U	**8.2 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Naphthalene	2100	19.1 U	19.7 U	**8.1 J**	**7.9 J**	**5.4 J**	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Phenanthrene	1500	**15.8 J**	19.7 U	**14.6 J**	**11.9 J**	**6.3 J**	19.5 U	19.7 U	19.8 U	19.4 U	**38.1**	19.3 U	19.7 U	19.7 U
Pyrene	2600	**23.5**	19.7 U	**6.2 J**	**48.3**	18.9 U	19.5 U	**5.5 J**	**5.9 J**	19.4 U	**8.1 J**	19.3 U	19.7 U	19.7 U
PCB Aroclors (µg/kg)														
Total DMMP PCB Aroclors (U = 0)	130	**5.3 J**	4 U	4 U	3.9 UJ	4 U	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U

non-detect exceedance
detected exceedance
AET-based SQS different from DMMP SL

Table 11
SMS Comparison for Samples with TOC less than 0.5%

Sample ID / Depth / Analyte	SQS	C-23-A1-190222 0 - 2 ft	C-23-B1-190222 2 - 4 ft	C-24-A-190223 0 - 2 ft	C-24-B-190223 2 - 4 ft	C-25-A-190222 0 - 2 ft	C-25-B-190222 2 - 4 ft
Conventional Parameters (%)							
Total organic carbon		**0.07**	**0.04**	**0.06**	**0.04**	**0.29**	**0.44**
Metals (mg/kg)							
Arsenic	57	**2.41**	**2**	**1.99**	**1.16**	**2.79**	**2.59**
Cadmium	5.1	**0.04 J**	**0.04 J**	0.11 U	0.1 U	**0.05 J**	0.12 U
Chromium	260	**10.1**	**9.02**	**11.3**	**9.86**	**15.5**	**13.2**
Copper	390	**15.1**	**12.8**	**13.4**	**11.2**	**27.7**	**19.4**
Lead	450	**1.84**	**1.45**	**1.64**	**1.6**	**2.42**	**1.79**
Mercury	0.41	0.0232 U	**0.0101 J**	**0.0112 J**	**0.00818 J**	**0.0219 J**	**0.0191 J**
Silver	6.1	**0.04 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.07 J**	**0.05 J**
Zinc	410	**23.8**	**21.2**	**23**	**22.4**	**73.9**	**20.1**
Semivolatile Organics (ug/kg)							
Benzoic acid	650	**15.4 J**	98.6 U	**43.9 J**	**25.5 J**	**33.6 J**	**84.3 J**
Benzyl alcohol	57	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Hexachlorobutadiene	11	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
2,4-Dimethylphenol	29	24.9 UJ	24.6 UJ	24.5 U	24.7 U	24.7 UJ	24.2 UJ
2-Methylphenol (o-Cresol)	63	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
4-Methylphenol (p-Cresol)	670	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Pentachlorophenol	360	20 UJ	19.7 UJ	19.6 UJ	19.8 UJ	19.8 UJ	19.3 UJ
Phenol	420	6.8 U	6.5 U	10 U	7.9 U	14.8 U	19.5 U
Semivolatile Organics (ug/kg)							
1,2,4-Trichlorobenzene	31	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
1,2-Dichlorobenzene	35	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
1,4-Dichlorobenzene	110	5 UJ	4.9 UJ	4.9 U	4.9 U	4.9 UJ	4.8 UJ
Hexachlorobenzene	22	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
bis(2-Ethylhexyl)phthalate	1300	49.9 U	49.3 U	49.1 U	49.4 U	**30.4 J**	**31.4 J**
Butylbenzyl phthalate	63	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Diethyl phthalate	200	30.9 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Dimethyl phthalate	71	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Di-n-butyl phthalate	1400	87.1 U	142 U	19.6 U	19.8 U	140 U	171 U
Di-n-octyl phthalate	6200	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Dibenzofuran	540	20 U	19.7 U	19.6 U	19.8 U	19.8 U	**5.9 J**
n-Nitrosodiphenylamine	28	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Polycyclic Aromatic Hydrocarbons (ug/kg)							
2-Methylnaphthalene	670	20 U	19.7 U	19.6 U	19.8 U	19.8 U	**17.9 J**
Acenaphthene	500	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Acenaphthylene	1300	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Anthracene	960	20 UJ	19.7 UJ	19.6 UJ	19.8 UJ	19.8 UJ	19.3 UJ
Benzo(a)anthracene	1300	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Benzo(a)pyrene	1600	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Benzo(b,j,k)fluoranthenes	3200	39.9 U	39.4 U	39.3 U	39.6 U	39.5 U	38.7 U
Benzo(g,h,i)perylene	670	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Chrysene	1400	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Dibenzo(a,h)anthracene	230	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Fluoranthene	1700	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Fluorene	540	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Indeno(1,2,3-c,d)pyrene	600	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Naphthalene	2100	20 UJ	19.7 UJ	19.6 U	19.8 U	19.8 UJ	**5.8 J**
Phenanthrene	1500	20 U	19.7 U	19.6 U	19.8 U	**6.7 J**	**15 J**
Pyrene	2600	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
PCB Aroclors (µg/kg)							
Total DMMP PCB Aroclors (U = 0)	130	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U

non-detect exceedance
detected exceedance
AET-based SQS different from DMMP SL

Table 12
Probability of Suitability for Beneficial Use of Non-Native Material

Section	Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Detected SL/BT Exceedance	Dioxins/furans above 4/10 pptr TEQ	PAH above 2000 ug/kg	Beneficial Use Suitable/Unsuitable	Suitability Probablility	Average suitability probability	Rounded Suitability Probability
Mouth	C-1	A	0 to 2	-49.9 to -51.9	no	no	no	suitable	100	85.71	**85**
		B	2 to 4	-51.9 to -53.9	no	no	no	suitable	100		
	C-2	A	0 to 2	-51.4 to -53.4	no	no	no	suitable	100		
	C-3	A	0 to 2.7	-52.5 to -55.2	Total Chlordane non-detect	no	no	unsuitable	0		
		B	2.7 to 5.8	-55.2 to -58.3	no	no	no	suitable	100		
	C-4	A	0 to 2	-53.6 to -55.6	no	no	no	suitable	100		
	C-5	A	0 to 2	-51.5 to -53.5	no	no	no	suitable	100		
Middle	C-7	A	0 to 2	-50.4 to -52.4	no	4.38	no	unsuitable	0	40.91	**40**
	C-8	A	0 to 2	-52.0 to -54.0	no	5.00	no	unsuitable	0		
		B	2 to 4	-54.0 to -56.0	no	no	no	suitable	100		
	C-10	A	0 to 2	-49.0 to -51.0	no	8.79	no	unsuitable	0		
		B	2 to 4	-51.0 to -53.0	Tributyltin	7.42	no	unsuitable	0		
		C	4 to 6	-53.0 to -55.0	no	no	no	suitable	100		
	C-11	A	0 to 2	-51.6 to -53.6	Total Chlordane non-detect	5.92	no	unsuitable	0		
	C-12	A	0 to 2	-22.7 to -24.7	Total PCB Aroclors	56.2	no	unsuitable	0		
		B	2 to 4	-24.7 to -26.7	no	54.5	no	unsuitable	0		
		C	4 to 6	-26.7 to -28.7	no	17.7	no	unsuitable	0		
		D	6 to 8	-28.7 to -30.7	no	no	no	suitable	100		
		E	8 to 10	-30.7 to -32.7	no	no	no	suitable	100		
	C-13	A	0 to 2	-39.0 to -41	no	5.34	no	unsuitable	0		
		B	2 to 4	-41.0 to -43.0	no	7.73	no	unsuitable	0		
		C	4 to 6	-43.0 to -45.0	no	11.88	no	unsuitable	0		
		D	6 to 8	-45.0 to -47.0	no	7.64	no	unsuitable	0		
		E	8 to 10	-47.0 to -49.0	no	no	no	suitable	100		
	C-14	A	0 to 2	-52.6 to -54.6	no	no	no	suitable	100		
		B	2 to 4	-54.6 to -56.6	no	no	no	suitable	100		
	C-15	A	0 to 2	-45.6 to -47.6	no	10.6	no	unsuitable	0		
		B	2 to 4	-47.6 to -49.6	no	no	no	suitable	100		
		C	4 to 6	-49.6 to -51.6	no	no	no	suitable	100		
Head	C-16	A	0 to 2	-50.6 to -52.6	no	no	no	suitable	100	100	**100**
	C-17	A	0 to 2	-19.7 to -21.7	no	no	no	suitable	100		
		B	2 to 4	-21.7 to -23.7	no	no	no	suitable	100		
		C	4 to 8	-23.7 to -25.7	no	no	no	suitable	100		
	C-18	A	0 to 2.3	-52.2 to -54.5	no	no	no	suitable	100		
	C-24	A	0 to 2	-51.1 to -53.1	no	no	no	suitable	100		
	C-25	A	0 to 2	-51.4 to -53.4	no	no	no	suitable	100		
		B	2 to 4	-53.4 to -55.4	no	no	no	suitable	100		

above SL, BT or dioxin above 4 pptr TEQ
dioxin above 10 pptr TEQ
all less than SLs/BTs

Table 13
Native Material - Probability of Suitability for Beneficial Use

Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Detected SL/BT Exceedance	Dioxins/furans above 4 pptr TEQ	PAH above 2000 ug/kg	Beneficial Use Suitable/Unsuitable	Suitability Probablility	Average suitability probability	Rounded Suitability Probability
C-1	C	4 to 6	-53.9 to -55.9	no	no	no	suitable	100	96.15	95
C-2	B	2 to 4	-53.4 to -55.4	no	no	no	suitable	100		
	C	4 to 6	-55.4 to -57.4	no	no	no	suitable	100		
	D	6 to 8.6	57.4 to -60.0	no	no	no	suitable	100		
C-4	B	2 to 4	-55.6 to -57.6	no	no	no	suitable	100		
C-5	B	2 to 4	-53.5 to -55.5	no	no	no	suitable	100		
C-6	A	0 to 2	-53.9 to -55.9	no	no	no	suitable	100		
	B	2 to 4	-55.9 to -57.9	no	no	no	suitable	100		
C-7	B	2 to 4	-52.4 to -54.4	Hexachlorobutadiene	no	no	unsuitable	0		
	C	4 to 6	-54.4 to -56.4	no	no	no	suitable	100		
C-9	A	0 to 2	-53.0 to -55.0	no	no	no	suitable	100		
	B	2 to 4	-55.0 to -57.0	no	no	no	suitable	100		
C-11	B	2 to 4	-53.6 to -55.6	no	no	no	suitable	100		
C-16	B	2 to 4	-52.6 to -54.6	no	no	no	suitable	100		
C-18	B	3.9 to 6.3	-54.5 to -56.9	no	no	no	suitable	100		
C-19	A	0 to 2	-52.4 to -54.4	no	no	no	suitable	100		
	B	2 to 4	-54.4 to -56.4	no	no	no	suitable	100		
C-20	A	0 to 2	-51.3 to -53.3	no	no	no	suitable	100		
	B	2 to 4	-53.3 to -55.3	no	no	no	suitable	100		
C-21	A	0 to 2	-53.7 to -55.7	no	no	no	suitable	100		
	B	2 to 4	-55.7 to -57.7	no	no	no	suitable	100		
C-22	A	0 to 2	-51.0 to -53.0	no	no	no	suitable	100		
	B	2 to 4	-53.0 to -55.0	no	no	no	suitable	100		
C-23	A	0 to 2	-53.7 to -55.7	no	no	no	suitable	100		
	B	2 to 4	-55.7 to -57.7	no	no	no	suitable	100		
C-24	B	2 to 4	-53.1 to -55.1	no	no	no	suitable	100		

above SL, BT or dioxin above 4 pptr TEQ
dioxin above 10 pptr TEQ
all less than SLs/BTs

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232-1274

September 5, 2019

Laura A. Boerner
Chief, Planning, Environmental, & Cultural Resources Branch
P.O. Box 3755
Seattle, WA 98124-3755
ATTN: CENWS-PMP

Re: Fish and Wildlife Coordination Act Planning Aid Letter on the Corps of Engineers' National Environmental Policy Act environmental assessment (EA) for the Tacoma Harbor, WA Navigation Improvement Project, Pierce, County, Washington.

Dear Chief Boerner;

The National Marine Fisheries Service (NMFS) has reviewed the December 21, 2019 Public Notice for the proposed Tacoma Harbor deepening in the Blair Waterway of Commencement Bay in Pierce County, Washington. This Planning Aid Letter is written in response to the public notice, under the authority given to NMFS through the Fish and Wildlife Coordination Act (16 USC 661-667e; 48 Stat. 401), because trust resources within NMFS' jurisdiction will be affected by the proposed project.

These trust resources include Endangered Species Act (ESA) listed Puget Sound (PS) Chinook salmon *(Oncorhynchus tshawytscha),* PS steelhead (*O. mykiss*), Southern Resident (SR) Killer Whale (*Orcinus orca*), and designated essential fish habitat (EFH) for various life stages of Pacific Coast salmon, Pacific Coast groundfish, and coastal pelagic species. Other species that fall within the fiduciary responsibility of the Federal government are the variety of fishes and shellfishes traditionally harvested by treaty tribes.

Purpose and Need for Proposed Action

The proposal involves the deepening of the Blair Waterway in Commencement Bay, Tacoma, Washington (Figure 1). The Tacoma Harbor currently measures approximately 51 feet MLLW (mean lower low water), a measurement that is equal to the average height of the lowest tide recorded every day during a 19-year period. Initial alternatives include deepening the Blair Waterway from minus 51 feet to up to minus 58 feet Mean Lower Low Water (MLLW) and widening the existing authorized channel (330 to 520 feet wide) to better accommodate larger vessels already calling at Tacoma Harbor, such as the post-Panamax Generation 4.

The Corps and the Port recognize that channel deepening is essential to maintaining the Port's competitive position as a premier international trade gateway, particularly relative to Canadian ports. A deeper harbor would eliminate transit delays due to tidal changes and allow larger, fully-loaded ships to more efficiently and cost-effectively visit the Port of Tacoma. The Tacoma

Harbor is a major gateway for containerized traffic and the channels must have sufficient depth for partially loaded vessels to call, take on additional cargo, and leave fully loaded. Tide restrictions, light loading, or other operational inefficiencies created by inadequate channel depth currently limits the Port's competitiveness, especially when competing with nearby and naturally deep harbors in British Columbia and the outer coast.

Figure 1. Aerial Image of Blair Waterway

Sediment that is determined to be suitable for beneficial reuse will either go to open water disposal or may be used at the potential Saltchuck marine site. Saltchuck is a deeper water site located adjacent to other restoration actions. The material placed would be intended to raise the elevation to create nearshore juvenile Chinook rearing habitat (Figure 2).

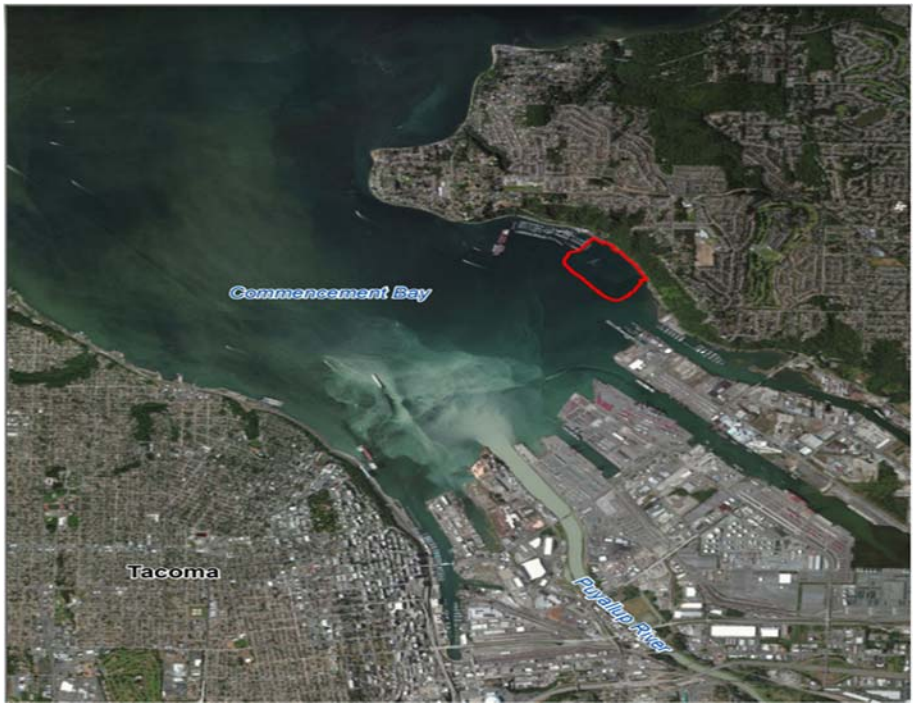


Figure 2. Location of the potential Saltchuck mitigation site

Existing Conditions
Lingering effects of more than a century of human development combined with numerous ongoing activities in the industrial waterways have contributed to the currently degraded environmental baseline conditions in Commencement Bay, including the Blair Waterway. In 1981, the U.S. Environmental Protection Agency (EPA) listed Commencement Bay as a Federal Superfund site. As a result of this, the cleanup of contaminants has been a high priority. After the completion of the dredging, the EPA deleted the Blair Waterway and all lands that drain to the Blair Waterway from the National Priorities List.

The shorelines of Commencement Bay have been highly altered using riprap and other materials to provide bank protection. Blair Waterway comprises seven percent of the total of armored shoreline that cover 71 percent of the length of the Commencement Bay shoreline. Based on shoreline surveys and aerial photo interpretation of the area, approximately five miles, or 20 percent of the Commencement Bay shoreline, is covered by wide over-water structures (Kerwin 1999). The existing project area is presently altered using riprap that provides low to medium quality feeding and refuge habitat for juvenile salmon (Spence et al. 1996).

At present, the small amount of functional salmonid habitat within Commencement Bay shorelines is gradually increasing in acreage because of habitat restoration projects and natural processes. The importance of nearshore marine habitat, as part of a restoration strategy for habitat function within the estuary, has been emphasized by the Chinook salmon habitat protection and restoration strategy for the Puyallup Watershed and is an important step toward improving the overall ecological functionality of the area.

Proposed Action and Potential Effects

The proposed project as described above involves deepening the navigational channel by dredging the Blair Waterway in Commencement Bay to accommodate loading and unloading of larger container ships. The Corps has indicated that deepening the navigational shipping channel to accommodate larger container ships is a viable alternative to meet the business needs of the Port of Tacoma. Other alternatives or measures are available or are currently being used, but these measures over the long-term do not solve the Port's issues on cost savings and reducing navigation challenges for larger ships entering the Port.

The Corps' in-water work window for Commencement Bay July 15 to February 15 which can reduce, but not avoid, effects on ESA listed species or designated critical habitat.

Potential construction-related impacts associated with dredging the Blair Waterway would include water quality impacts due to increased turbidity, suspended sediments, and contaminants. The variety of effects of increased turbidity and suspended sediment may be characterized as lethal, sublethal or behavioral (Bash et al. 2001; Newcombe and MacDonald 1991; Waters 1995). Lethal effects include gill trauma (physical damage to the respiratory structures), severely reduced respiratory function and performance, and smothering and other effects that can reduce egg-to-fry survival (Bash et al. 2001). Sublethal effects include physiological stress reducing the ability of a fish to perform vital functions (Cederholm and Reid 1987), increased metabolic oxygen demand and susceptibility to disease and other stressors (Bash et al. 2001), and reduced feeding efficiency (Bash et al. 2001; Berg and Northcote 1985; Waters 1995). Sublethal effects can act separately or cumulatively to reduce growth rates and increase fish mortality over time. Behavioral effects include avoidance, loss of territoriality, and related secondary effects to feeding rates and efficiency (Bash et al. 2001).

Do to the industrial nature of the area, dredging of the Blair Waterway has the potential to cause the release or resuspension of contaminants. The effects to aquatic life differ depending upon the type of contaminant. Metal, polyaromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs), as groupings of related contaminants, present a risk of additive or synergistic effects. Potential effects of bioaccumulation include inhibited reproduction, delayed fry emergence, liver disease or malfunction, morphological abnormalities, immune system impairment, and mortality.

Dredging will cause benthic habitat disturbance for EFH species that may forage in deep water. Juvenile salmon would not be affected as they forage almost exclusively in nearshore areas. The recovery of disturbed habitats following dredging ultimately depends upon the nature of the sediment at the dredge or disposal site, sources and types of re-colonizing animals, and the extent of the disturbance.

The dredging of the navigation channel will result in larger vessels (container ships) utilizing the Blair Waterway to load and unload at Port facilities and privately-owned industrial docks. Vessel traffic is one area that has been identified as having a potential effect on the feeding behavior of the whales. SR killer whales come into the Puget Sound on an irregular basis and for a limited amount of time usually during the winter. The amount of effect from vessel traffic on killer whales during the time they are present in Washington waters is unknown.

Coordination with Federal and State Agencies and Tribal Governments

The NMFS participated in meetings with the COE, had numerous discussions with agencies related to the Tacoma Harbor General Investigation, and coordinated with relevant resource agencies, and the Puyallup Tribe. The information provided in this letter is based on conversations with the Puyallup Tribe, WDFW, and the EPA. Many of the same concerns, conclusions, and recommendations are shared by the NMFS, the Tribe, WDFW, and the EPA. This Planning Aid Letter highlights concerns regarding potential risks and damages to fish, wildlife, and tribal trust resources associated with the Tacoma Harbor deepening project.

In addition to the coordination described above, in order to provide recommendations that benefit the fish and wildlife resources, NMFS reviewed the status of ESA-listed Species and Critical Habitats (See Appendix A for summary), and the Chinook salmon habitat protection and restoration strategy for the Puyallup Watershed. Specific recovery actions identified for Commencement Bay include restoring estuarine and nearshore habitat.

Recommendations

At the outset, in the context of this proposed action, and other federal water resource development proposals, we emphasize the necessity of upholding treaty fishing rights and other/related tribal trust responsibilities.

NMFS further recommends that the U.S. Army Corps of Engineers (COE), prior to issuing its 404 Clean Water Act permit: (1) work with NMFS, US Fish and Wildlife Service, Pierce County, Washington State Department of Fish and Wildlife (WDFW), Environmental Protection Agency (EPA), and the Puyallup Tribe to determine restoration actions to mitigate for project impacts; (2) coordinate with the NMFS throughout the development of the alternatives and design of the project to expedite the ESA section 7 consultation; (3) develop a contingency plan for possible contaminants; (4) provide a full characterization of sediment quality that will be used in nearshore placement; (5) include an analysis of vessel effects to marine mammals; and (6) maximize habitat restoration in the nearshore.

These recommendations are provided in greater detail here:

1. The Corps should work with NMFS, USFWS, Pierce County, WDFW, EPA, and the Puyallup Tribe to determine restoration actions to mitigate for project impacts, as well as impacts associated with interrelated and interdependent action such as long-term habitat loss, increased shade, changes in vessel sizes. Mitigation should meet the objectives of the current Recovery Plans for Puget Sound Chinook salmon.

2. Coordinate with the NMFS throughout the development of the alternatives and design of the project to expedite the ESA section 7 consultation.

    Early coordination can (1) provide an opportunity for the Service(s) to suggest conservation measures that can be incorporated into the project to avoid, reduce, or minimize potential adverse effects to listed species; (2) identify design alternatives or mitigation opportunities that can benefit the recovery of listed species; and (3) provide technical assistance on specific species habitat

requirements that could be incorporated into the project.

3. Develop a contingency plan to minimize water quality effects should contaminants be discovered during sediment sampling prior to dredging.

4. Because of the possibility of contaminants, sediment used in nearshore placement of dredged material at the Saltchuck marine site needs to be fully characterized to ensure fish or their prey resources will not be adversely affected. The Corps should provide a full characterization of sediment quality that will be used in nearshore placement to confirm fish or their prey resources will not be adversely affected.

5. Include an analysis of effects to marine mammals from larger vessels that will be transiting through Puget Sound to the Blair Waterway.

6. Maximize nearshore habitat restoration. Restored habitat function to areas will benefit ESA listed juvenile salmon and their prey resources, which in turn is beneficial to SRKW. Restored nearshore habitat also benefits designated EFH, and provides beneficial stewardship of treaty trust resources.

7. Perform monitoring of habitat restoration site to confirm that fish use established at baseline or improved levels, and at what time frame.

Summary and Service Position

Dredging of the Blair Waterway will retain the degraded condition of habitat in Commencement Bay that has been impacted for over 100 years, and which, despite its designation as critical habitat, does not have sufficient habitat conditions to improve conservation outcomes for ESA listed resources, and which currently fails to meet treaty obligations because consumption of fishes and shellfishes harvested from the area must be restricted to avoid human health impacts. Detrimental effects of the Blair Waterway dredging include water quality degradation, benthic effects, exposure of protected and trust species, and habitat and species disruptions associated with increased vessel size. Multiple beneficial effects would result from restored nearshore marine habitat.

Thank you for the opportunity to comment on the proposed project. If you have any questions, please contact Bonnie Shorin, of the Oregon/Washington Coastal Area Office at (360) 753-9578, or by email at Bonnie.Shorin@noaa.gov.

Sincerely,

for

Kim W. Kratz, Ph.D
Assistant Regional Administrator
Oregon Washington Coastal Office

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APPENDIX

Status of the Species

PS Chinook

This Evolutionary Significant Unit (ESU) comprises 22 populations distributed over five geographic areas. Most populations within the ESU have declined in abundance over the past 7 to 10 years, with widespread negative trends in natural-origin spawner abundance, and hatchery-origin spawners present in high fractions in most populations outside of the Skagit watershed. Escapement levels for all populations remain well below the Technical Review Team (TRT) planning ranges for recovery, and most populations are consistently below the spawner-recruit levels identified by the TRT as consistent with recovery.

Limiting factors include:

- Degraded floodplain and in-river channel structure
- Degraded estuarine conditions and loss of estuarine habitat
- Degraded riparian areas and loss of in-river large woody debris
- Excessive fine-grained sediment in spawning gravel
- Degraded water quality and temperature
- Degraded nearshore conditions
- Impaired passage for migrating fish
- Severely altered flow regime

PS Steelhead

This DPS comprises 32 populations. The DPS is currently at very low viability, with most of the 32 populations and all three population groups at low viability. Information considered during the most recent status review indicates that the biological risks faced by the Puget Sound Steelhead DPS have not substantively changed since the listing in 2007, or since the 2011 status review. Furthermore, the Puget Sound Steelhead TRT recently concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 populations. In the near term, the outlook for environmental conditions affecting Puget Sound steelhead is not optimistic. While harvest and hatchery production of steelhead in Puget Sound are currently at low levels and are not likely to increase substantially in the foreseeable future, some recent environmental trends not favorable to Puget Sound steelhead survival and production are expected to continue.

Limiting factors include:

- Continued destruction and modification of habitat
- Widespread declines in adult abundance despite significant reductions in harvest
- Threats to diversity posed by use of two hatchery steelhead stocks
- Declining diversity in the DPS, including the uncertain but weak status of summer-run fish
- A reduction in spatial structure
- Reduced habitat quality
- Urbanization
- Dikes, hardening of banks with riprap, and channelization

SR Killer Whale
The Southern Resident killer whale DPS is composed of a single population that ranges as far south as central California and as far north as southeast Alaska. The estimated effective size of the population (based on the number of breeding individuals under ideal genetic conditions) is very small — <30 whales, or about 1/3 of the current population size. The small effective population size, the absence of gene flow from other populations, and documented breeding within pods may elevate the risk from inbreeding and other issues associated with genetic deterioration. As of July 1, 2013, there were 26 whales in J pod, 19 whales in K pod and 37 whales in L pod, for a total of 82 whales. Estimates for the historical abundance of Southern Resident killer whales range from 140 whales (based on public display removals to 400 whales, as used in population viability analysis scenarios.

Limiting factors include:

- Quantity and quality of prey
- Exposure to toxic chemicals
- Disturbance from sound and vessels
- Risk from oil spills

Chinook Salmon and SR Killer Whale Critical Habitat

There is no designated PS steelhead critical habitat in the project area.

PS Chinook salmon
The NMFS designated critical habitat for the Puget Sound Chinook salmon on September 2, 2005 (70 FR 52630). One of the six PBFs of Puget Sound Chinook salmon critical habitat are in the action area:

The action area is located within the marine physical or biological features (PBF) of PS Chinook critical habitat. The PBFs for PS Chinook salmon marine critical habitat are:

(1) Water quality and quantity conditions and (2) Forage, including aquatic invertebrates and fish, supporting growth and maturation; and (3) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

Dredging activities will result in temporary degradation of water quality due to increased turbidity, suspended sediments, and possible contaminants.

SR Killer Whale
The final rule listing Southern Resident killer whales (SRKW) as endangered identified several potential factors that may have caused their decline or may be limiting recovery. These are: quantity and quality of prey, toxic chemicals which accumulate in top predators, and disturbance from sound and vessel traffic. The rule also identified oil spills as a potential risk factor for this species (73 FR 4176).

SR Killer Whales are not known to frequent the Blair Waterway. Vessel traffic transiting the Puget Sound may affect the feeding behavior of SR killer whales.

Essential Fish Habitat

The project area includes habitats that have been designated as EFH for various life-history stages of 17 species of groundfish, four coastal pelagic species, and three species of Pacific salmon.

Appendix E

Example of Noise Propagation from Pile Installation in the Blair Waterway

The Corps has proposed potential slope stabilization along four areas of the Blair Waterway. Sideslope stability requirements will be further analyzed and addressed in the preconstruction and engineering development (PED) phase, when ship simulation is conducted, and confirms the final channel alignment and width. Stabilization measures may include, but are not limited to, secant wall, sheet pile wall, and/or 1.5:1 slopes with rock toe stabilization. The actual stabilization method employed for each area will depend on whether or not the top of the slope in each area extends into the upland facilities and, if it does not, the available clearance (i.e., distance) between the top of the slope to upland facilities. Upland is land elevated above shore land, in an area above where water flows. Upland facilities include parking lots, buildings, utilities, or other infrastructure.

Exact information about the means and methods of the actual potential slope stabilization measures to be used are not available to complete a detailed noise analysis, at this time. However, previous work in the Blair Waterway found that noise levels were unlikely to exceed 160 dB_{RMS} during vibratory installation of 12-24-inch concrete piles (BergerABAM 2012). The distance at which 160 dB_{RMS} was expected to attenuate to 120 dB_{RMS} was approximately 2.8 miles (BergerABAM 2012), which is approximately the distance between Area 1 (Area 1: STA 44+00.00 to STA 48+00.0) and the mouth of Commencement Bay. The Blair Waterway and shape of Commencement Bay are expected to contain a substantial portion of noise generated. Appendix E (Berger ABAM 2012) is an example of estimated noise propagation during pile installation, and how noise is likely to propagate during slope stabilization. Based on final designs of slope stabilization measures, materials, and installation details developed in PED, a more refined noise analysis of the particular slope stabilization methods will be performed, if warranted, such as if actual proposed slope stabilization at a particular area uses noise-generating construction methods such as vibratory hammer installation.

Please see Section 5.1.3 (Fish, Wildlife, and Invertebrates) and 5.2.5 (Southern Resident Killer Whale [SRKW]) for additional information about anticipated noise generation during construction based on the level of project detail during the feasibility study.

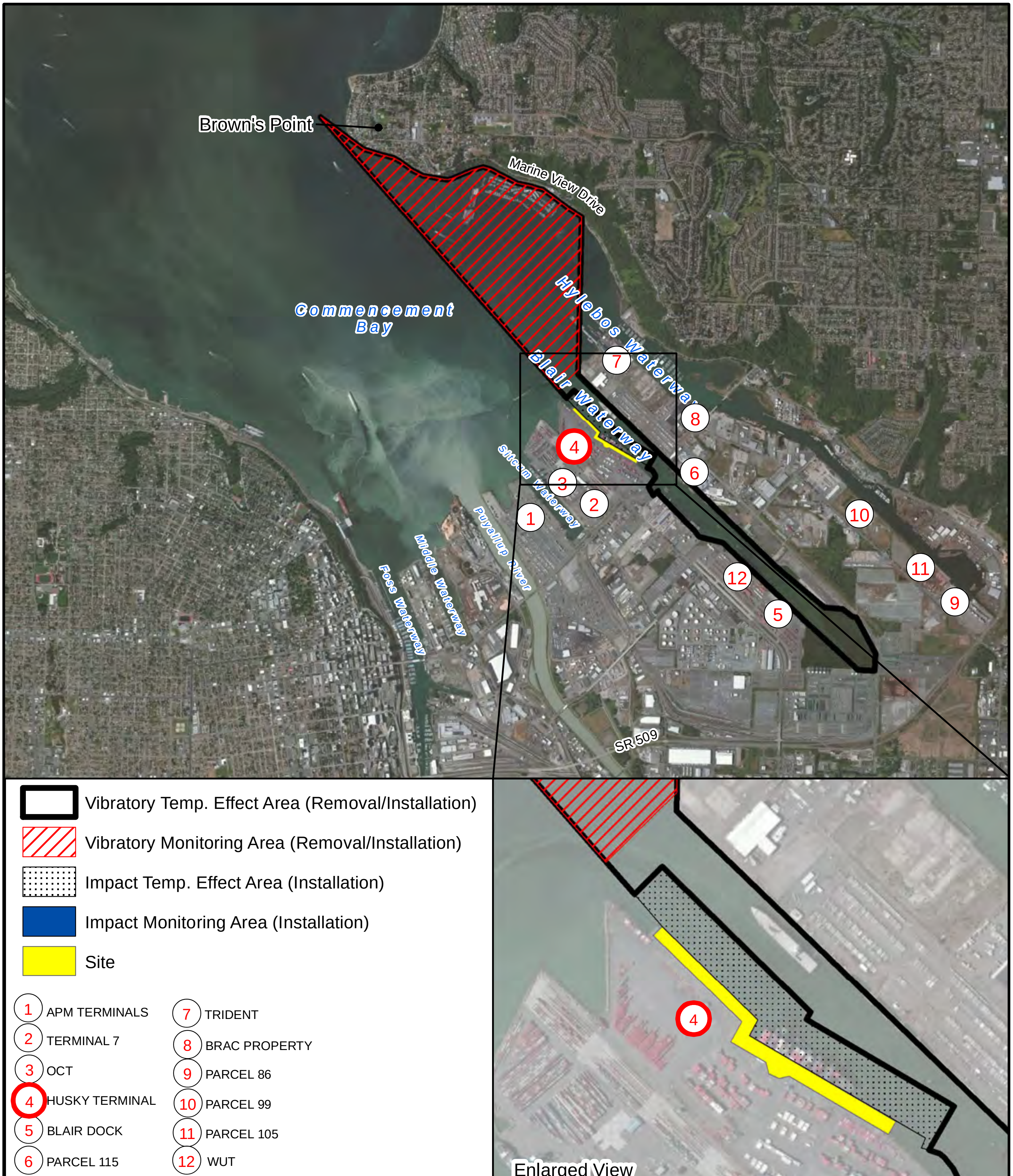

Figure 5 - Site 4

Programmatic Piling Repair Project - Biological Evaluation
Appendix C: Marine Mammal Monitoring Plan
Temporary Effect and Monitoring Areas

N
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0 0.25 0.5 1 1.5 Miles

Source: Pierce County GIS (2011)

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Vibratory Temp. Effect Area (Removal/Installation)

Vibratory Monitoring Area (Removal/Installation)

Impact Temp. Effect Area (Installation)

Impact Monitoring Area (Installation)

Site

1 APM TERMINALS
2 TERMINAL 7
3 OCT
4 HUSKY TERMINAL
5 BLAIR DOCK
6 PARCEL 115
7 TRIDENT
8 BRAC PROPERTY
9 PARCEL 86
10 PARCEL 99
11 PARCEL 105
12 WUT

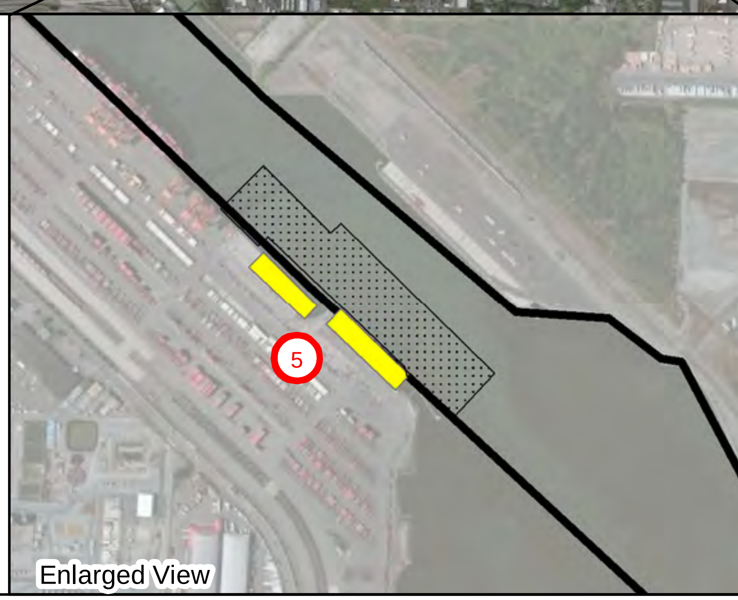

Figure 6 - Site 5

Programmatic Piling Repair Project - Biological Evaluation
Appendix C: Marine Mammal Monitoring Plan
Temporary Effect and Monitoring Areas

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0 0.25 0.5 1 1.5 Miles

Source: Pierce County GIS (2011)

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Figure 7 - Site 6

Programmatic Piling Repair Project - Biological Evaluation
Appendix C: Marine Mammal Monitoring Plan
Temporary Effect and Monitoring Areas

0 0.25 0.5 1 1.5 Miles

Source: Pierce County GIS (2011)

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In Reply Refer To:
2022-0002215
xRef: 01EWFW00-2020-I-0829

Laura Boerner
Planning, Environmental, and Cultural Resources Branch
U.S. Army Corps of Engineers, Seattle District
4735 E. Marginal Way South, Building 1202
Seattle, Washington 98134-2388

Dear Ms. Boerner:

Subject: Tacoma Harbor Federal Navigation Channel Improvement Project

This letter is in response to your March 20, 2020, request for our concurrence with your determination, that the proposed action located in the Port of Tacoma/ Tacoma Harbor (Port), Pierce County, Washington, "may affect, but is not likely to adversely affect" listed species and designated critical habitat under the jurisdiction of the U.S. Fish and Wildlife Service (Service). We received your letter, Biological Assessment, and other materials, providing information in support of "may affect, not likely to adversely affect" determinations, on March 20, 2020. These materials included a Preliminary Design and Model Justification for the Saltchuk Beneficial Use Site (Saltchuk Site), a Draft Water Quality Monitoring and Protection Plan, and a Dredged Material Management Program (DMMP) Suitability Memo. Additional information was requested and received by the Service, in correspondence and in meetings, from May, June, and December 2020, June and December 2021, and January 2022. This consultation was completed in accordance with section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (ESA).

The U.S. Army Corps of Engineers – Seattle District (Corps) requested informal consultation, pursuant to section 7(a)(2) of the ESA, for the listed species and designated critical habitat identified below:

- Bull trout (*Salvelinus confluentus*)
- Designated bull trout critical habitat
- Marbled murrelet (*Brachyramphus marmoratus*)

The Corps has determined that the action will have “no effect” on additional listed species and designated critical habitat that are known to occur in Pierce County. The determination of “no effect” to listed resources rests with the federal action agency. The Service has no regulatory or statutory authority for concurring with “no effect” determinations, and no consultation with the Service is required. We recommend that the Corps document their analyses and maintain that documentation as part of their files.

The Corps and Port propose to implement alternatives identified by a General Investigations Study and Integrated Feasibility Report and Environmental Assessment, consisting of deep draft improvements to the federal navigation system in Tacoma Harbor, Washington. The Corps and Port propose to dredge and deepen the Blair Waterway federal navigation channel (channel) and berths, from a current maximum depth of approximately -51 mean lower low water (MLLW), to new maximum depth of approximately -57 MLLW. The proposed action will also widen the existing channel, from current widths ranging from approximately 330 to 1,682 ft, to proposed widths ranging from approximately 450 ft to 1,935 ft, at specific locations (Table 1; Figure 1); expand and increase the depth of the existing channel turning basin boundary, from a diameter of approximately 1,682 ft, to a diameter of approximately 1,935 ft (Table 1; Figure 1), and a new maximum depth of -57 MLLW; establish and maintain recommended channel side-slopes at ratios of 2:1 (2H:1V); and, dispose and beneficially reuse approximately 2.8 million cubic yards (CY) of dredged material. According to the Corps, the proposed deep draft improvements will eliminate transit delays due to tidal changes, and allow larger, fully-loaded ships to more efficiently and cost effectively visit the Port. According to the Corps, ‘light loading’, tidal restrictions, and other operational inefficiencies created by inadequate channel depths currently limit the Port’s ability to accommodate vessel shipping loads.

Table 1. Current, Federally Authorized and Proposed Widths by Channel Station (STA).

Station Along Channel	Authorized Width (feet)	Proposed Width (feet)
STA -5 to STA 0	-	865
STA 0 to STA 12	520	800
STA 12 to STA 44	520, 343	520
STA 44 to STA 52	520	520
STA 52 to STA 79	520, 330	520
STA 79 to STA 100	330	450
STA 100 to STA 116	330	525
STA 116 to STA 140	1,682	1,935

Dredging operations will produce approximately 2.8 million CY of material, and the Corps identifies approximately 2.4 million CY as suitable for open-water disposal or beneficial reuse. The Corps and Port propose to place approximately 1.8 million CY for beneficial reuse at the Saltchuk Site in Commencement Bay (located north and east of the Hylebos Waterway), a former nearshore log storage site where beneficial reuse of dredged material is proposed as a means to enhance habitat for salmonids (Port of Tacoma 2015; FWS Consultation # 2015-I-

0685). The existing DMMP Commencement Bay open-water disposal site would receive the remaining suitable dredged material, approximately 0.6 million CY (FWS Consultation # 2015-I-0724). All dredged material that is determined to be unsuitable for open-water disposal and beneficial reuse, will be transported to an approved upland disposal site (approximately 0.4 million CY). Dredging of the channel, and placement and disposal of dredged material, will require 24-hour operations, seasonally over the course of four years. The established and proposed in-water work windows are: August 16 – February 15 (DMMP Commencement Bay Site); July 16 – February 15 (All Other Dredging and Beneficial Reuse Activities).

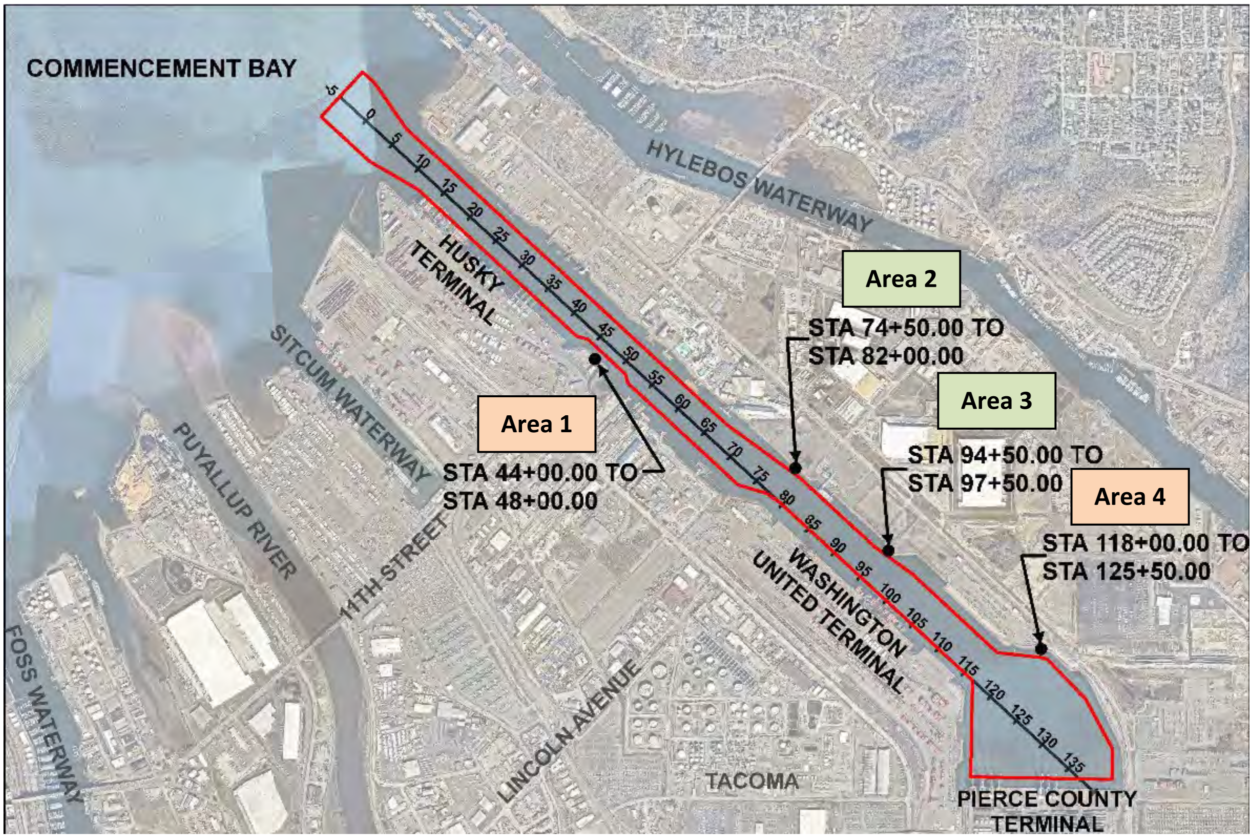

Figure 1. Side Slope Stabilization Areas by Channel Station (STA).

The proposed action will establish and maintain recommended channel side-slopes at ratios of 2:1 (2H:1V). The Corps and Port expect and propose to implement engineered slope stabilization and strengthening (armored slope rock toe and/or secant pile wall), at four locations (Figure 1; Areas 1, 2, 3, and 4), along approximately eight percent of the channel (i.e., measured by channel length). For Areas 1 and 4, the proposed action would include approximately 1,150 linear ft of armored slope rock toe (400 ft and 750 ft, respectively); for Areas 2 and 3, the proposed action would include approximately 1,050 linear ft of secant pile wall (750 ft and 300 ft, respectively). The proposed slope stabilization and strengthening would augment existing engineered channel side-slopes, to protect and maintain existing water-dependent uses and properties, including property or properties owned and administered by the Puyallup Tribe of Indians (Area 2).

Methods of construction and required equipment include but are not limited to the following: conventional and environmental clam shell buckets, excavators, and dredging equipment, operating from fixed locations and barges; tugs, skiffs, and workboats; bottom-dump barges; drill rigs and/ or augers; and vibratory pile driving equipment. All open-water disposal and beneficial reuse of dredged material will comply with a current, valid Site Use Authorization(s) approved by the DMMP.

The Corps has provided sufficient information, to determine the effects of the proposed action and to conclude whether the proposed action would adversely affect federally listed species and/or designated critical habitat. Our concurrence is based on information provided by the federal action agency, best available science, and complete and successful implementation of the conservation measures included by the federal action agency.

Status of the Species – Bull Trout and Designated Bull Trout Critical Habitat

The closest population of bull trout is in the Puyallup River, which enters Commencement Bay through the Puyallup Waterway. Anadromous and fluvial bull trout use the lower reaches of the Puyallup, Carbon, and White Rivers for foraging, migration, and overwintering, and anadromous bull trout seasonally use Commencement Bay and nearshore marine waters of Puget Sound for foraging and migration. Use of the nearshore marine waters is highest in the spring, and bull trout have been documented in Commencement Bay during the months of April, May, and June. A number of studies have investigated seasonal distribution of bull trout and utilization of nearshore marine habitats in the Puget Sound. These studies document far-ranging patterns of bull trout movement, and opportunistic feeding where prey is abundant and concentrated.

Low numbers of native char have been documented during sampling efforts conducted by the Puyallup Tribe of Indians and others (Ratte and Salo 1985). Three bull trout were captured in beach seines, between the Hylebos Waterway and Brown’s Point, during a 16-year study from 1980 through 1995; beach seining was conducted between February and August, and one bull trout was caught in each of three years. In 2006, a bull trout was radio tracked leaving the Puyallup River on June 28, migrated to Brown’s Point on July 2, and was back in the Puyallup River on July 7. Numerous sampling efforts also show that juvenile Chinook salmon (*Oncorhynchus tshawytscha*), a prey species for bull trout, use the Blair Waterway in relatively low numbers (Duker et al. 1989). These and other studies or sampling efforts indicate that bull trout do utilize Commencement Bay, and are highly migratory during their time in nearshore marine waters. Based on the geographic location and baseline environmental conditions, we expect that bull trout use Commencement Bay in low numbers.

The urban and industrial waterfronts in Tacoma, inclusive of the action area, are highly altered. Vertical seawalls, bulkheads, angular bank armor, and large overwater structures extend along the entire length of the waterfronts. Sediment and water quality are degraded and natural forms of habitat complexity are almost completely absent. All of the baseline environmental conditions are either at risk or not properly functioning.

The final revised rule designating bull trout critical habitat (75 FR 63898 [October 18, 2010]) identifies nine Primary Constituent Elements (PCEs) essential for the conservation of the species. The 2010 designation uses the term PCE. The new critical habitat regulations (81 FR 7214) replace this term with physical or biological features (PBFs). This shift in terminology does not change the approach used in conducting our analyses, whether the original designation identified PCEs, PBFs, or essential features. In this letter, the term PCE is synonymous with PBF or essential features of critical habitat.

In marine nearshore areas, the inshore extent of designated bull trout critical habitat is the mean higher high-water line; designated critical habitat extends offshore to depths of -10 meters (-33 ft) MLLW (75 FR 63935 [October 18, 2010]). Marine nearshore areas contain only a subset of the identified PCEs for bull trout (PCEs 2, 3, 4, and 8) (75 FR 63932 [October 18, 2010]):

> (***PCE #2***) Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.
>
> (***PCE #3***) An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.
>
> (***PCE #4***) Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.
>
> (***PCE #8***) Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

Within the action area, baseline environmental conditions include dredged and artificially over-deepened marine waters (in excess of -33 ft MLLW), vertical seawalls, bulkheads, angular bank armor, and large overwater structures along the entire length of the Blair Waterway. Sediment and water quality are degraded and natural forms of habitat complexity are almost completely absent. All of the baseline environmental conditions and current PCE functions are severely degraded.

Status of the Species – Marbled Murrelet

Marbled murrelets forage in the nearshore marine waters of Puget Sound and have been documented off Brown's Point. Based on survey data, marbled murrelet densities in southern Puget Sound are lower than in northern Puget Sound, the Straits, and the outer Washington coast. Although marbled murrelets are periodically documented along the waterfronts of Commencement Bay, there are few or no records of marbled murrelets foraging in the industrial waterways.

The urban and industrial waterfronts in Tacoma, inclusive of the action area, are highly altered. Vertical seawalls, bulkheads, angular bank armor, and large overwater structures extend along the entire length of the waterfronts. Sediment and water quality are degraded and natural forms of habitat complexity are almost completely absent. All of the baseline environmental conditions are either at risk or not properly functioning. Foraging opportunities for marbled murrelets are extremely poor within and along the entire Blair Waterway, and we expect that marbled murrelets use the action area infrequently and in very low numbers.

Temporary Exposures and Effects to Bull Trout

Construction of the proposed deep draft improvements will be completed during a time of year (July 16 to February 15) when few, if any, bull trout are present in the action area. Typically, anadromous bull trout return to their natal waters to spawn and overwinter during these months. During these same months, there are no seasonally abundant prey resources that are likely to attract bull trout to the action area.

Construction will result in temporary impacts to water quality, including temporary increases in turbidity and water column contaminant concentrations. We assume, with effective implementation of the Water Quality Monitoring and Protection Plan, and with adherence to DMMP requirements, these effects to water quality will be intermittent, limited in physical extent, duration, and intensity, and will not cause or contribute to any measurable increase to the extent of existing sediment contamination. The proposed action will permanently remove approximately 0.4 million CY of contaminated sediment and other sources of degraded water quality (e.g., creosote treated wood and wood structures).

Temporary exposures resulting in injury or mortality are extremely unlikely and therefore considered discountable. Sound levels sufficient to disrupt normal behaviors (i.e., the ability to successfully feed, move, and/or shelter) will be intermittent and limited in duration, will be laterally constrained by existing landforms, and will not extend to the higher functioning habitats in close proximity (including the mouth of the Puyallup River). The Service concludes that the foreseeable temporary exposures and effects are unlikely to elicit anything more than a mild behavioral response. The effects of the action, temporary and permanent, will not prevent bull trout from successfully foraging and migrating in the action area, and are considered insignificant.

Effects to the PCEs of Designated Bull Trout Critical Habitat, Habitat and Prey

With full and successful implementation of the conservation measures included as part of the proposed action, we expect that the foreseeable effects of the action will not measurably degrade or diminish habitat functions or prey resources in the action area. Therefore, the foreseeable effects of the action are considered insignificant.

Construction of the proposed deep draft improvements, inclusive of the proposed permanent features (i.e., a widened and deepened channel, engineered slope stabilization and strengthening), will result in impacts to habitat that supports bull trout and their prey. However, these impacts will be limited in physical extent and will not measurably degrade habitat functions, including prey production and availability.

The proposed action will not cause or contribute to any measurable increase to the current extent of existing sediment contamination. Instead, the proposed action will permanently remove approximately 0.4 million CY of contaminated sediment and other sources of degraded water quality (e.g., creosote treated wood and wood structures).

The placement and beneficial reuse of approximately 1.8 million CY of clean dredged material at the Saltchuk Site in Commencement Bay, will provide and enhance approximately 50 acres of shallow subtidal and intertidal nearshore marine habitat. Current depths (-55 to -5 MLLW), will be raised to -20 MLLW (approximately 36 acres), to -10 MLLW (approximately 12 acres), and to -5 MLLW (approximately 3 acres). The proposed action will thereby provide measurable benefits to bull trout and their prey.

(***PCE #2***) Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

- The Blair Waterway retains and provides little or no existing function as migration habitat. Baseline environmental conditions include dredged and artificially over-deepened marine waters (in excess of -33 ft MLLW), vertical seawalls, bulkheads, angular bank armor, and large overwater structures along its entire length. The Blair Waterway exists today as a 'dead-end' channel, and does not connect in a functional way to the Puyallup Waterway, Puyallup River, or to adjacent higher-functioning nearshore marine waters (e.g., north and east of the Hylebos Waterway).

- The proposed action will present a temporarily impediment or barrier within migration habitat; i.e., temporary impacts to water quality, including impacts that may elicit mild behavioral responses (e.g., avoidance). However, the proposed action will not preclude bull trout movement through the action area, either during or after construction, and any measurable effects will be temporary. Migration habitat will not be permanently altered, destroyed, or degraded.

- Foreseeable effects to the current function of this PCE are therefore considered insignificant.

(***PCE #3***) An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

- The Blair Waterway does not support significant bull trout prey resources. The Blair Waterway exists today as a 'dead-end' channel, and does not connect in a functional way to the Puyallup Waterway, Puyallup River, or to adjacent higher-functioning nearshore marine waters (e.g., north and east of the Hylebos Waterway). Limited potential spawning habitats for marine forage fish are present, but outside the dredge prism and will not be affected. Use of the action area by juvenile salmonids is limited, and construction of the proposed deep draft improvements includes specific measures to avoid and minimize impacts to these prey resources.

- Placement and beneficial reuse of clean dredged material at the Saltchuk Site will provide and enhance approximately 50 acres of shallow subtidal and intertidal nearshore marine habitat. Current depths will be raised to -20 MLLW and shallower. The proposed action will thereby provide measurable benefits to bull trout and their prey.

- Foreseeable effects to the current function of this PCE are therefore considered insignificant.

(***PCE #4***) Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.

- Natural forms of habitat complexity are almost completely absent from the Blair Waterway. Baseline environmental conditions include dredged and artificially over-deepened marine waters (in excess of -33 ft MLLW), vertical seawalls, bulkheads, angular bank armor, and large overwater structures along its entire length. Sediment and water quality are degraded, and the Blair Waterway exists today as a 'dead-end' channel.

- The Blair Waterway was previously approved for the removal of 2.1 million CY of dredged material, to achieve the current depth of -51 ft MLLW (Corps 2001). Since 2008, six maintenance dredging actions have been approved for the Blair Waterway (FWS Consultation #s 2008-I-0607, 2009-I-0160, 2009-I-0285, 2011-I-0390, 2015-I-0365, and 2016-I-0060). Since 2008, six actions installing, maintaining, or repairing bank armor have been approved for the Blair Waterway (FWS Consultation #s 2008-I-0587, 2009-I-0285, 2011-I-0078, 2011-I-0294, 2012-I-0272, and 2013-I-0449). In summary, these actions have continued to maintain the Blair Waterway's degraded state.

- Features and indicators corresponding to PCE #4 are almost completely absent (Table 2). The proposed action will affect no significant change to the features and indicators of complex marine shoreline habitat or habitat forming processes (Table 2).

Table 2. Features and Indicators Corresponding to PCE #4; Baseline and Expected Conditions.

Feature / Indicator	Baseline Condition	Expected Condition	Net Change
Large Wood	Not present	Not present	No change
Side Channels	Not present	Not present	No change
Pools	Not present	Not present	No change
Undercut Banks	Not present	Not present	No change
Unembedded Substrates	Not present	Not present	No change
Variety of:			
Depths	Minimal	Minimal	No change
Gradients	Minimal	Minimal	No change
Velocities	Minimal	Minimal	No change
Complex Structure	Minimal	Minimal	No change

- Placement and beneficial reuse of clean dredged material at the Saltchuk Site will provide and enhance approximately 50 acres of shallow subtidal and intertidal nearshore marine habitat. Current depths will be raised to -20 MLLW and shallower. The proposed action will thereby provide measurable benefits to bull trout and their prey.

- Foreseeable effects to the current function of this PCE are therefore considered insignificant.

(***PCE #8***) Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

- Construction will result in temporary impacts to water quality, including temporary increases in turbidity and water column contaminant concentrations. We assume, with effective implementation of the Water Quality Monitoring and Protection Plan, and with adherence to DMMP requirements, these effects to water quality will be intermittent, limited in physical extent, duration, and intensity, and will not cause or contribute to any measurable increase to the extent of existing sediment contamination. The proposed action will permanently remove approximately 0.4 million CY of contaminated sediment and other sources of degraded water quality (e.g., creosote treated wood and wood structures).

- Foreseeable effects to the current function of this PCE are therefore considered insignificant.

Exposures and Effects to Marbled Murrelet

Construction will result in temporary impacts to water quality, including temporary increases in turbidity and water column contaminant concentrations. These effects to water quality will be intermittent, limited in physical extent, duration, and intensity, and will not cause or contribute to any measurable increase to the extent of existing sediment contamination. The proposed action will permanently remove approximately 0.4 million CY of contaminated sediment and other sources of degraded water quality (e.g., creosote treated wood and wood structures).

Placement and beneficial reuse of clean dredged material at the Saltchuk Site will provide and enhance approximately 50 acres of shallow subtidal and intertidal nearshore marine habitat. Current depths will be raised to -20 MLLW and shallower. The proposed action will thereby provide measurable benefits to marbled murrelet prey.

Temporary exposures resulting in injury or mortality are extremely unlikely and therefore considered discountable. Sound levels sufficient to disrupt normal behaviors (i.e., the ability to successfully feed, move, and/or shelter) will be intermittent and limited in duration, will be laterally constrained by existing landforms, and will not extend to the higher functioning habitats in close proximity. The Service concludes that the foreseeable temporary exposures and effects are unlikely to elicit anything more than a mild behavioral response. The effects of the action, temporary and permanent, will not prevent marbled murrelets from successfully foraging and loafing in the action area, and are considered insignificant.

Conclusion

This concludes consultation pursuant to the regulations implementing the ESA (50 CFR 402.13). Our review and concurrence with your effect determinations is based on implementation of the project as described. It is the responsibility of the federal action agency to ensure that the projects they authorize or carry out are in compliance with the regulatory permit and ESA. If a permittee or the federal action agency deviates from the measures outlined in a permit or project description, the federal action agency has the obligation to reinitiate consultation and comply with section 7(d).

This project should be re-analyzed and re-initiation may be necessary if 1) new information reveals effects of the action that may affect listed species or critical habitat in a manner, or to an extent, not considered in this consultation, 2) if the action is subsequently modified in a manner that causes an effect to a listed species or critical habitat that was not considered in this consultation, and/or 3) a new species is listed or critical habitat is designated that may be affected by this project.

This letter constitutes a complete response by the Service to your request for informal consultation. A record of this consultation is on file at the Washington Fish and Wildlife Office, in Lacey, Washington. If you have any questions about this letter or our shared responsibilities under the ESA, please contact Ryan McReynolds (ryan_mcreynolds@fws.gov) or Assistant Field Supervisor Curtis Tanner (curtis_tanner@fws.gov).

Sincerely,

for Brad Thompson, State Supervisor
Washington Fish and Wildlife Office

cc:
Corps, Seattle, WA (K. Whitlock)
Corps, Seattle, WA (F. Goetz)

Literature Cited

Corps (U.S. Army Corps of Engineers). 2001. Determination on the suitability of proposed dredged material from the Pierce County Terminal (PCT) expansion site in the Blair Waterway, Commencement Bay, Tacoma, Washington, (Permit #2000-2-00765) evaluated under Section 404 of the Clean Water Act for open-water disposal at the Commencement Bay open water site. CENS-OD-TS-DMMO. Available at: https://usace.contentdm.oclc.org/digital/collection/p266001coll1/id/8505

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OR 97232-1274

Refer to NMFS No:
WCRO-2020-00645

February 16, 2022

Laura Boerner
Planning Chief
Environmental and Cultural Resources Branch
Corps of Engineers, Seattle District
Post Office Box 3755
Seattle, Washington 98124-3755

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the U.S. Army Corps of Engineers' Proposed Port of Tacoma's Harbor Navigation Improvement Project in the Blair Waterway of Tacoma Harbor, Pierce County, Washington (HUC 171100190204).

Dear Ms. Boerner:

Thank you for your letter of March 20, 2020, requesting initiation of consultation with the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Port of Tacoma's Harbor Navigation Improvement Project. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).[1]

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)) for this action.

The enclosed document contains a biological opinion prepared by NMFS pursuant to section 7 of the ESA on the effects of the proposed action. In this opinion, NMFS concludes that the proposed action would adversely affect but is not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon, PS steelhead, Puget Sound Georgia Basin (PS/GB) bocaccio, and PS/GB yelloweye rockfish. NMFS also concludes that the proposed action is likely to adversely affect designated critical habitat for PS Chinook salmon but is not likely to result in the destruction or adverse modification of that designated critical habitat. This opinion also documents our rationale and conclusion that the proposed action is not likely to adversely affect green sturgeon, eulachon, and Southern Resident killer whales (SRKW) or designated critical habitat for SRKW.

[1] For purposes of this consultation, we also considered whether the substantive analysis and its conclusions regarding the effects of the proposed actions articulated in the Biological Opinion and its Incidental Take Statement would be any different under the 50 CFR part 402 regulations as they existed prior to the 2019 Rule. We have determined that they would not be any different.

This opinion includes an incidental take statement (ITS) that describes reasonable and prudent measures (RPMs) NMFS considers necessary or appropriate to minimize the incidental take associated with this action, and sets forth terms and conditions that the COE must comply with in order to be exempt from the prohibitions of section 9 of the ESA.

This document also includes the results of our analysis of the action's likely effects on essential fish habitat (EFH) pursuant to Section 305(b) of the MSA. NMFS reviewed the likely effects of the proposed action on EFH, and concluded that the action would adversely affect designated EFH for Pacific Coast salmon and Pacific Coast groundfish. Therefore, we have included the results of that review in Section 3 of this document. NMFS also provides Conservation Recommendations to minimize adverse effects to EFH. Section 305(b)(4)(B) of the MSA requires that an action agency provide a detailed response in writing to the NMFS within 30 days after receiving an EFH Conservation Recommendation.

Please contact David Price in the Central Puget Sound Branch of the Oregon/Washington Coastal Office by email at David.Price@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Kim W. Kratz. Ph.D.
Assistant Regional Administrator
Oregon Washington Coastal Office

cc: Kaitlin Whitlock, USACE
Fred Goetz, USACE
Kristine Ceragioli, USACE

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the

Port of Tacoma Navigation Improvements

NMFS Consultation Number: WCRO-2020-00645

Action Agency: U.S. Army Corps of Engineers, Seattle District

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Puget Sound Chinook Salmon (*Oncorhynchus tshawytscha)*	Threatened	Yes	No	Yes	No
Puget Sound Steelhead (*O. mykiss*)	Threatened	Yes	No	NA	NA
Puget Sound/Georgia Basin boccacio rockfish (*Sebastes paucispinis*)	Endangered	Yes	No	No	NA
Puget Sound/Georgia Basin yelloweye rockfish (*S. ruberrimus*)	Threatened	Yes	No	NA	NA
Southern Resident Killer Whale (*Orcinus orca*)	Endangered	No	No	No	No
Green Sturgeon (*Acipenser medirostris*)	Threatened	No	No	NA	NA
Eulachon (*Thaleichthys pacificus*)	Threatened	No	No	NA	NA
Humpback whale, Central America DPS (*Megaptera novaeangliae*)	Endangered	No	No	NA	NA
Humpback whale, Mexico DPS (*Megaptera novaeangliae*)	Threatened	No	No	NA	NA

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes
Pacific Coast Groundfish	Yes	Yes
Coastal Pelagic	No	No

Issued By:

Kim W. Kratz, Ph.D
Assistant Regional Administrator
Oregon Washington Coastal Office

Date: February 16, 2022

TABLE OF CONTENTS

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3, below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared this biological opinion (Opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.), and implementing regulations at 50 CFR 402, as amended.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the Oregon Washington Coastal Office in Lacey, Washington.

1.2 Consultation History

On March 20, 2020, the U.S. Army Corps of Engineers Seattle District (Corps) requested formal ESA section 7 consultation on the effects of authorizing proposed deepening and widening of the Blair Waterway in the Port of Tacoma. The Corps proposes this authorization under Section 209 of the Rivers and Harbors Act of 1962, Public Law 87-874 which allows for the evaluation of alternatives for navigation improvement and consideration of ecosystem restoration in the form of beneficial use of dredge material at Tacoma Harbor. In addition, evaluation of beneficial use of dredged material as part of this study is authorized by Section 204 of the Water Resources Development Act of 1992, as amended by Section 1038(2) of the Water Resources Reform and Development Act of 2014 and Section 1122(i)(2) of the Water Resources Development Act of 2016 – Regional Sediment Management. Section 204(d), as amended, provides that, in developing and carrying out a federal water resources development project involving the disposal of dredged material, the Assistant Secretary of the Army for Civil Works (ASA(CW)) may select, with the consent of the non-federal interest, a disposal method that is not the least cost option, if the ASA(CW) determines that the incremental costs of the disposal method are reasonable in relation to the environmental benefits. The action also triggers MSA consultation because EFH for Pacific Coast salmon, Pacific Coast groundfish, and coastal pelagic species in the Puget Sound (a Habitat Area of Particular Concern (HAPC)) may be affected. The request for consultation included a biological assessment (BA) and multiple supplemental documents.

Since March 2020, correspondence regarding the proposed action subject to the ESA Section 7 consultation occurred between staff at NMFS and the Corps. This includes, but is not limited to clarification on the scope of potential side-slope stabilization methods via email on May 12, 2020; June 24, 2020; and December 9, 2021.

On September 11, 2020, NMFS requested additional information regarding the analysis and effects described in the BA. On December 8, 2020, the Corps responded to the technical questions in a memorandum to NMFS. Within that memorandum, the Corps revised its effects determination for Puget Sound Georgia Basin (PS/GB) rockfish from may affect, but is not likely to adversely affect (NLAA) to may affect, likely to adversely affect (LAA). As indicated in Table 1, NMFS was unable to concur with the Corps determination that the proposed action may affect, but is not likely to adversely affect PS steelhead. This species is included in formal consultation on the proposed action.

On February 22 2021, NMFS asked the Corps to specify the discretion it has in maintaining the currently authorized federal navigation channel at Blair Waterway, as well as what discretion it will have if an improved navigation channel is authorized by Congress at that location. The Corps provided that information on March 29, 2021, in a letter to NMFS. The information provided in the March 29, 2021, letter has been used to help define the environmental baseline and effects of the action considered in this consultation. NMFS acknowledges and accepts the following rationale to define the environmental baseline for this consultation:

> "Congress authorized the Blair Waterway in its current configuration, in a maintained state, and it is not within the Corps' discretion to alter its current configuration without seeking further congressional authorization. The ongoing consequences to the environment of the existing operation and configuration of the federal navigation channel, in a maintained state, as well as the effects of placing dredged material in the open-water disposal site at Commencement Bay (as addressed as part of a previous consultation), are therefore, within the "environmental baseline" considered." [2]

On January 3, 2022, the Corps confirmed with NMFS that side slope stabilization measures would be necessary at four locations to accommodate the proposed widening. On January 4, 2022, via phone, NMFS requested additional information regarding the slope stabilization measures currently in place at each of the four locations. The Corps provide pictures and a written description of current shoreline conditions via email on January 4, 2022. On January 5, 2022, NMFS asked the Corps to clarify the extent of shoreline armoring existing throughout the entire Blair Waterway. The Corps responded on January 6, indicating that, with the exception of mitigation/restoration sites, the entire Blair Waterway was armored. On January 12, 2022, NMFS requested clarification of the resulting channel slopes following installation of stabilization measures. The Corps responded informing NMFS that the channel slope waterward of the proposed secant walls at areas 2 and 3 would be maintained at 2H:1V and riprap at areas 1 and 4 would be 1.5H:1V. Based on these conversation regarding the design of the shoreline stabilization components of the proposed action NMFS analyzed the effects of secant walls with waterward 2H:1V slopes at areas 2 and 3 and riprap on a 1.5H:1V slope at areas 1 and 4.

[2] Page 3 of the March 29, 2021, letter from Alexander "Xander" L. Bullock, Colonel, Corps of Engineers, District Commander to Barry Thom, Regional Administrator, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, West Coast Region.

NMFS initiated formal ESA and MSA consultation with the Corps on August 18, 2021.

Table 1. Effects determinations made by the Corps and NMFS for the ESA-listed species and critical habitat in the project area.

Species	Status	Corps Species Determination	Corps Critical Habitat Determination	NMFS Species Determination	NMFS Critical Habitat Determination	Species Listing	Critical Habitat Listing
Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*)	T	LAA	LAA	LAA	LAA	06/28/05 (70 FR 37160)	09/02/05 (70 FR 52630)
Puget Sound steelhead (*O. mykiss*)	T	NLAA	NLAA	LAA	N/A	05/11/07 (72 FR 26722)	02/24/16 (81 FR 9252)
Puget Sound/Georgia Basin yelloweye rockfish (*Sebastes ruberrimus*)	T	LAA	N/A	LAA	N/A	04/28/10 (75 FR 22276)	02/11/15 (79 FR 68041)
Puget Sound/Georgia Basin bocaccio (*Sebastes paucispinis*)	E	LAA	N/A	LAA	N/A	04/28/10 (75 FR 22276)	02/11/15 (709 FR 68041)
Southern Resident Killer Whales (*Orcinus orca*)	E	NLAA	NLAA	NLAA	NLAA	11/18/05 (70 FR 57565)	11/29/06 (71 FR 69054)
Green Sturgeon (*Acipenser medirostris*)	T	NLAA	N/A	NLAA	N/A	04/07/06 (71 FR 17757)	11/09/09 (74 FR 52299)
Eulachon (*Thaleichthys pacificus*)	T	NLAA	N/A	NLAA	N/A	3/18/10 (75 FR 13012)	10/20/11 (76 FR 65323)
Humpback whale, Central America DPS (*Megaptera novaeangliae*)	E	Did not address	Did not address	NLAA	N/A	10/11/16 (81 FR 62259)	04/21/21 (86 FR 21082)
Humpback whale, Mexico DPS (*Megaptera novaeangliae*)	T	Did not address	Did not address	NLAA	N/A	10/11/16 (81 FR 62259)	04/21/21 (86 FR 21082)

T = Threatened E = Endangered LAA = likely to adversely affect NLAA = not likely to adversely affect
N/A = not applicable. The action area is outside designated critical habitat, or critical habitat has not been designated.

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies (50 CFR 402.02).

The U.S. Army Corps of Engineers (Corps) has developed a General Investigations study (GI), and integrated feasibility report and environmental assessment (IFR/EA), which provides the results of a deep draft navigation feasibility study undertaken to identify and evaluate alternatives to improve the navigation system's efficiency in Tacoma Harbor, Washington. This study is authorized by Section 209 of the Rivers and Harbors Act of 1962, as amended (Public Law 87-874). The Corps has undertaken this study in partnership with the Port of Tacoma (Port) as the non-federal sponsor. A recommended plan has been selected (described below) from four alternatives. Because the recommended plan forms the basis of a Chief's Report to Congress and is not a final design, NMFS is required to make assumptions in components of the action in order to complete an effects analysis. Where necessary, we identify our assumptions throughout this Opinion.

The Corps and the Port are proposing to deepen and widen the Blair Waterway to improve shipping capability and efficiency (Figure 1). The work is anticipated to take approximately four years. The Corps has determined the deepest channel that is economically justified is 57 feet below Mean Lower Low Water (MLLW). A deeper harbor would eliminate transit delays due to tidal changes and allow larger, fully loaded ships to more efficiently and cost-effectively visit the Port. Tide restrictions, light loading, or other operational inefficiencies created by inadequate channel depth currently limits the Port's capacity to accommodate increased vessel shipping loads. The proposed action would improve navigation in the Blair Waterway by deepening and widening the existing federal channel. Specific components of the proposed action include:

- Deepening the existing Blair Waterway from a depth of -51 MLLW to -57 MLLW along its entire length (approximately 2.75 miles).
- Widening the channel from 450 feet to 865 feet at specific locations (Table 2). Armoring the waterway is not proposed.
- Install slope stabilization structures to accommodate channel widening along four sections of the waterway.
    - Areas 1 and 4 would be stabilized using riprap on a 1.5H:1V slope.
    - Areas 2 and 3 would be stabilized using secant walls with a 2H:1V waterward slope.
- Expanding the existing turning basin boundary at the end of the Blair Waterway to a diameter of 1,935 feet from 1,682 and deepening the turning basin to -57 feet MLLW.

Dredging of the Blair waterway would result in approximately 2.8 million cubic yards of sediment material. 1.85 million cubic yards of suitable[3] dredged material would be placed at the Saltchuk beneficial use site; 550,000 cubic yards of material would be placed at the Commencement Bay open water disposal site; and approximately 400,000 cubic yards of material deemed unsuitable for open water disposal or beneficial use would be transported to an upland disposal site.

[3] See https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll11/id/5397 for more information on suitable vs. unsuitable dredged materials.

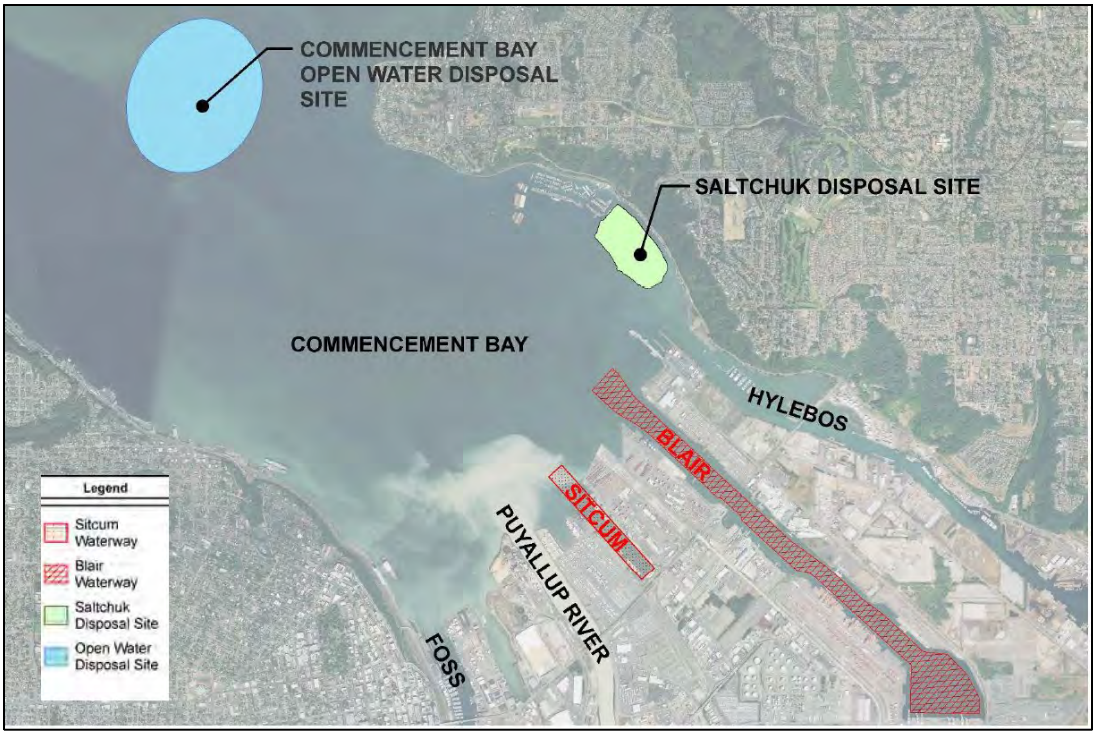

Table 2. Federally authorized and proposed widths by channel station (STA) at Blair Waterway.

Stations along the channel	Currently Authorized widths (feet)	Proposed width (feet)
STA -5 to STA 0	NA	865
STA 0 to STA 12	520	800
STA 12 to STA 44	520, narrowing to 343	520
STA 44 to STA 52	520	520
STA 52 to STA 79	520, narrowing to 330	520
STA 79 to STA 100	330	450
STA 100 to STA 116	330, widening to 1,682	525
STA 116 to STA 140 (turning basin)	1,682	1,935

1.3.1 Channel Deepening and Material Disposal

Under the recommended plan, disposal of dredged sediments would occur in three locations, including the Saltchuk beneficial use site, the Dredged Material Management Program (DMMP) open-water non-dispersive disposal site in Commencement Bay, and an upland disposal site. A mechanical clamshell bucket dredge would be used to remove suitable materials from the Blair Waterway and place approximately 1.8 million cubic yards (cy) of beneficial use sediment at the Saltchuk site and approximately 562,000 cubic yards (cy) of dredged material would be placed at the Dredged Material Management Program (DMMP) Commencement Bay open water disposal site (Figure 1). A Feasibility-level advisory suitability determination by the DMMP Agencies (U.S. Army Corps of Engineers, Washington State Department of Ecology, Washington State

Department of Natural Resource, and the Environmental Protection Agency) evaluated the potential in-water placement of 2.5 million cubic yards of dredged material from the Blair waterway at the Commencement Bay disposal site or potential beneficial use. This analysis involved the characterization of sediment core testing and indicates that approximately 392,000 cy of sediment dredged from the Blair Waterway may be unsuitable for in-water disposal, and would be transported to an upland disposal site. These quantities assume that the dredging contractor would remove the two-foot allowable over-depth during dredging. To ensure unsuitable material remains isolated during dredging, a vertical and horizontal buffer would be used in the final dredging prism design. The DMMP agencies also indicated that to ensure that unsuitable material would be separated from unsuitable material during dredging, a minimum one-foot vertical buffer and an appropriate horizontal buffer would be added to the unsuitable portions of the final dredge prism. Material deemed unsuitable for placement at Saltchuk or the Commencement Bay in-water disposal site would be removed from the channel using an environmental clamshell bucket to limit the amount of suspended and potentially unsuitable sediments.

During construction, several pieces of in-water equipment would be operating up to 24 hours per day including the dredge tugboat, barge, skiff, and survey boat. Only one dredge would be operating at a time, but would be running nearly continuously. Equipment would primarily be operating within the Blair Waterway, but the barge would travel to the open-water disposal site and the Saltchuk site to dispose of dredged materials. One or two tugboats would be used to transport barges between construction and disposal sites. Dredged materials would be placed on a barge adjacent to the site where material is actively being removed. The estimated amount of time required to complete dredging work is approximately four years, which results in roughly one-fourth to one-third of the waterway being dredged each year. A survey vessel would slowly transit the area to monitor dredging progress.

Washington Administrative Code (WAC 220-660-330) requires in-water work in commencement bay to occur between July 15 and February 15. However, to be more protective, the Corps proposed an in-water work window of August 16 to February 15, which also adheres to the in-water work window for material disposal at the Commencement Bay open-water disposal site (NMFS 2015a).

Consultations with NMFS and the U.S. Fish and Wildlife Service (USFWS) on disposal of dredged material at the DMMP open-water disposal sites in Puget Sound, including the Commencement Bay site, were conducted separately (USACE 2015; NMFS 2015a). The effects of sediment disposal at DMMP open-water disposal sites have already been considered in the programmatic formal consultation for their continued use through 2040 (NMFS 2015a), and as such, the use of the DMMP open-water disposal site for disposal of sediments are considered part of the environmental baseline for this consultation. The environmental baseline includes the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

Future maintenance dredging is not part of the proposed action, and is not considered in this Opinion. Therefore, future operation and maintenance dredging, including manner and timing, would be subject to separate, future, ESA Section 7 consultation(s).

1.3.2 Waterway Width Expansion and Slope Stabilization Measures

As proposed, the Corps will install additional side slope stabilization measures at select areas (Areas 1-4). Additional evaluation of slope stabilization measures, including no additional stabilization measures, will be considered in the Pre-construction Engineering and Design (PED) phase along the following stationing (Figure 2):

- Area 1: STA 44+00.00 to STA 48+00.00
- Area 2: STA 74+50.00 to STA 82+00.00
- Area 3: STA 94+50.00 to STA 97+50.00
- Area 4: STA 118+00.00 to STA 125+50.00

Stabilization measures include a secant wall at sites 2 and 3, which includes the existing 2:1 slope waterward of the wall, and replacement riprap at 1.5:1 slopes at sites 1 and 4[4]. The greatest extent of slope stabilization would be riprap from +10 MLLW to -57 MLLW (about 7.52 acres among four possible locations) with a secant wall (1,130 feet in length at two locations; about 4% of the total Blair Waterway shoreline: 28,566 linear feet). Where used, the proposed method for secant pile installation is augering and vibratory pile driving. Vibratory pile driving may be used to install steel casings prior to drilling. Vibratory driving may also be used to install temporary sheetpile cofferdams prior to pouring concrete. Impact pile driving would not be used at any point in the secant wall installation process. Dredging may occur before or after shoreline stabilization measures are installed. Because shoreline stabilization designs are not finalized the Corps estimates that installation of secant walls may take between 44 and 157 days depending on the diameter and height of the finalized structures. The Corps expects piles to range between 2-4 feet in diameter and 20-50 feet tall. Existing riprap would be removed prior to beginning construction.

NMFS evaluated both stabilization methods (riprap and secant stabilization) and assumed that each would be used as described in the January 12 and 20, 2022, emails from the Corps. Changes to those designs, described in detail below, would require reinitiating consultation with NMFS, except that if no armoring were determined to be necessary, reinitiation of consultation would not be necessary for that element of the proposed action.

Area 1 (STA 44+00.00 to STA 48+00.00) is about a third of the way into the channel on the southwestern side (Figure 2). Slopes extend to the edge of the adjacent upland facilities, which consist of an asphalt-paved parking lot. NMFS assumes that replacement stabilization measures in the form of 1.5H:1V slope-rock toe combination would be required at this location after conferring with the Corps. Once the design is further refined with additional analysis in PED, the

[4] Corps email on January 12, 2022 from Kaitlin Whitlock.

final engineering solution at this location may change to include a secant wall or an alternative slope stabilization measure. A change in stabilization methods from a 1.5 H:1 V slope-rock toe combination will require re-initiation, except that if no armoring were determined to be necessary, reinitiation of consultation would not be necessary for that element of the proposed action.

Area 2 (STA 74+50.00 to STA 82+00.00) is about midway into the channel on the north side. A 2H:1V slope reaches well into the uplands in Area 2, prompting the need for proposed stabilization measures. A secant wall is proposed to protect this location (January 12, 2022 email from the Corps). Once the design is further refined with additional analysis in PED, the final engineering solution at this location may change to include an alternative slope stabilization measure, which would require re-initiation of this Opinion, except that if no armoring were determined to be necessary, reinitiation of consultation would not be necessary for that element of the proposed action.

Area 3 (STA 94+50.00 to STA 97+50.00) is on the north side of the channel and is Puyallup Tribe property (Figure 2). As with Area 2, a 2H:1V slope extends into the uplands. A secant wall is proposed to protect this location (January 12, 2022 email from Kaitlin Whitlock, COE). Once the design is further refined with additional analysis in PED, the final engineering solution at this location may change to include an alternative slope stabilization measure, which would require re-initiation of this Opinion., except that if no armoring were determined to be necessary, reinitiation of consultation would not be necessary for that element of the proposed action..

Area 4 (STA 118+00.00 to STA 125+50.00) is on the north side of the channel within the entrance to the turning basin (Figure 2). It is similar to Area 1, where a 2H:1V slope marginally extends into the uplands. This area does not include upland facilities or major infrastructure, the land here is owned by the Port, and it is used for storage. The Corps proposes that replacement stabilization measures in the form of a 1.5 H:1V slope-rock toe revetment would be required at this location. Once the design is further refined with additional analysis in PED, the final engineering solution at this location may change to include a secant wall or an alternative slope stabilization measure. A change in stabilization methods from a 1.5 H:1 V slope-rock toe combination will require re-initiation, except that if no armoring were determined to be necessary, reinitiation of consultation would not be necessary for that element of the proposed action.

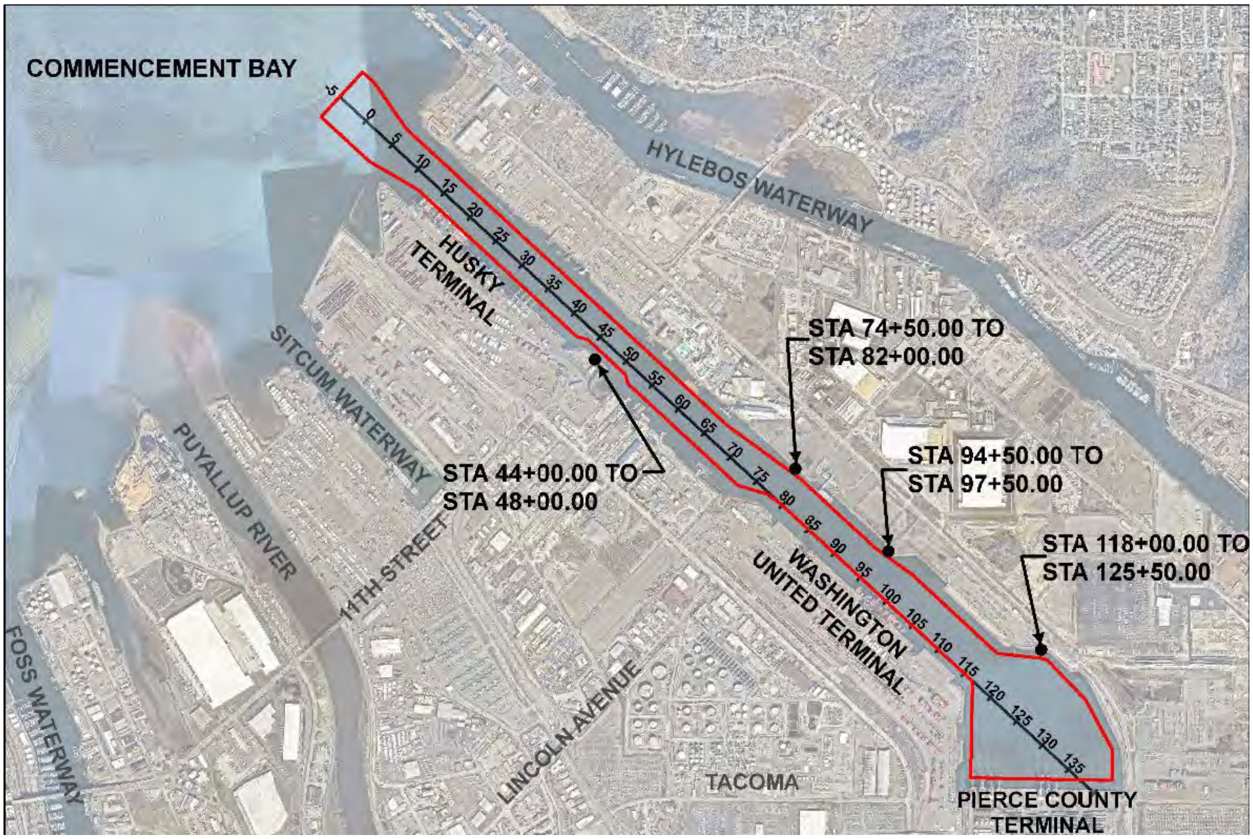

Figure 2. Potential side slope stabilization areas, Blair Waterway. Map from COE, 2020.

1.3.3 Material Placement at Saltchuk

The Saltchuk site, located north of the Blair Waterway (Figure 1), is where dredged material would be placed to restore nearshore intertidal and subtidal habitat substrate for juvenile and adult Chinook salmon, steelhead, bull trout, larval and juvenile rockfish, forage fish, and epibenthic and benthic invertebrates. The final design of the Saltchuk beneficial use site would be developed in the pre-construction engineering design (PED) phase. A full sediment characterization by DMMP agencies in PED would provide additional information to verify assumptions about in-water disposal. In addition, once further design and information is developed in PED, coordination would occur with NMFS, other natural resource agencies, and tribes to specify the criteria used to determine suitability of in-water disposal for restoration of intertidal and subtidal habitat at this location. NMFS assumes that a fully developed Saltchuk site plan is reasonably likely to occur; however, insofar as the project details are unavailable for analysis, we assume that the deposit of beneficial use sediment will occur at Saltchuk, but we do not assume that the site will develop into a fully restored site without future efforts. This is conservative assumption. The actions at Saltchuk may yield greater beneficial effects than are considered here, but a precautionary approach gives any benefit of doubt to listed species and critical habitat.

During Saltchuk disposal of dredged material, a bottom-dump barge would be used for the first bench for material deeper than -20 MLLW. A flat deck barge with a mounted excavator would be needed to place material at shallower depths. The Corps assumes a 1,200 to 3,000 cubic yard barge would be used to transport material from the Blair Waterway to the disposal sites. Based on the estimated amount of dredged material going to the disposal sites between 600 and 1,500 trips would be made over about four years depending on the size of barge.

1.3.4 Conservation Measures and Best Management Practices

Conservation measures and best management practices (BMP) described in the biological assessment that are part of the proposed action and intended to minimize adverse effects to ESA-listed species and their designated critical habitats include the following:

1. Comply with all applicable water quality standards and enforceable conditions issued in the water quality certification and adhere to monitoring protocols in the water quality monitoring plan.
2. Dredge and place material at Saltchuk only within the designated in-water work window of August 16 through February 15.
3. Prior to dredging, the entire footprint of the Blair waterway project area would undergo additional sediment testing to determine suitability for aquatic disposal, and all material determined unsuitable for in-water disposal would be transported for upland disposal at an appropriate facility.
4. An environmental clamshell bucket would be used in all areas in which sediment has been determined unsuitable for aquatic disposal to minimize resuspension of contaminated sediment.
5. The side slopes of the navigation channel would be graded to ensure that no sloughing would occur.
6. All equipment would be inspected daily to ensure that it is in proper working condition and has no leaks of fuel or hydraulic fluids. Each vessel would have a spill kit on board at all times.

NMFS also considered whether or not the proposed action would cause any other activities. We determined that the proposed action would alter the future shipping in Puget Sound. The deeper depth would allow for Post-Panamax vessels currently calling on the port to transport more cargo more efficiently. The Draft Integrated Feasibility Report/Environmental Assessment (IFR/EA; COE, 2021) prepared for this project reports that channel deepening does not increase the Port’s landside capacity or decrease transportation costs by enough to increase the Port’s container market share. As a result, the analysis assumes channel deepening does not induce additional cargo volume or vessel calls. Instead, deepening to -57 MLLW allows vessels to load to their full draft and carry more cargo in each transit. The greater efficiency provided at the terminals results in shipping services requiring fewer total trips to transport the same cargo volume (thereby reducing transportation costs). The analysis in the IFR/EA (COE, 2021) shows a channel deepening in the Blair Waterway to -57 MLLW would lead to a reduction of 150 and 163 vessel calls in 2030 and 2035, respectively (Table 3). This represents a 27 percent reduction in total vessel calls as a result of the proposed action. Additionally, channel deepening can reduce or eliminate the practice of ships sitting idle in Commencement Bay waiting for appropriate tide conditions to transit the waterway. By lowering and eliminating wait times at the Port the total time each vessel is emitting underwater noise in central Puget Sound would be reduced.

For the purposes of the analysis in this Opinion, a reduction in vessel traffic in the navigation channel is considered a consequence of the proposed action. Current levels of vessel traffic are not considered a consequence of the proposed action because that traffic would likely continue to occur even without the proposed action. In other words, the proposed action is considered to reduce impacts, such as noise and risk of marine mammal strike, caused by vessels calling on the Port of Tacoma Blair Waterway.

Table 3. Vessel calls to the Port of Tacoma Blair Waterway by year (2030 and 2035), class, and channel depth (current vs. proposed). Vessel draft to and from the Port is indicated for each vessel class. Table adapted from the 2020 Corps Biological Assessment.

Vessel Class	Draft Depth, To (ft.)	Draft Depth, From (ft.)	Current Depth (-51 ft. MLLW)	Proposed Depth (-57 ft. MLLW)
2030				
Panamax – PX	30.8	44.8	0	0
Post Panamax – PPX1	35.4	47.6	49	0
Super Post-Panamax – PPX2	39.4	49.2	155	54
Ultra Post-Panamax – PPX3	40	53	229	229
New Post-Panamax – PPX4	45	54	116	116
		Total Calls	**549**	**399**
2035				
Panamax – PX	30.8	44.8	0	0
Post Panamax – PPX1	35.4	47.6	81	0
Super Post-Panamax – PPX2	39.4	49.2	132	50
Ultra Post-Panamax – PPX3	40	53	189	189
New Post-Panamax – PPX4	45	54	189	189
		Total Calls	**591**	**428**

1.4 Action Area

"Action area" means all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area is determined by the greatest extent of physical, chemical, and biological effects stemming from the project. The proposed action would cause a range of effects including temporary effects related to construction, intermittent effects caused by reduced marine vessels, and enduring effects related to deepening and widening of Blair Waterway and the placement of dredged sediment at Saltchuk.

The Corps defines the action area as a 3-mile radius surrounding the Blair Waterway to fully capture the effects within Commencement Bay and the lower Puyallup River, including potential noise and turbidity effects from dredging operations. We expect the low current velocity in the Blair Waterway would limit the distance fine particles would travel from dredging site based on available aerial imagery from the Puyallup River (see Figure 1). Likewise, we anticipate that sound effects (noise) would attenuate within 3 miles of dredging operations due to the use of a clamshell bucket. We expanded the action area to include the shipping lanes of Puget Sound leading to Blair Waterway (Figure 3). The proposed action is expected to reduce the number of vessels utilizing the Port because the deeper depth would allow vessels currently using the Port to be loaded to full capacity per trip (as described above in Section 1.3).

The greater efficiency for each vessel would lead to a reduction in vessel calls on the Port for the foreseeable future. While the reduction in vessel use at the Port would be most concentrated around the Port itself, each vessel travels through Puget Sound via shipping lanes to reach Commencement Bay; meaning impacts from reduced vessel trips extend beyond the Blair Waterway in Commencement Bay, to include transit through Puget Sound. Only a portion of effects are expected to extend into the shipping lanes of the Puget Sound (described more thoroughly in Section 2.4) and these effects are expected to be entirely positive on listed species and critical habitat. The action area overlaps with the geographic ranges of the ESA-listed species and the boundaries of some designated critical habitats identified in Table 1. The action area also overlaps with areas that have been designated, under the MSA, as EFH for Pacific Coast salmon, Pacific Coast groundfish, and coastal pelagic species.

US-Canada
Pacific Coast
Puget Sound
Shipping Lanes
Commencement Bay
Open Water Disposal
Site
Puget Sound
Saltchuk
Site
Approximation
of Action Area
3-mile radius
Blair Waterway
Puyallup River
Tacoma

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

The Corps determined that the proposed action is likely to adversely affect PS Chinook salmon, PS/GB yelloweye rockfish, and PS/GB bocaccio, and is likely to adversely affect designated critical habitat for PS Chinook salmon (Table 1). The Corps determined that the proposed action is not likely to adversely affect PS steelhead, SRKW, green sturgeon, or Eulachon or SRKW and PS steelhead critical habitat (Corps 2020a, 2020b).

NMFS considered effects of the proposed action on the species listed in Table 1. NMFS included humpback whales, Central America and Mexico DPSs, in this Opinion given the action area includes large portions of the Puget Sound including areas where humpback whales have been observed and are periodically known to occur.

2.1 Analytical Approach

This Opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This Opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this Opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision does not change the scope of our analysis, and in this Opinion we use the terms "effects" and "consequences" interchangeably.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

The following analysis evaluates a 50-year period to determine project effects on ESA-listed species and critical habitat. The 50-year period was derived from the economic analysis completed by the Corps as part of the Integrated Feasibility Report and Environmental Assessment (IFR/EA), which examines the economic impacts of widening and deepening the channel over a 50-year period. We utilized the same 50-year time period to evaluate project effects because it is difficult to anticipate how baseline conditions may change beyond 50-years. Moreover, given the dynamic economic and industrial nature of the Port of Tacoma, uncertainty associated with the response of species and habitats to climate change, and expected population growth and industrial and residential development in the Puget Sound (discussed in more detail in Section 2.5), it would be impossible to analyze effects of the proposed action past 50-years.

The following effects analysis of the proposed action on ESA-listed species and critical habitats was limited due to the feasibility phase-level design information provided by the Corps. As part of the Corps' planning process, further work would occur should Congress authorize the recommended plan and provide appropriations to conduct further engineering and final designs. Therefore assumptions were made in order to complete the effects analysis included in this Opinion. Specifically, we assume that placement of dredged material at the Saltchuk beneficial use site is reasonably likely to occur, but would not result in a fully restored site without future efforts. Additionally, we assume that slope stabilization measures as described in Section 1.3.2 are reasonably likely to occur as part of the proposed channel widening; if slope stabilization methods or locations change as a result of final engineering analysis in PED, future reinitiation of consultation with NMFS would likely be required. Vessel traffic is anticipated to decrease as a result of the proposed action, but, as discussed in the effects section, we lack sufficient information to evaluate changes from the environmental baseline from some aspects of the larger vessels. Finally, we assume that all conservation measures and BMPs would be implemented as described in the Proposed Action section above (Section 1.3.3) and the BA.

2.2 Rangewide Status of the Species and Critical Habitat

This Opinion examines the status of each species that is likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The Opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species.

One factor affecting the status of ESA-listed species considered in this Opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of designated critical habitats in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snowpack, increases winter flows, and advances the timing of spring melt (Mote et al. 2014; Mote et al 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013; Mote et al. 2014).

During the last century, average regional air temperatures in the Pacific Northwest increased by 1-1.4°F as an annual average, and up to 2°F in some seasons (based on average linear increase per decade; Abatzoglou et al. 2014; Kunkel et al. 2013). Recent temperatures in all but two years since 1998 ranked above the 20th century average (Mote et al. 2014). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014).

Decreases in summer precipitation of as much as 30 percent by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote et al. 2013). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

The combined effects of increasing air temperatures and decreasing spring through fall flows are expected to cause increasing stream temperatures; in 2015 this resulted in 3.5-5.3°C increases in Columbia Basin streams and a peak temperature of 26°C in the Willamette (NWFSC 2015).

Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009).

The Northwest Fishery Science Center (NWFSC 2015) reported that model projections of climate conditions affecting Puget Sound salmonids were not optimistic, and recent and unfavorable environmental trends are expected to continue. A negative pattern in the Pacific Decadal Oscillation[5] has recently emerged, which adds uncertainty to the short-term duration of warming trends. However, the long-term trends of climate change and other environmental indicators suggest the continuation of warming ocean temperatures; fragmented or degraded freshwater spawning and rearing habitat; reduced snowpack; altered hydrographs producing reduced summer river flows and warmer water; and low marine survival for salmonids in the Salish Sea (NWFSC 2015). Overall, the marine heat wave in 2014-2016 had the most drastic impact on marine ecosystems in 2015, with lingering effects into 2016 and 2017. Conditions had somewhat returned to "normal" in 2018, but another marine heat wave in 2019 again set off a series of marine ecosystem changes across the North Pacific (Ford, in press). One reason for lingering effects of ecosystem response is due to biological lags. These lags result from species impacts at larval or juvenile stages, which are typically most sensitive to extreme temperatures or changes in food supply. It is only once these species grow to adult size or recruit into fisheries that the impact of the heat wave is apparent.

Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen (DO) and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999; Winder and Schindler 2004; Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright & Weitkamp 2013; Raymondi et al. 2013).

As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode et al. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (McMahon and Hartman 1989; Lawson et al. 2004).

In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0-3.7°C by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and

[5] https://www.ncdc.noaa.gov/teleconnections/pdo/.

abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011; Reeder et al. 2013).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. A 38 percent to 109 percent increase in acidity is projected by the end of this century in all but the most stringent CO_2 mitigation scenarios, and is essentially irreversible over a time scale of centuries (IPCC 2014). Regional factors appear to be amplifying acidification in the Northeast Pacific Ocean, which is occurring earlier and more acutely than in other regions and is already impacting important local marine species (Barton et al. 2012; Feely et al. 2012). Acidification also affects sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012; Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011; Reeder et al. 2013). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Tillmann and Siemann 2011; Reeder et al. 2013).

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these evolutionarily significant units ESUs (Ford, in press). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney et al. 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of ESA-listed species in the future.

2.2.1 Status of ESA-Listed Fish Species

For Pacific salmon, steelhead, and certain other listed fish species, we commonly use the four "viable salmonid population" (VSP) criteria (McElhany et al. 2000) to assess the viability of the populations that, together, constitute the species. These four criteria (spatial structure, diversity, abundance, and productivity) encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, populations can adapt to various environmental conditions and sustain in the natural environment.

“Spatial structure” refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population’s spatial structure depends on quality and spatial configuration critical habitat, and the dispersal characteristics and dynamics of individuals in the population.

“Diversity” refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation in single genes to complex life history traits (McElhany et al. 2000).

“Abundance” generally refers to the number adults in the naturally produced (i.e., the progeny of naturally spawning parents) in the environment (e.g., on spawning grounds).
“Productivity,” as applied to viability factors, refers to the entire life cycle (i.e., the number of naturally-spawning adults produced per parent). When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhany et al. (2000) use the terms “population growth rate” and “productivity” interchangeably when referring to production over the entire life cycle. They also refer to “trend in abundance,” which is the manifestation of long-term population growth rate.

For species with multiple populations, once the biological status of a species’ populations has been determined, we assess the status of the entire species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany et al. 2000).

The summaries that follow describe the status of ESA-listed PS Chinook salmon, PS steelhead, and PS/GB yelloweye and bocaccio rockfish that occur within the geographic area of the proposed action analyzed in this Opinion. More detailed information on the status and trends of these listed resources, and their biology and ecology, are in the listing regulations and critical habitat designations published in the Federal Register (Table 1).

Status of Puget Sound Chinook Salmon

The PS Chinook salmon evolutionarily significant unit (ESU) was listed as threatened on June 28, 2005 (70 FR 37160) (Table 1). NMFS adopted a recovery plan for this ESU in January 2007. The recovery plan consists of two documents: the Puget Sound salmon recovery plan (Shared Strategy for Puget Sound 2007) and a supplement by NMFS (2006). The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus et al. 2002). The PSTRT’s biological recovery criteria will be met when all of the following conditions are achieved:

- The viability status of all populations in the ESU is improved from current conditions, and when considered in the aggregate, persistence of the ESU is assured;
- Two to four Chinook salmon populations in each of the five biogeographical regions of the ESU achieve viability, depending on the historical biological characteristics and acceptable risk levels for populations within each region;
- At least one population from each major genetic and life history group historically present within each of the five biogeographical regions is viable;
- Tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations are functioning in a manner that is sufficient to support an ESU-wide recovery scenario; Production of Chinook salmon from tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations occurs in a manner consistent with ESU recovery; and
- Populations that do not meet the viability criteria for all VSP parameters are sustained to provide ecological functions and preserve options for ESU recovery.

On October 4, 2019, NMFS published notice of NMFS' intent to initiate a new 5-year status review for 28 listed species of Pacific salmon and steelhead and requesting updated information from the public to inform the status review (84 FR 53117). On March 24, 2020, NMFS extended the public comment period, from the original March 27, 2020, through May 26, 2020 (85 FR 16619). The Northwest Fishery Science Center (NWFSC), and NMFS' West coast Regional Office (WCRO) are currently preparing the final status review documents. In this section, we utilize some of the information in the draft viability risk assessment (Ford, in press), in order to provide the most recent information for our evaluation in this Opinion.

Where possible, particularly as new material becomes available, the latest final status review information (NMFS 2016) is supplemented with more recent information and other population specific data that may not have been available during the status review, so that NMFS is assured of using the best available information for this Opinion.

Spatial Structure and Diversity: The Puget Sound Chinook salmon ESU includes all naturally spawning populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington. The ESU also includes the progeny of numerous artificial propagation programs (NWFSC 2015). The PSTRT identified 22 extant populations, grouped into five major geographic regions, based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity. The PSTRT distributed the 22 populations among five major biogeographical regions, or major population groups (MPG), that are based on similarities in hydrographic, biogeographic, and geologic characteristics.

Three of the five MPGs (Strait of Juan de Fuca, Georgia Basin, and Hood Canal) contain only two populations, both of which must be recovered to viability to recover the ESU (NMFS 2006b). Under the Puget Sound Salmon Recovery Plan, the Suiattle and one each of the early, moderately early, and late run-timing populations in the Whidbey Basin Region, as well as the

White and Nisqually (or other late-timed) populations in the Central/South Sound Region must also achieve viability (NMFS 2006b).

The Technical Recovery Team (TRT) did not define the relative roles of the remaining populations in the Whidbey and Central/South Sound Basins for ESU viability. Therefore, NMFS developed additional guidance which considers distinctions in genetic legacy and watershed condition, among other factors, in assessing the risks to survival and recovery of the listed species by the proposed actions across all populations within the PS Chinook ESU. In doing so, it is important to take into account whether the genetic legacy of the population is intact or if it is no longer distinct within the ESU. Populations are defined by their relative isolation from each other and by the unique genetic characteristics that evolve, as a result of that isolation, and adaption to their specific habitats. If these populations still retain their historic genetic legacy, then the appropriate course, to ensure their survival and recovery, is to preserve that genetic legacy and rebuild those populations. Preserving that legacy requires both a sense of urgency and the actions necessary and appropriate to preserve the legacy that remains. However, if the genetic legacy is gone, then the appropriate course is to recover the populations using the individuals that best approximate the genetic legacy of the original population, reduce the effects of the factors that have limited their production, and provide the opportunity for them to readapt to the existing conditions.

In keeping with this approach, NMFS further classified PS Chinook populations into three tiers based on a systematic framework that considers the population's life history and production and watershed characteristics (NMFS 2010) (Figure 4). This framework, termed the Population Recovery Approach, carries forward the biological viability and delisting criteria described in the Supplement to the Puget Sound Salmon Recovery Plan (Ruckelshaus et al. 2002; NMFS 2006b). The assigned tier indicates the relative role of each of the 22 populations comprising the ESU to the viability of the ESU and its recovery. Tier 1 populations are most important for preservation, restoration, and ESU recovery. Tier 2 populations play a less important role in recovery of the ESU. Tier 3 populations play the least important role. When we analyze proposed actions, we evaluate impacts at the individual population scale for their effects on the viability of the ESU. We expect that impacts to Tier 1 populations would be more likely to affect the viability of the ESU, as a whole, than similar impacts to Tier 2 or 3 populations, because of the relatively greater importance of Tier 1 populations to overall ESU viability and recovery. NMFS has incorporated this and similar approaches in previous ESA section 4(d) determinations and Opinions on Puget Sound salmon fisheries and regional recovery planning (NMFS 2005b; 2005d; 2008f; 2008e; 2010a; 2011a; 2013b; 2014b; 2015c; 2016f; 2017b; 2018c; 2019b; 2021e).

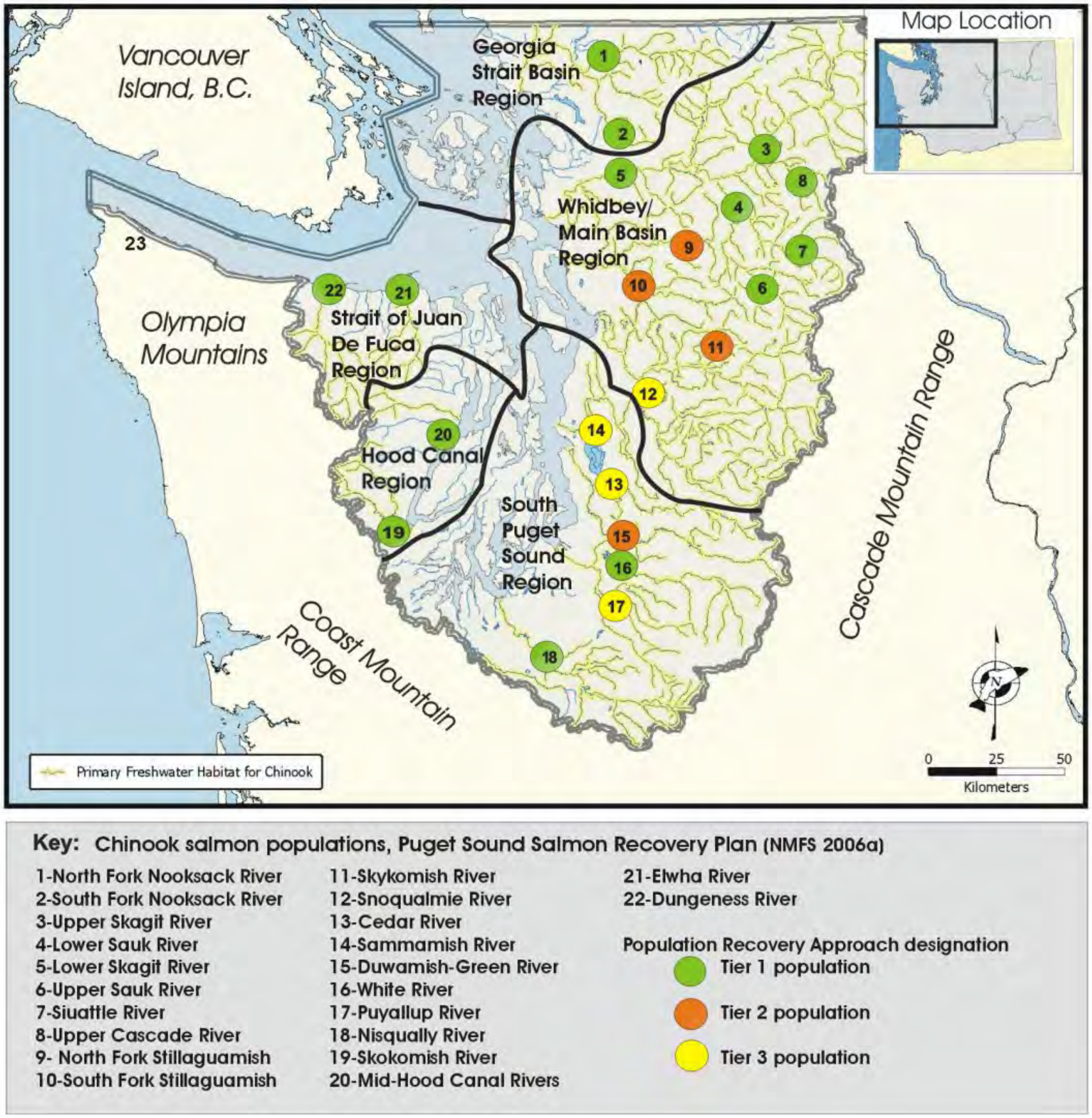

Figure 4. Puget Sound Chinook populations with tiered recovery designations.

The ESU also includes Chinook salmon from certain artificial propagation programs. Artificial propagation (hatchery) programs (26) were added to the listed Chinook salmon ESU in 2005, as part of the final listing determinations for 16 ESUs of West Coast Salmon and Final 4(d) Protective Regulations for Threatened Salmonid ESUs (70 FR 37160). In October of 2016, NMFS proposed revisions to the hatchery programs included as part of some Pacific salmon ESUs and steelhead DPSs listed under the ESA (81 FR 72759). NMFS issued its final rule in December of 2020, which includes 25 hatchery programs as part of the listed Puget Sound Chinook salmon ESU (85 FR 81822).

Since 1999, most PS Chinook populations have mean natural-origin spawner escapement levels well below levels identified as required for recovery to low extinction risk. Long-term, natural-origin mean escapements for eight populations are at or below their critical thresholds.[6] Both populations in three of the five biogeographical regions are below or near their critical threshold: Georgia Strait, Hood Canal and Strait of Juan de Fuca. When hatchery spawners are included, aggregate average escapement is over 1,000 for one of the two populations in each of these three regions, reducing the demographic risk to the populations in these regions. Additionally, hatchery spawners help two of the remaining three of these populations achieve total spawner abundances above their critical threshold, reducing demographic risk. Nine populations are above their rebuilding thresholds,[7] seven of them in the Whidbey/Main Basin Region. In 2018 NMFS and the NWFSC updated the rebuilding thresholds for several key Puget Sound populations. These thresholds represent the Maximum Sustained Yield estimate of spawners based on available habitat. The new spawner-recruit analyses for several populations indicated a significant reduction in the number of spawners that can be supported by the available habitat when compared to analyses conducted 10 to 15 years ago. This may be due to further habitat degradation or improved productivity assessment or, more likely, a combination of the two. For example, the updated rebuilding escapement threshold for the Green River is 1,700 spawners compared to the previous rebuilding escapement threshold of 5,523 spawners[8]. So, although several populations are above the updated rebuilding thresholds, indicating that escapement is sufficient for the available habitat in many cases, the overall abundance has declined.

Measures of spatial structure and diversity can give some indication of the resilience of a population to sustain itself. Spatial structure can be measured in various ways, but here we assess the proportion of natural-origin spawners (wild fish) vs. hatchery-origin spawners on the spawning grounds (Ford, in press).

Since 1990, there is a general declining population trend in the proportion of natural-origin spawners across the ESU (Table 4). While there are several populations that have maintained high levels of natural-origin spawner proportions, mostly in the Skagit and Snohomish basins, many others maintain high proportions of hatchery-origin spawners (Table 4). It should be noted that the pre-2005-2009 estimates of mean natural-origin fractions occurred prior to the widespread adoption of mass marking of hatchery produced fish. Estimates of hatchery and natural-origin proportions of fish since the implementation of mass marking are considered more robust. Several of these populations have long-standing or more recent conservation hatchery programs associated with them—North Fork (NF) and South Fork (SF) Nooksack, NF and SF

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[6] After taking into account uncertainty, the critical threshold is defined as a point below which: (1) depensatory processes are likely to reduce the population below replacement; (2) the population is at risk from inbreeding depression or fixation of deleterious mutations; or (3) productivity variation due to demographic stochasticity becomes a substantial source of risk (NMFS 2000).

[7] The rebuilding threshold is defined as the escapement that will achieve Maximum Sustainable Yield (MSY) under current environmental and habitat conditions (NMFS 2000), and is based on an updated spawner-recruit assessment in the Puget Sound Chinook Harvest Management Plan, December 1, 2018. Thresholds were based on population-specific data, where available.

[8] The historic Green River escapement goal was established in 1977 as the average of estimated natural spawning escapements from 1965-1974. This goal does not reflect the lower productivity associated with the current condition of habitat. Reference the source for the historical objective from MUP (PSIT and WDFW 2017)(Green River MUP).

Stillaguamish, White River, Mid-Hood Canal, Dungeness, and the Elwha. These conservation programs are in place to maintain or increase the overall abundance of these populations, helping to conserve the diversity and increase the spatial distribution of these populations in the absence of properly functioning habitat. With the exception of the Mid-Hood Canal program, these conservation hatchery programs culture the extant, native Chinook salmon stock in these basins. With the exception of the NF and SF Stillaguamish, the remainder of the populations included in these conservation programs are identified in NMFS (2006b) as essential for the recovery of the Puget Sound Chinook salmon ESU (Table 4).

Table 4. Five-year mean of fraction of natural-origin spawners[9] (sum of all estimates divided by the number of estimates) (Ford, in press).

Population	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019
NF Nooksack R. spring	0.28	0.11	0.19	0.14	0.13
SF Nooksack R. spring	0.26	0.55	0.57	0.42	0.45
Low. Skagit R. fall	0.94	0.91	0.86	0.92	0.84
Up. Skagit R. summer	0.91	0.87	0.84	0.95	0.91
Cascade R. spring	0.98	0.92	0.89	0.94	0.86
Low. Sauk R. summer	0.94	0.97	0.95	0.91	0.98
Up. Sauk R. spring	0.99	1.00	0.98	0.97	0.99
Suiattle R. spring	0.99	0.97	0.99	0.99	0.97
NF Stillaguamish R. summer/fall	0.59	0.70	0.40	0.43	0.45
SF Stillaguamish R. summer/fall	0.59	0.70	0.40	0.54	0.46
Skykomish R. summer	0.49	0.52	0.76	0.69	0.62
Snoqualmie R. fall	0.81	0.89	0.81	0.78	0.75
Sammamish R. fall	0.29	0.36	0.16	0.07	0.16
Cedar R. fall	0.61	0.59	0.82	0.78	0.71
Green R. fall	0.55	0.47	0.43	0.39	0.30
White R. spring	0.54	0.79	0.43	0.32	0.15
Puyallup R. fall	0.88	0.79	0.52	0.41	0.32
Nisqually R. fall	0.80	0.61	0.30	0.30	0.47
Skokomish R. fall	0.40	0.46	0.45	0.10	0.16
Mid-Hood Canal fall	0.76	0.79	0.61	0.33	0.89
Dungeness R. summer	1.00	0.32	0.43	0.25	0.25
Elwha R. fall	0.41	0.53	0.35	0.06	0.05

In addition, spatial structure, or geographic distribution, of the White, Skagit, Elwha,[10] and Skokomish populations has been substantially reduced or impeded by the loss of access to the upper portions of those tributary basins due to flood control activities and hydropower development. Habitat conditions conducive to salmon survival in most other watersheds have been reduced significantly by the effects of land use, including urbanization, forestry, agriculture, and development (NMFS 2005a; SSPS 2005; NMFS 2008c; 2008d; 2008b). It is

[9] Estimates of hatchery and natural-origin spawning abundances, prior to the 2005-2009 period are based on pre-mass marking of hatchery-origin fish and, as such, may not be directly comparable to the 2005-2009 forward estimates.

[10] Removal of the two Elwha River dams and restoration of the natural habitat in the watershed began in 2011.

likely that genetic and life history diversity has been significantly adversely affected by this habitat loss.

Between 1990 and 2021, the proportion of natural-origin spawners has trended downward across the ESU, with the Whidbey Basin the only MPG with consistently high fractions of natural-origin spawner abundance. All other MPG have either variable or declining spawning populations with high proportions of hatchery-origin spawners (NWFSC 2015, Ford, in press). Overall, the new information on abundance, productivity, spatial structure and diversity since the 2015 status review supports no change in the biological risk category (NWFSC 2015; Ford, in press).

<u>Abundance and Productivity</u>: The abundance of the PS Chinook salmon over time shows that individual populations have varied with increasing or decreasing abundance. Generally, many populations experienced increases in total abundance during the years 2000-2008, and more recently in 2015-2017, but general declines during 2009-2014, and a downturn again in the two most recent years available for the current status review, 2017-2018. Abundance across the Puget Sound ESU has generally increased since the last status review, with only 2 of the 22 populations (Cascade and North Fork and South Fork Stillaguamish) showing a negative percent change in the 5-year geometric mean natural- origin spawner abundances since the prior status review (Table 5). However, 15 of 20 populations with positive percent change in the 5-year geometric mean natural-origin spawner abundances since the prior status review have relatively low population abundances of <1000 fish, so some of these increases represent small changes in total abundance (Ford, in press). Also, given lack of high confidence in survey techniques, particularly with small populations, there is substantial uncertainty in quantifying fish and detecting trends in small populations (Gallagher et al. 2010).

Table 5. Extant PS Chinook salmon populations in each biogeographic region and percent change between the most recent two 5-year periods (2010-2014 and 2015-2019). Five-year geometric mean of raw natural-origin spawner counts. This is the raw total spawner estimate times the fraction natural-origin estimate, if available. In parentheses, 5-year geometric mean of raw total spawner estimates (i.e., hatchery and natural) are shown. A value only in parentheses means that a total spawner estimate was available but no (or only one) estimate of natural-origin spawners was available. The geometric mean was computed as the product of estimates raised to the power 1 over the number of counts available (2 to 5). A minimum of 2 values were used to compute the geometric mean. Percent change between the most recent two 5-year periods is shown on the far right (Ford, in press).

Biogeographic Region	Population (Watershed)	2010-2014	2015-2019	Population trend (% change)
Strait of Georgia	**North Fork Nooksack River**	136 (1205)	137 (1553)	Positive 1% (29)
	South Fork Nooksack River	13 (35)	42 (106)	Positive 223% (203)
Strait of Juan de Fuca	**Elwha River**	71 (1349)	134 (2810)	Positive 89% (108)
	Dungeness River	66 (279)	114 (476)	Positive 73% (71)
Hood Canal	**Skokomish River**	136 (1485)	265 (2074)	Positive 95% (40)
	Mid Hood Canal River	80 (295)	196 (222)	Positive 145% (-25)
Whidbey Basin	Skykomish River	1698 (2462)	1736 (2806)	Positive 3% (14)
	Snoqualmie River	839 (1082)	856 (1146)	Positive 2% (6)
	North Fork Stillaguamish River	417 (996)	302 (762)	Negative 28% (-23)
	South Fork Stillaguamish River	34 (68)	37 (96)	Positive 9% (41)
	Lower Skagit River	1416 (1541)	2130 (2640)	Positive 50% (71)
	Upper Sauk River	854 (880)	1318 (1330)	Positive 54% (51)
	Lower Sauk River	376 (416)	635 (649)	Positive 69% (56)
	Suiattle River	376 (378)	640 (657)	Positive 70% (74)
	Upper Cascade River	298 (317)	185 (223)	Negative 38% (-30)
Central/South Puget Sound Basin	North Lake Washington/ Sammamish River	82 (1289)	126 (879)	Positive 54% (-32)
	Green/Duwamish River	785 (2109)	1822 (6373)	Positive 132% (202)
	Puyallup River	450 (1134)	577 (1942)	Positive 28% (71)
	White River	652 (2161)	895 (6244)	Positive 37% (189)
	Cedar River	699 (914)	889 (1253)	Positive 27% (37)
	Nisqually River	481 (1823)	766 (1841)	Positive 59% (1)

Trends in abundance over longer time periods are generally slightly negative. Fifteen-year trends in log natural-origin spawner abundance were computed over two time periods (1990-2005 and 2004- 2019) for each Puget Sound Chinook salmon population. Trends were negative in the latter period for 16 of the 22 populations and for four of the 22 populations (SF Nooksack, SF Stillaguamish, Green and Puyallup) in the earlier period. Thus, there is a general decline in natural-origin spawner abundance across all MPGs in the recent fifteen years. Upper Sauk and Suiattle (Whidbey Basin MPG), Nisqually (Central/South MPG) and Mid-Hood Canal (Hood Canal MPG) are the only populations with positive trends, though Mid-Hood Canal has an extremely low population size. Further, no change in trend between the two time periods was detected in SF Nooksack (Strait of Georgia MPG), Green and Nisqually (Central/South MPG). The average trend across the ESU for the 1990-2005 15-year time period was 0.03 (Figure 5). The average trend across the ESU for the later 15-year time period (2004-2019) was -0.02. The previous status review in 2015 (NWFSC 2015) concluded there were widespread negative trends for the total ESU despite that escapements and trends for individual populations were variable. The addition of the data to 2018 now also shows even more substantially either flat or negative trends for the entire ESU in natural-origin Chinook salmon spawner population abundances (Ford, in press).

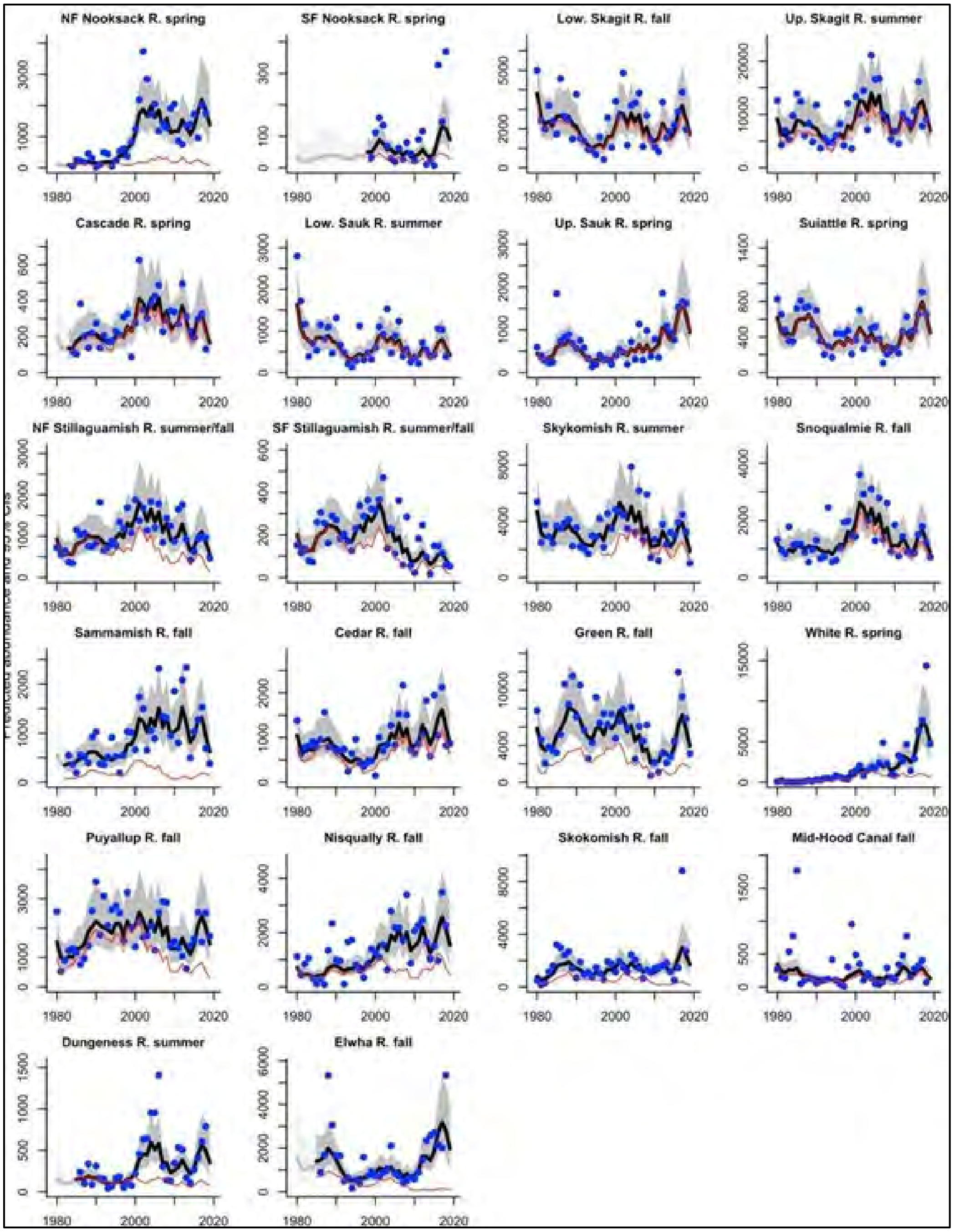

Figure 5. Smoothed trend in estimated total (thick black line, with 95 percent confidence internal in gray) and natural (thin red line) PS Chinook salmon population spawning abundance. In portions of a time series where a population has no annual estimate but smoothed spawning abundance is estimated from correlations with other populations the smoothed estimate is shown in light gray. Points show the annual raw spawning abundance estimates. For some trends the smoothed estimate may be influenced by earlier data points not included in the plot (Ford, in press).

Across the Puget Sound ESU, 10 of 22 Puget Sound populations show natural productivity below replacement in nearly all years since the mid-1980's (Figure 5). These include the North and South Forks Nooksack in the Strait of Georgia MPG, North and South Forks Stillaguamish and Skykomish in Whidbey Basin MPG, Sammamish, Green and Puyallup in the Central/South MPG, the Skokomish in the Hood Canal MPG, and Elwha in the Strait of Juan de Fuca MPG. Productivity in the Whidbey Basin MPG populations was above zero the mid-late 1990's, with the exception of Skykomish and North and South Forks Stillaguamish populations. White River population in the Central/South MPG was above replacement from the early 1980's to 2001, but has dropped in productivity consistently since the late 1980's. In recent years, only 5 populations have had productivities above zero. These are Lower Skagit, Upper Skagit, Lower Sauk, Upper Sauk, and Suiattle, all Skagit River populations in the Whidbey Basin MPG. This is consistent with, and continues the decline reported in the 2015 Status Review (NWFSC 2015).

All Puget Sound Chinook salmon populations continue to remain well below recovery levels (Ford, in press). Most populations also remain consistently below the spawner-recruit levels identified by the TRT as necessary for recovery. Across the ESU, most native-origin populations have slightly increased in abundance since the last status review in 2016, but have small negative trends over the past 15 years (Figure 6). Productivity remains low in most populations. Hatchery-origin spawners are present in high fractions in most populations outside the Skagit watershed, and in many watersheds the fraction of spawner abundances that are natural-origin have declined over time. Habitat protection, restoration and rebuilding programs in all watersheds have improved stream and estuary conditions despite record numbers of humans moving into the Puget Sound region in the past two decades. Bi-annual four-year work plans document the many completed habitat actions that were initially identified in the Puget Sound Chinook salmon recovery plan. However, the expected benefits from restoration actions is likely to take years or decades to produce significant improvement in natural population viability parameters (see Roni et al. 2010).

Development of a monitoring and adaptive management program was required by NMFS in the 2007 Supplement to the Shared Strategy Recovery Plan (NMFS 2006b), and since the last review the Puget Sound Partnership has completed this, but this program is still not fully functional for providing an assessment of watershed habitat restoration/recovery programs, nor does it fully integrate the essentially discrete habitat, harvest and hatchery programs. A recent white paper produced by the Salmon Science Advisory Group, of the Puget Sound Partnership concludes there has been "a general inability of monitoring to link restoration, changes in habitat conditions, and fish response at large-scales" (PSP 2021). A number of watershed groups are in the process of updating their Recovery Plan Chapters and this includes prioritizing and updating recovery strategies and actions, as well as assessing prior accomplishments. Overall, recent information on PS Chinook salmon abundance and productivity since the 2016 status review indicates a slight increase in abundance but does not indicate a change in biological risk to the ESU despite moderate inter-annual variability among populations and a general decline in abundance over the last 15 years (Ford, in press).

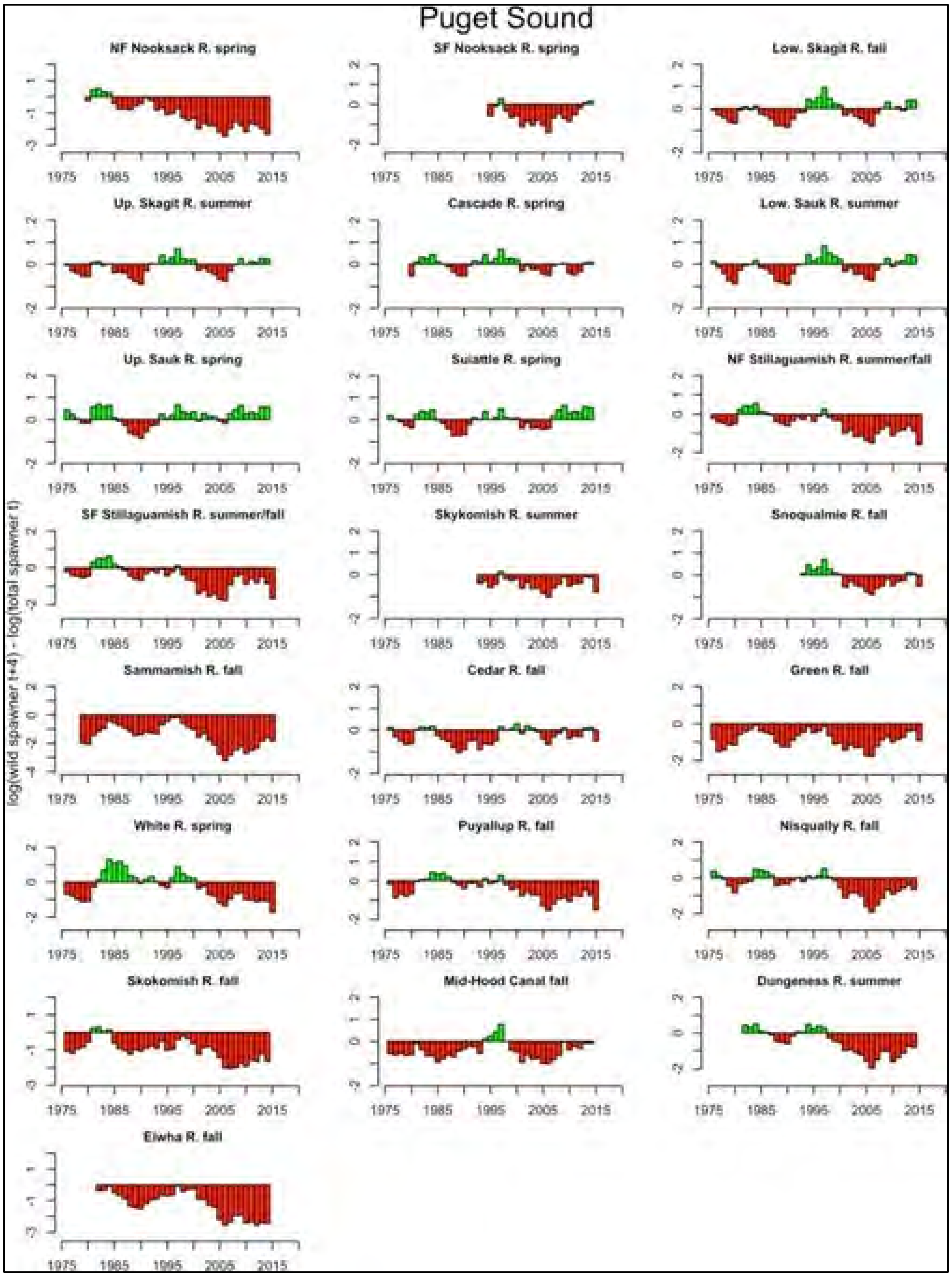

Figure 6. Trends in Chinook salmon population productivity, estimated as the log of the smoothed natural-origin spawning abundance in year t – smoothed natural-origin spawning abundance in year (t – 4) (Ford, in press).

Limiting Factors: Limiting factors for this species include:

- Degraded floodplain and in-river channel structure
- Degraded estuarine conditions and loss of estuarine habitat
- Riparian area degradation and loss of in-river large woody debris

- Excessive fine-grained sediment in spawning gravel
- Degraded water quality and temperature
- Degraded nearshore conditions
- Impaired passage for migrating fish
- Altered flow regime

<u>PS Chinook Salmon Recovery Plan</u>: Nearshore areas serve as the nursery for juvenile PS Chinook salmon. Riparian vegetation, shade and insect production, and forage fish eggs along marine shorelines and river deltas help to provide food, cover and thermoregulation in shallow water habitats. Forage fish spawn in large aggregations along shorelines with suitable habitat, which produce prey for juvenile PS Chinook salmon. Juvenile salmon commonly occupy "pocket estuaries" where freshwater inputs provide salinity gradients that make adjusting to the marine environment less physiologically demanding. Pocket estuaries also provide refugia from predators. As the juvenile salmon grow and adjust, they move out to more exposed shorelines such as eelgrass, kelp beds and rocky shorelines where they continue to grow and migrate into the ocean environment. Productive shoreline habitats of Puget Sound are necessary for the recovery of Puget Sound salmon (SSPS 2007).

The Puget Sound Recovery Plan (Volumes 1 and 2) includes specific recovery actions for each of the 22 extant populations of PS Chinook salmon. General protection and restoration actions summarized from the plan include:

- Aggressively protect functioning drift cells and feeder bluffs that support eelgrass bands and depositional features;
- Counties should pass strong regulations and policies limiting increased armoring of these shorelines and offering incentives for protection;
- Aggressively protect areas, especially shallow water/low gradient habitats and pocket estuaries, within 5 miles of river deltas;
- Protect the forage fish spawning areas;
- Conduct limited beach nourishment on a periodic basis to mimic the natural sediment transport processes in select sections where corridor functions may be impaired by extensive armoring;
- Maintain the functioning of shallow, fine substrate features in and near 11 natal estuaries for Chinook salmon (to support rearing of fry);
- Maintain migratory corridors along the shores of Puget Sound;
- Maintain the production of food resources for salmon;
- Maintain functioning nearshore ecosystem processes (i.e., sediment delivery and transport; tidal circulation) that create and support the above habitat features and functions;
- Increase the function and capacity of nearshore and marine habitats to support key needs of salmon;
- Protect and restore shallow, low velocity, fine substrate habitats along marine shorelines, including eelgrass beds and pocket estuaries, especially adjacent to major river deltas;
- Protect and restore riparian areas;
- Protect and restore estuarine habitats of major river mouths;

- Protect and restore spawning areas and critical rearing and migration habitats for forage fish;
- Protect and restore drift cell processes (including sediment supply, e.g., from feeder bluffs, transport, and deposition) that create and maintain nearshore habitat features such as spits, lagoons, bays, beaches.

Development of shoreline and estuary areas of Puget Sound is expected to continue to adversely impact the quality of marine habitat for PS Chinook salmon. Projected changes in nearshore and estuary development based on documented rates of developed land cover change in Bartz et al. (2015) show that between 2008 and 2060, an additional 14.7 hectares of development of shoreline areas and 204 hectares of estuary development can be expected.

Status of Puget Sound Steelhead

The PS steelhead DPS was listed as a threatened species under the ESA on May 11, 2007 (72 FR 26722). Subsequent status assessments of the DPS after the ESA-listing decision have found that the status of PS steelhead regarding risk of extinction has not changed substantially (Ford et al. 2011a; NMFS 2016a) (81 FR 33468, May 26, 2016) (Ford, in press). On October 4, 2019 NMFS published a Federal Register notice (84 FR 53117), announcing NMFS' intent to initiate a new 5-year status review for 28 listed species of Pacific salmon and steelhead and requesting updated information from the public to inform the most recent five-year status review. On March 24, 2020, NMFS extended the public comment period, from the original March 27, 2020, through May 26, 2020 (85 FR 16619). The NWFSC and the NMFS' WCR are currently preparing the final five-year status review documents.

The PS Steelhead TRT produced viability criteria, including population viability analyses (PVAs), for 20 of 32 demographically independent populations (DIPs) and three major population groups (MPGs) in the DPS (Hard et al. 2015). It also completed a report identifying historical populations of the DPS (Myers et al. 2015). The DIPs are based on genetic, environmental, and life history characteristics. Populations display winter, summer, or summer/winter run timing (Myers et al. 2015). The TRT concludes that the DPS is currently at "very low" viability, with most of the 32 DIPs and all three MPGs at "low" viability.
The designation of the DPS as "threatened" is based upon the extinction risk of the component populations. For a DIP to be considered viable, it must have at least an 85 percent probability of meeting the viability criteria, as calculated by Hard et al. (2015).

At the time of listing the Puget Sound steelhead Biological Review Team (BRT) considered the major risk factors associated with spatial structure and diversity of PS steelhead to be: (1) the low abundance of several summer run populations; (2) the sharply diminishing abundance of some winter steelhead populations, especially in south Puget Sound, Hood Canal, and the Strait of Juan de Fuca; and (3) continued releases of out-of-ESU hatchery fish from Skamania-derived summer run and Chambers Creek-derived winter run stocks (Hard et al. 2007; Hard et al. 2015). Loss of diversity and spatial structure were judged to be "moderate" risk factors (Hard et al. 2007). In 2011 the BRT identified degradation and fragmentation of freshwater habitat, with consequential effects on connectivity, as the primary limiting factors and threats facing the PS steelhead DPS (Ford et al. 2011a). The BRT also determined that most of the steelhead populations within the DPS continued to show downward trends in estimated abundance, with a few sharp declines (Ford et al. 2011a). The 2015 status review concurred that harvest and hatchery production of steelhead in Puget Sound were at low levels and not likely to increase substantially in the foreseeable future, thus these risks have been reduced since the time of listing. However, unfavorable environmental trends previously identified (Ford et al. 2011a) were expected to continue (Hard et al. 2015).

In this Opinion, where possible, the 2015 status review information is supplemented with information and other population specific data available considered during the drafting of the 2020 five-year status review for PS steelhead.

On December 27, 2019, we published a recovery plan for PS steelhead (84 FR 71379) (NMFS 2019a). The Puget Sound steelhead Recovery Plan (Plan) (NMFS 2019a) provides guidance to recover the species to the point that it can be naturally self-sustaining over the long term. To achieve full recovery, steelhead populations in Puget Sound need to be robust enough to withstand natural environmental variation and some catastrophic events, and they should be resilient enough to support harvest and habitat loss due to human population growth. The Plan aims to improve steelhead viability by addressing the pressures that contribute to the current condition: habitat loss/degradation, water withdrawals, declining water quality, fish passage barriers, dam operations, harvest, hatcheries, climate change effects, and reduced early marine survival. NMFS is using the recovery plan to organize and coordinate recovery of the species in partnership with state, local, tribal, and federal resource managers, and the many watershed restoration partners in the Puget Sound. Consultations, including this one, will incorporate information from the Plan (NMFS 2019a).

In the Plan, NMFS and the PSSTRT modified the 2013 and 2015 PSSTRT viability criteria to produce the viability criteria for PS steelhead, as described below:

- All three MPGs (North Cascade, Central-South Puget Sound, and Hood Canal-Strait of Juan de Fuca) (Figure 6) must be viable (Hard et al. 2015). The three MPGs differ substantially in key biological and habitat characteristics that contribute in distinct ways to the overall viability, diversity, and spatial structure of the DPS.
- There must be sufficient data available for NMFS to determine that each MPG is viable.

The Plan (NMFS 2019h) also established MPG-level viability criteria. The following are specific criteria are required for MPG viability:

- At least 50 percent of steelhead populations in the MPG achieve viability.
- Natural production of steelhead from tributaries to Puget Sound that are not identified in any of the 32 identified populations provides sufficient ecological diversity and productivity to support DPS-wide recovery.
- In addition to the minimum number of viable DIPs (50 percent) required above, all DIPs in the MPG must achieve an average MPG-level viability that is equivalent to or greater than the geometric mean (averaged over all the DIPs in the MPG) viability score of at least 2.2 using the 1–3 scale for individual DIPs described under the DIP viability discussion in the PSSTRT Viability Criteria document (Hard et al. 2015). This criterion is intended to ensure that MPG viability is not measured (and achieved) solely by the strongest DIPs, but also by other populations that are sufficiently healthy to achieve

MPG-wide resilience. The Plan allows for an alternative evaluation method to that in Hard et al. (2015) may be developed and used to assess MPG viability.

The Plan (NMFS 2019h) also identified specific DIPs in each of the three MPGs which must attain viability. These DIPs, by MPG, are described as follows:

For the **North Cascades MPG** eight of the sixteen DIPs in the North Cascades MPG must be viable. The eight (five winter-run and three summer-run) DIPs described below must be viable to meet this criterion:

- Of the eleven DIPs with winter or winter/summer runs, five must be viable:
- Nooksack River Winter-Run;
- Stillaguamish River Winter-Run;
- One from the Skagit River (either the Skagit River Summer-Run and Winter-Run or the Sauk River Summer-Run and Winter-Run);
- One from the Snohomish River watershed (Pilchuck, Snoqualmie, or Snohomish/Skykomish River Winter-Run); and
- One other winter or summer/winter run from the MPG at large.

The rationale for this is that there are four major watersheds in this MPG, and one viable population from each will help attain geographic spread and habitat diversity within core extant steelhead habitat (NMFS 2019h). Of the five summer-run DIPs in this MPG, three must be viable, representing each of the three major watersheds containing summer-run populations (Nooksack, Stillaguamish, Snohomish rivers). Therefore, the priority summer-run populations are as follows:

- South Fork Nooksack River Summer-Run;
- One DIP from the Stillaguamish River (Deer Creek Summer-Run or Canyon Creek Summer-Run); and
- One DIP from the Snohomish River (Tolt River Summer-Run or North Fork Skykomish River Summer-Run).

As described, these priority populations in the North Cascades MPG include specific, winter or winter/summer-run populations from the Nooksack, Stillaguamish, Skagit or Sauk, and Snohomish River basins and three summer-run populations from the Nooksack, Stillaguamish, and Snohomish basins. These populations are targeted to achieve viable status to support MPG viability. Having viable populations in these basins assures geographic spread, provides habitat diversity, reduces catastrophic risk, and increases life-history diversity (NMFS 2019h).

For the **Central and South Puget Sound MPG** four of the eight DIPs in the Central and South Puget Sound MPG must be viable. The four DIPs described below must be viable to meet this criterion:

- Green River Winter-Run;
- Nisqually River Winter-Run;
- Puyallup/Carbon rivers Winter-Run, or the White River Winter-Run; and
- At least one additional DIP from this MPG: Cedar River, North Lake Washington/Sammamish Tributaries, South Puget Sound Tributaries, or East Kitsap Peninsula Tributaries.

The rationale for this prioritization is that steelhead inhabiting the Green, Puyallup, and Nisqually River watersheds currently represent the core extant steelhead populations and these watersheds contain important diversity of stream habitats in the MPG.

For the **Hood Canal and Strait of Juan de Fuca MPG** four of the eight DIPs in the Hood Canal and Strait of Juan de Fuca MPG must be viable. The four DIPs described below must be viable to meet this criterion:

- Elwha River Winter/Summer-Run (see rationale below);
- Skokomish River Winter-Run;
- One from the remaining Hood Canal populations: West Hood Canal Tributaries Winter-Run, East Hood Canal Tributaries Winter-Run, or South Hood Canal Tributaries Winter-Run; and
- One from the remaining Strait of Juan de Fuca populations: Dungeness Winter-Run, Strait of Juan de Fuca Tributaries Winter-Run, or Sequim/Discovery Bay Tributaries Winter-Run.

The rationale for this prioritization is that the Elwha and Skokomish rivers are the two largest single watersheds in the MPG and bracket the geographic extent of the MPG. Furthermore, both Elwha and Skokomish populations have recently exhibited summer-run life histories, although the Dungeness River population was the only summer/winter run in this MPG recognized by the PSSTRT in Hard et al. (2015). Two additional populations, one population from the Strait of Juan de Fuca area and one population from the Hood Canal area, are needed for a viable MPG to maximize geographic spread and habitat diversity.

Lastly, the Plan (NMFS 2019h) also identified additional attributes, or characteristics which should be associated with a viable MPG.

- All major diversity and spatial structure conditions are represented, based on the following considerations:
- Populations are distributed geographically throughout each MPG to reduce risk of catastrophic extirpation; and
- Diverse habitat types are present within each MPG (one example is lower elevation/gradient watersheds characterized by a rain-dominated hydrograph and higher elevation/gradient watersheds characterized by a snow-influenced hydrograph).

Federal and state steelhead recovery and management efforts will provide new tools and data and technical analyses to further refine PS steelhead population structure and viability, if needed, and better define the role of individual populations at the watershed level and in the DPS. Future consultations will incorporate information from the Plan (NMFS 2019h).

Spatial Structure and Diversity: The PS steelhead DPS is the anadromous form of *O. mykiss* that occur in rivers, below natural barriers to migration, in northwestern Washington State that drain to Puget Sound, Hood Canal, and the Strait of Juan de Fuca between the U.S./Canada border and the Elwha River, inclusive. Non-anadromous ‘‘resident’’ *O. mykiss* occur within the range of PS steelhead but are not part of the DPS due to marked differences in physical, physiological, ecological, and behavioral characteristics (Hard et al. 2007). In October of 2016, NMFS proposed revisions to the hatchery programs included as part of Pacific salmon ESUs and steelhead DPSs listed under the ESA (81 FR 72759). NMFS issued its final rule in December of 2020 (85 FR 81822). This final rule includes steelhead from five artificial propagation programs in the PS steelhead DPS: the Green River Natural Program; White River Winter Steelhead Supplementation Program; Hood Canal Steelhead Supplementation Program; the Lower Elwha Fish Hatchery Wild Steelhead Recovery Program; and the Fish Restoration Facility Program. (85 FR 81822, December 17, 2020).

In 2013, the PSSTRT completed its evaluation of factors that influence the diversity and spatial structure VSP criteria for steelhead in the DPS. For spatial structure, this included the fraction of available intrinsic potential rearing and spawning habitat that is occupied compared to what is needed for viability[11]. For diversity, these factors included hatchery fish production, contribution of resident fish to anadromous fish production, and run timing of adult steelhead. Quantitative information on spatial structure and connectivity was not available for most PS steelhead populations, so a Bayesian Network framework was used to assess the influence of these factors on steelhead viability at the population, MPG, and DPS scales. The PSSTRT concluded that low population viability was widespread throughout the DPS and populations showed evidence of diminished spatial structure and diversity. Specifically, population viability associated with spatial structure and diversity was highest in the Northern Cascades MPG and lowest in the Central and South Puget Sound MPG (Puget Sound Steelhead Technical Recovery Team 2011). Diversity was generally higher for populations within the Northern Cascades MPG, where more variability in viability was expressed and diversity generally higher, compared to populations in both the Central and South Puget Sound and Hood Canal and Strait of Juan de Fuca MPG, where diversity was depressed and viabilities were generally lower (NWFSC 2015). Most PS steelhead populations were given intermediate scores for spatial structure and low scores for diversity because of extensive hatchery influence, low breeding population sizes, and freshwater habitat fragmentation or loss (NWFSC 2015). The PSSTRT concluded that the Puget Sound DPS was at very low viability, considering the status of all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). For spatial structure there were a number of events that occurred in Puget Sound during the last review period (2015-2019) that are anticipated to improve status populations within several of the MPGs within the DPS.

Since the PSSTRT completed its 2013 review, the only additional spatial structure and diversity data that have become available have been estimates of the fraction of hatchery fish on the spawning grounds (NWFSC 2015). Since publication of the NWFSC report in 2015, reductions in hatchery programs founded from non-listed and out of DPS stocks (i.e., Skamania) have occurred. In addition, the fraction of out of DPS hatchery steelhead spawning naturally are low for many rivers (NWFSC 2015; NMFS 2016i; 2016h). The fraction of natural-origin steelhead spawners was 0.9 or greater for the 2005-2009 and 2010-2014 time periods for all populations where data were available, but the Snoqualmie and Stillaguamish Rivers. For 17 of 22 DIPs across the DPS, the five-year average for the fraction of natural-origin steelhead spawners exceeded 0.75 from 2005 to 2009; this average was near 1.0 for 8 populations, where data were available, from 2010 to 2014 (NWFSC 2015). However, the fraction of natural-origin steelhead spawners could not be estimated for a substantial number of DIPs during the 2010 to 2014 period, or for the most recent 2015 – 2019 timeframe (NWFSC 2015; 2020). In some river

[11] Where intrinsic potential is the area of habitat suitable for steelhead rearing and spawning, at least under historical conditions (Puget Sound Steelhead Technical Recovery Team 2011; PSSTRT 2013).

systems, such as the Green River, Snohomish/Skykomish Rivers, and the Stillaguamish Rivers these estimates were higher than some guidelines recommend (e.g., no more than 5percent hatchery-origin spawners on spawning grounds for isolated hatchery programs (HSRG 2009) over the 2005-2009 and 2010-2014 timeframes. The draft NWFSC viability risk assessment (Ford, in press) states that a third of the 32 PS steelhead populations continue to lack monitoring and abundance data, and in most cases, it is likely that abundances are very low.

Early winter-run fish produced in isolated hatchery programs are derived from Chambers Creek stock in southern Puget Sound, which has been selected for early spawn timing, a trait known to be inheritable in salmonids.[12] Summer-run fish produced in isolated hatchery programs were historically derived from the Skamania River summer stock in the lower Columbia River Basin (i.e., from outside the DPS). The production and release of hatchery fish of both run types (winter and summer) may continue to pose risk to diversity in natural-origin steelhead in the DPS, as described in Hard et al. (2007) and Hard et al. (2015). However, the draft NWFSC viability risk assessment (Ford, in press) states that risks to natural-origin PS steelhead that may be attributable to hatchery-related effects has decreased since the 2015 status review due to reductions in production of non-listed stocks, and the replacement with localized stocks. The three summer steelhead programs continuing to propagate Skamania derived stocks from outside of Puget Sound should be phased out completely by 2031 (NMFS 2019c; Ford, in press). Lastly, annual reporting from the operators and current science suggest that risks remain at the same low to negligible levels as evaluated in 2016 and 2019 (NMFS 2016b; 2019c; 2019g; 2019h).

More information on PS steelhead spatial structure and diversity can be found in NMFS's PSSTRT viability report and NMFS's status review update on salmon and steelhead (NWFSC 2015) and recent viability risk assessment (Ford, in press).

Abundance and Productivity: The viability of the PS steelhead DPS has improved somewhat since the Puget Sound Steelhead TRT concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). Increases in spawner abundance have been observed in a number of populations over the last five years; however, these improvements were disproportionately found within the South and Central Puget Sound and Strait of Juan de Fuca and Hood Canal MPGs, and primarily among smaller populations. The recent positive trends among winter-run populations in the White, Nisqually, and Skokomish rivers improve the demographic risks facing those populations. The abundance, productivity, spatial structure, and diversity of Elwha River steelhead winter and summer-runs has dramatically improved following the removal of the Elwha River dams improved. Improvements in abundance have not been as widely observed in the Northern Puget Sound MPG. The declines of summer and winter-run populations in the Snohomish Basin are especially concerning. These populations figure prominently as sources of abundance for the MPG and DPS (NMFS 2019a). Additionally, the decline in the Tolt River summer-run steelhead population was especially alarming given that it is the only summer-run population for which we have abundance estimates. The demographic and diversity risks to the Tolt River summer-run DIP are very high. In fact, all summer-run steelhead populations in the North Cascades MPG are likely at a very high demographic risk. In spite of improvements in some areas, most populations

[12] The native-origin Chambers Creek steelhead stock is now extinct.

are still at relatively low abundance levels, with about a third of the DIPs unmonitored and presumably at very low levels (Ford, in press).

As described in the recovery plan, recovery targets were calculated using a two-tiered approach adjusting for years of low and high productivity (NMFS 2019a). Abundance information is unavailable for approximately one-third of the DIPs, disproportionately so for summer-run populations. In most cases where no information is available it is assumed that abundances are very low. Some population abundance estimates are only representative of part of the population (index reaches, etc.). Where recent five-year abundance information is available, 30 percent (6 of 20 populations) are less than 10 percent of their high productivity recovery targets (lower abundance target), 65 percent (13 of 20) are between 10 and 50 percent, and 5 percent (1 of 20) are greater than 50 percent of their low abundance targets (Table 6). A key element to achieving recovery is recovering a representative number of both winter- and summer-run steelhead populations, and the restoration of viable summer-run DIPs is a long-term endeavor (NMFS 2019a). Fortunately, the relatively rapid reestablishment of summer-run steelhead in the Elwha River does provide a model for potentially re-anadromizing summer-run steelhead sequestered behind impassable dams.

Table 6. Recent (2015-2019) 5-year geometric mean of raw wild spawner counts for Puget Sound steelhead populations and population groups compared with Puget Sound Steelhead Recovery Plan high and low productivity recovery targets (NMFS 2019). (SR) – Summer-run. Abundance is compared to the high productivity individual DIP targets. Colors indicate the relative proportion of the recovery target currently obtained: red (<10%), orange (10%>x<50%), yellow (50%>x<100%), green (>100%). "*" denotes an interim recovery target.

Major Population Group	Demographically Independent Population	Abundance (2015-2019)	Recovery Target	
			High Productivity	Low Productivity
Northern Cascades	Drayton Harbor Tributaries	N/A	1,100	3,700
	Nooksack River	1,906	6,500	21,700
	South Fork Nooksack River (SR)	N/A	400	1,300
	Samish River & Independent Tributaries	1,305	1,800	6,100
	Skagit River	7,181	15,000 *	
	Sauk River	N/A		
	Nookachamps River	N/A		
	Baker River	N/A		
	Stillaguamish River	487	7,000	23,400
	Canyon Creek (SR)	N/A	100	400
	Deer Creek (SR)	N/A	700	2,300
	Snohomish/Skykomish River	690	6,100	20,600
	Pilchuck River	638	2,500	8,200
	Snoqualmie River	500	3,400	11,400
	Tolt River (SR)	40	300	1,200
	North Fork Skykomish River (SR)	N/A	200	500
Central and South Sound	Cedar River	N/A	1,200	4,000
	North Lake Washington Tributaries	N/A	4,800	16,000
	Green River	1,282	5,600	18,700
	Puyallup/Carbon River	136	4,500	15,100
	White River	130	3,600	12,000
	Nisqually River	1,368	6,100	20,500
	East Kitsap Tributaries	N/A	2,600	8,700
	South Sound Tributaries	N/A	6,300	21,200
Strait of Juan de Fuca	Elwha River	1,241	2,619	
	Dungeness River	408	1,200	4,100
	Strait of Juan de Fuca Independent Tributaries	95	1,000	3,300
	Sequim and Discovery Bay Tributaries	N/A	500	1,700
	Skokomish River	958	2,200	7,300
	West Hood Canal Tributaries	150	2,500	8,400
	East Hood Canal Tributaries	93	1,800	6,200
	South Hook Canal Tributaries	91	2,100	7,100

There are a number of planned, ongoing, and completed actions that will likely benefit steelhead populations in the near term, but have not yet influenced adult abundance. Among these, the removal of the diversion dam on the Middle Fork Nooksack River, the Pilchuck Dam removal, passage improvements at Mud Mountain Dam, the ongoing passage program in the North Fork

Skokomish River, and the planned passage program at Howard Hanson Dam. Dam removal in the Elwha River, and the resurgence of the endemic winter and summer-run steelhead populations have underscored the benefits of restoring fish passage. The Elwha River scenario is somewhat unique in that upstream habitat is in pristine condition and smolts emigrate into the Strait of Juan de Fuca and not Puget Sound or Hood Canal.

Improvements in spatial structure can only be effective if done in concert with necessary improvements in habitat. Habitat restoration efforts are ongoing, but land development and habitat degradation concurrent with increasing human population in the Puget Sound corridor may results in a continuing net loss of habitat. Recovery efforts in conjunction with improved ocean and climatic conditions have resulted in improved viability status for the majority of populations in this DPS; however, absolute abundances are still low, especially summer-run populations, and the DPS remains at high to moderate risk of extinction. However, since 2015, fifteen of the 21 populations indicate small to substantive increases in abundance.[13] Nevertheless, most steelhead populations remain small. From 2015 to 2019, nine of the 21 steelhead populations had fewer than 250 natural spawners annually, and 12 of the 21 steelhead populations had 500 or fewer natural spawners (Table 7).

[13] Nooksack River, Samish River/Bellingham Bays Tributaries, Skagit River, Stillaguamish River, Pilchuck River, Cedar River, Green River, Puyallup River, Nisqually River, White River, S. Hood Canal, Eastside Hood Canal Tributaries, Westside Hood Canal Tributaries, Skokomish River and Elwha River winter-run populations. The Skagit River and Elwha River summer-run steelhead are also showing increasing trends (Ford, in press).

Table 7. Five-year geometric mean of raw natural spawner counts for Puget Sound steelhead. This is the raw total spawner count times the fraction natural estimate, if available. Percent change between the most recent two 5-year periods is shown on the far right. (W=winter run; S=summer run).

Biogeographic Region	Population	2010-2014	2015-2019	Population trend (% Change)
North Cascades	Samish R./ Bellingham Bay Tribs. (W)	748	1305	Positive (74)
	Nooksack R. (W)	1745	1906	Positive (9)
	Skagit R. (S and W)	6391	7181	Positive (12)
	Stillaguamish R. (W)	386	487	Positive (26)
	Snohomish/ Skykomish R. (W)	975	690	Negative (-29)
	Pilchuck R. (W)	626	638	Positive (2)
	Snoqualmie R. (W)	706	500	Negative (-29)
	Tolt R. (S)	108	40	Negative (-63)
Central/South Puget Sound Basin	N. Lake WA Tribs. (W)	-	-	-
	Cedar R. (W)	4	6	Positive (50)
	Green R. (W)	662	1289	Positive (95)
	White R. (W)	514	451	Negative (-12)
	Puyallup R. (W)	85	201	Positive (136)
	Carbon R. (W)	(290)	(735)	Positive (153)
	Nisqually R. (W)	477	1368	Positive (187)
Hood Canal/Strait of Juan de Fuca	S. Hood Canal (W)	69	91	Positive (32)
	Eastside Hood Canal Tribs (W)	60	93	Positive (55)
	Skokomish R. (W)	533	958	Positive (80)
	Westside Hood Canal Tribs (W)	138	150	Positive (9)
	Dungeness R. (S and W)	517	448	Negative (-13)
	Strait of Juan de Fuca Independents (W)	151	95	Negative (-37)
	Elwha R. (W)	680	1241	Positive (82)

Limiting factors. In our 2013 proposed rule designating critical habitat for this species (USDC 2013), we noted that the following factors for decline for PS steelhead persist as limiting factors:

- The continued destruction and modification of steelhead habitat
- Widespread declines in adult abundance (total run size), despite significant reductions in harvest in recent years
- Threats to diversity posed by use of two hatchery steelhead stocks (Chambers Creek and Skamania)

- Declining diversity in the DPS, including the uncertain but weak status of summer run fish
- A reduction in spatial structure
- Reduced habitat quality through changes in river hydrology, temperature profile, downstream gravel recruitment, and reduced movement of large woody debris
- In the lower reaches of many rivers and their tributaries in Puget Sound where urban development has occurred, increased flood frequency and peak flows during storms and reduced groundwater-driven summer flows, with resultant gravel scour, bank erosion, and sediment deposition
- Dikes, hardening of banks with riprap, and channelization, which have reduced river braiding and sinuosity, increasing the likelihood of gravel scour and dislocation of rearing juveniles

<u>PS steelhead Recovery Plan</u>: Juvenile Puget Sound steelhead are less dependent on nearshore habitats for early marine rearing than Chinook or Chum salmon; nevertheless, nearshore, estuarine, and shoreline habitats provide important features necessary for the recovery of steelhead. Puget Sound steelhead spend only a few days to a few weeks migrating through the large fjord, but mortality rates during this life stage are critically high (Moore et al. 2010; Moore and Berejikian 2017). Early marine mortality of Puget Sound steelhead is recognized as a primary limitation to the species' survival and recovery (NMFS 2019a). Factors in the marine environment influencing steelhead survival include predation, access to prey (primarily forage fish), contaminants (toxics), disease and parasites, migration obstructions (e.g., the Hood Canal bridge), and degraded habitat conditions which exacerbate these factors.

The PS steelhead recovery plan identifies ten ecological concerns that directly impact salmon and steelhead:

- Habitat quantity (anthropogenic barriers, natural barriers, competition);
- Injury and mortality (predation, pathogens, mechanical injury, contaminated food);
- Food (altered primary productivity, food-competition, altered prey species composition and diversity);
- Riparian condition (riparian condition, large wood recruitment);
- Peripheral and transitional habitats (side channel and wetland condition, estuary conditions, nearshore conditions);
- Channel structure and form (bed and channel form, instream structural complexity);
- Sediment conditions (decreased sediment quantity, increased sediment quantity);
- Water quality (temperature, oxygen, gas saturation, turbidity, pH, salinity, toxic contaminants);
- Water quantity (increased water quantity, decreased water quantity, altered flow timing); and
- Population-level effects (reduced genetic adaptiveness, small population effects, demographic changes, life history changes).

The Puget Sound steelhead recovery plan and its associated appendix 3 includes specific recovery actions for the marine environment. General protection and restoration actions summarized from the plan include:

- Continue to improve the assessments of harbor seal predation rates on juvenile steelhead;
- Remove docks and floats which act as artificial haul-out sites for seals and sea lions;
- Consistent with the MMPA, test acoustic deterrents and other hazing techniques to reduce steelhead predation from harbor seals;
- Develop non-lethal actions for "problem animals and locations" to deter predation;
- Increase forage fish habitat to increase abundance of steelhead prey;
- Remove bulkheads and other shoreline armoring to increase forage fish;
- Acquire important forage fish habitat to protect high forage fish production areas;
- Add beach wrack to increase forage fish egg survival;
- Protect and restore aquatic vegetation (e.g., eelgrass and kelp);
- Remove creosote pilings to reduce mortality of herring eggs;
- Increase the assessment of migratory blockages, especially the Hood Canal bridge, where differential mortality has been documented;
- Identify and remedy sources of watershed chemical contaminants (e.g., PBDEs and PCBs).

Status of Puget Sound Georgia Basin Rockfish

NMFS adopted a recovery plan for both PS/GB bocaccio and yelloweye rockfish in 2017. There are no estimates of historic or present-day abundance of yelloweye rockfish, or PS/GB bocaccio across the full DPSs area. In 2013, the WDFW published abundance estimates from a remotely operated vehicle survey conducted in 2008 in the San Juan Island area (Pacunski et al. 2013). This survey was conducted exclusively within rocky habitats and represents the best available abundance estimates to date for one basin of the DPS. The survey produced estimates of 47,407 (25 percent variance) yelloweye rockfish, and 4,606 (100 percent variance) PS/GB bocaccio in the San Juan area (Tonnes et al. 2016). Though the WDFW has produced other ROV-based estimates of rockfish biomass in Washington waters of the DPSs, none have both covered the entirety of the DPSs and had sufficient sample size to accurately estimate population size for rare species, such as yelloweye rockfish and bocaccio.

Using several available, but spatiotemporally patchy, data series on rockfish occurrence and abundance in Puget Sound, Tolimieri et al. (2017) determined that total rockfish declined at a rate of 3.1 to 3.8 percent per year from 1977 to 2014 or a 69 to 76 percent total decline over that period. The two listed DPSs declined over-proportional compared to the total rockfish assemblage. Therefore, long-term population growth rate for the listed species was likely even lower (more negative) than that for total rockfish. While there is little to no evidence of recent recovery of total groundfish abundance in response to protective measures enacted over the last 25 years (Essington et al. 2013; 2021; van Duivenbode 2018), increases in the prevalence of several life stages of the more common rockfish species have been observed (Pacunski et al. 2020; LeClair et al. 2018). Given the slow maturation rate, episodic recruitment success, and rarity of yelloweye rockfish and bocaccio, combined with targeted fisheries being closed for over a decade, insufficient data exist to assess the recent recovery trajectory of these species.

Mature females of each listed species produce from several thousand to over a million eggs annually (Love et al. 2002). In rockfish the number of embryos produced by the female increases with size. For example, female copper rockfish that are 20 cm in length produce 5,000 eggs while a female 50 cm in length may produce 700,000 eggs (Palsson et al. 2009). These specific observations come from other rockfish, not the two listed species. However, the generality of maternal effects in *Sebastes spp*. suggests that some level of age or size influence on reproduction is likely for all species (Haldorson and Love 1991).

Larval rockfish rely on nearshore habitat. The nearshore is generally defined as habitats contiguous with the shoreline from extreme high water out to a depth no greater than 98 feet (30 m) relative to mean lower low water. This area generally coincides with the maximum depth of the photic zone and can contain physical or biological features essential to the conservation of many fish and invertebrate species, including PS/GB bocaccio. Approximately 27 percent of Puget Sound's shoreline has been modified by armoring (Simenstad et al. 2011). Nearshore habitats throughout the greater Puget Sound region have been affected by a variety of human activities, including agriculture, heavy industry, timber harvest, and the development of sea ports and residential property (Drake et al. 2010).

Juvenile yelloweye rockfish are not typically found in intertidal waters (Love et al. 1991; Studebaker et al. 2009). A few juveniles have been documented in shallow nearshore waters (Love et al. 2002; Palsson et al. 2009), but most settle in habitats along the shallow range of adult habitats in areas of complex bathymetry and rocky/boulder habitats and cloud sponges in waters greater than 98 feet (30 m) (Richards 1986; Love et al. 2002; Yamanaka et al. 2006). In British Columbia, juvenile yelloweye rockfish have been observed at a mean depth of 239 feet (73 m), with a minimum depth of 98 feet (30 m) (Yamanaka et al. 2006). Juvenile yelloweye rockfish occur in similar habitats as adults, though in areas with smaller crevices, including cloud sponge formations, crinoid aggregations on top of rocky ridges, and over cobble substrates (Weispfenning 2006; Yamanaka et al. 2006; Banks 2007).

Young-of-year juvenile bocaccio occur on shallow rocky reefs and nearshore areas (Moser 1967; Anderson 1983; Kendall and Lenarz 1986; Carr 1991; Love et al. 1991; Love 1996; Murphy et al. 2000; Love et al. 2002). Young bocaccio associate with macroalgae, especially kelps (*Laminariales*), and sandy areas that support seagrasses. They form aggregations near the bottom in association with drift algae and throughout the water column in association with canopy-forming kelps. It is likely that nearshore habitats used by juvenile bocaccio and other rockfish juveniles offer a beneficial mix of warmer temperatures, food, and refuge from predators (Love et al. 1991). Habitat formed by kelp provides structure for feeding, refuge from predators, and reduced currents that enable energy conservation for juvenile bocaccio. Juvenile bocaccio are exceptionally rare in greater Puget Sound, casting some doubt on whether the current population is capable of reproducing at a rate sufficient to support recovery (Palsson et al. 2009; Drake et al. 2010; NMFS 2017a).

The alteration of Puget Sound shorelines has been found to impact a variety of marine life, ranging from invertebrate fauna (Sobocinski 2003) to surf smelt egg viability (Rice 2006), but consequences of the alteration of Puget Sound shorelines on rockfish habitat such as kelp are less understood. Some areas around Puget Sound have shown a large decrease in kelp. Areas with floating and submerged kelp (families *Chordaceae*, *Alariaceae*, *Lessoniacea*, *Costariaceae*, and *Laminaricea*) support the highest densities of most juvenile rockfish species (Matthews 1989;

Halderson and Richards 1987; Carr 1983; Hayden-Spear 2006). Kelp habitat provides structure for feeding, predation refuge, and reduced currents that enable energy conservation for juveniles. Although loss of nearshore habitat quality is a threat to rockfish, the recovery plan for this species list the severity of this threat as low (NMFS 2017a). As such, the recovery plan lists the severity of this threat as very low in Canada, low in the San Juan Islands, moderate in Hood Canal, and high in the Main Basin and South Sound (NMFS 2017a).

A study of rockfish in Puget Sound found that larval rockfish appeared to occur in two peaks (early spring, late summer) that coincide with the main primary production peaks in Puget Sound. Both measures indicated that rockfish ichthyoplankton essentially disappeared from the surface waters by the beginning of November. Densities also tended to be lower in the more northerly basins (Whidbey and Rosario), compared to the Central and South Sound (Greene and Godersky 2012).

The U.S. portion of the Puget Sound/Georgia Basin that is occupied by yelloweye rockfish and PS/GB bocaccio can be divided into five areas, or Basins, based on the distribution of each species, geographic conditions, and habitat features. These five interconnected Basins are: (1) The San Juan/Strait of Juan de Fuca Basin, (2) Main Basin, (3) Whidbey Basin, (4) South Puget Sound, and (5) Hood Canal. See 79 FR 68041, Nov. 13, 2014 (Puget Sound/Georgia Basin Distinct Population Segments of yelloweye rockfish, Canary rockfish and Bocaccio; Designation of Critical Habitat).

Status of PS/GB Bocaccio

The PS/GB bocaccio distinct population segment (DPS) was listed as endangered on April 28, 2010 (75 FR 22276). In April 2016, we completed a 5-year status review that recommended the DPS retain its endangered classification (Tonnes et al. 2016), and we released a recovery plan in October 2017 (NMFS 2017a). Though PS/GB bocaccio were never a predominant segment of the multi-species rockfish population within the Puget Sound/Georgia Basin, their present-day abundance is likely a fraction of their pre-contemporary fishery abundance. Most PS/GB bocaccio within the DPS may have been historically spatially limited to several basins within the DPS. They were apparently historically most abundant in the Central and South Sound with no documented occurrences in the San Juan Basin until 2008 (Pacunski et al. 2013). The apparent reduction of populations of PS/GB bocaccio in the Main Basin and South Sound represents a further reduction in the historically spatially limited distribution of PS/GB bocaccio, and adds significant risk to the viability of the DPS (Tonnes et al. 2016).

The VSP criteria described by McElhaney et al. (2000), and summarized at the beginning of Section 2.2, identified spatial structure, diversity, abundance, and productivity as criteria to assess the viability of salmonid species because these criteria encompass a species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. These viability criteria reflect concepts that are well founded in conservation biology and are generally applicable to a wide variety of species because they describe demographic factors that individually and collectively provide strong indicators of extinction risk for a given species (Drake et al. 2010), and are therefore applied here for PS/GB bocaccio.

General Life History: The life history of PS/GB bocaccio includes a larval/pelagic juvenile stage that is followed by a juvenile stage, and subadult and adult stages. As with other rockfish, PS/GB bocaccio fertilize their eggs internally and the young are extruded as larvae that are about 4 to 5 mm in length. Females produce from several thousand to over a million offspring per spawning (Love et al. 2002). The timing of larval parturition in PS/GB bocaccio is uncertain, but likely occurs within a five- to six-month window that is centered near March (Greene and Godersky 2012; NMFS 2017a; Palsson et al. 2009). Larvae are distributed by prevailing currents until they are large enough to actively swim toward preferred habitats, but they can pursue food within short distances immediately after birth (Tagal et al. 2002). Larvae are distributed throughout the water column (Weis 2004), but are also observed under free-floating algae, seagrass, and detached kelp (Love et al. 2002; Shaffer et al. 1995). Unique oceanographic conditions within Puget Sound likely result in most larvae staying within the basin where they are released rather than being broadly dispersed (Drake et al. 2010). Recent modeling of passive particles serving as larval rockfish analogs, however, has demonstrated that this assumption can be substantially violated under certain conditions, resulting in larval transport among basins as well out both into and out of the DPS (Andrews et al. 2020).

At about 3 to 6 months old and 1.2 to 3.6 inches (3 to 9 cm) long, juvenile PS/GB bocaccio gravitate to shallow nearshore waters where they settle and grow. Rocky or cobble substrates with kelp is most typical, but sandy areas with eelgrass are also utilized for rearing (Carr 1983; Halderson and Richards 1987; Hayden-Spear 2006; Love et al. 1991 and 2002; Matthews 1989; NMFS 2017a; Palsson et al. 2009). Young of the year rockfish may spend months or more in shallow nearshore rearing habitats before transitioning toward deeper water habitats (Palsson et al. 2009). As PS/GB bocaccio grow, their habitat preference shifts toward deeper waters with high relief and complex bathymetry with rock and boulder-cobble complexes (Love et al. 2002), but they also utilize non-rocky substrates such as sand, mud, and other unconsolidated sediments (Miller and Borton 1980; Washington 1977). Adults are most commonly found between 131 to 820 feet (40 to 250 m) (Love et al. 2002; Orr et al. 2000). The maximum age of PS/GB bocaccio is unknown, but may exceed 50 years, and they reach reproductive maturity near age six.

Spatial Structure and Diversity: The PS/GB bocaccio DPS includes all bocaccio from inland marine waters east of the central Strait of Juan de Fuca and south of the northern Strait of Georgia. The waters of Puget Sound and Straits of Georgia can be divided into five interconnected basins that are largely hydrologically isolated from each other by relatively shallow sills (Burns 1985; Drake et al. 2010). The basins within US waters are: (1) San Juan, (2) Main, (4) South Sound, and (4) Hood Canal. The fifth basin consists of Canadian waters east and north of the San Juan Basin into the Straights of Georgia (Tonnes et al. 2016). Although most individuals of the PS/GB bocaccio DPS are believed to remain within the basin of their origin, including larvae and pelagic juveniles, some movement between basins occurs, and the DPS is currently considered a single population. Research intended to assess this assumption using genetic techniques was unable to collect sufficient samples for analysis (Andrews et al. 2018), but is ongoing.

Abundance and Productivity: The PS/GB bocaccio DPS exists at very low abundance and observations are relatively rare. No reliable range-wide historical or contemporary population estimates are available for the PS/GB bocaccio DPS. It is believed that prior to contemporary fishery removals, each of the major PS/GB basins likely hosted relatively large, though unevenly distributed, populations of PS/GB bocaccio. They were likely most common within the South Sound and Main Basin, but were never a predominant segment of the total rockfish abundance within the region (Drake et al. 2010). The best available information indicates that between 1965 and 2007, total rockfish populations have declined by about 70 percent in the Puget Sound region, and that PS/GB bocaccio have declined by an even greater extent (Drake et al. 2010; Tonnes et al. 2016; NMFS 2017a).

Limiting Factors: Factors limiting recovery for PS/GB bocaccio include:

- Fisheries removals (commercial and recreational bycatch)
- Derelict fishing gear in nearshore and deep-water environments
- Degraded water quality (chemical contamination, hypoxia, nutrients)
- Climate change
- Habitat disruption

Yelloweye Rockfish

Spatial Structure: PS/GB yelloweye rockfish occupy the waters of the Pacific coast from California to Alaska. Yelloweye rockfish in the waters of the Puget Sound/Georgia Basin were determined to be a Distinct Population Segment (DPS) (75 Fed. Reg. 22276). The Puget Sound/Georgia Basin DPS of yelloweye rockfish was listed as “threatened” under the ESA on April 28, 2010 (75 FR 22276). The DPSs include all yelloweye rockfish a found in waters of Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca east of Victoria Sill.

Diversity: New collection and analysis of PS/GB yelloweye rockfish tissue samples reveal significant genetic differentiation between the inland (DPS) and coastal samples. These new data are consistent with and further support the existence of a population of Puget Sound/Georgia Basin yelloweye rockfish that is discrete from coastal populations (Ford 2015; Tonnes et al. 2016). In addition, yelloweye rockfish from Hood Canal were genetically differentiated from other Puget Sound/Georgia Basin yelloweye rockfish, indicating a previously unknown degree of population differentiation within the DPS (Ford 2015; Tonnes et al. 2016). Other genetic analysis has found that yelloweye rockfish in the Georgia Basin had the lowest molecular genetic diversity of a collection of samples along the coast (Siegle et al. 2013). Although the adaptive significance of such microsatellite diversity is unclear, it may suggest low effective population size, increased drift, and thus lower genetic diversity in the PS/GB DPS.

Abundance: Yelloweye rockfish within the Puget Sound/Georgia Basin (in U.S. waters) are very likely the most abundant within the San Juan Basin of the DPS. Yelloweye rockfish spatial structure and connectivity is threatened by the apparent reduction of fish within each of the basins of the DPS. This reduction is probably most acute within the basins of Puget Sound proper. The severe reduction of fish in these basins may eventually result in a contraction of the DPS’ range. Recent research has found evidence for two populations of yelloweye rockfish within the DPS—one in Hood Canal and one within the rest of the Puget Sound/Georgia Basin.

In Puget Sound, catches of PS/GB yelloweye rockfish have declined as a proportion of the overall rockfish catch (Figure 2 and Figure 3, from Drake et al. 2010). Analysis of SCUBA surveys, recreational catch, and WDFW trawl surveys indicated total rockfish populations in the Puget Sound region are estimated to have declined between 3.1 and 3.8 percent per year for the past several decades, which corresponds to a 69 to 76 percent decline from 1977 to 2014 (Tonnes et al. 2016)

Productivity: Life history traits of yelloweye rockfish and PS/GB bocaccio suggest generally low levels of inherent productivity because they are long-lived, mature slowly, and have sporadic episodes of successful reproduction (Musick 1999; Tolimieri and Levin 2005). Yelloweye rockfish productivity may also be impacted by an Allee effect. This situation arises when reproductive adults are removed from the population and remaining individuals are eventually unable to encounter mates. This process then further reduces population density and can lead to extinction. Adult PS/GB yelloweye rockfish typically occupy relatively small ranges (Love et al. 2002), and the extent to which they may move to find suitable mates is unknown. However, there is insufficient information to determine that this is currently occurring for yelloweye rockfish and further research is needed (Hutchings and Reynolds 2004).

2.2.2 Status of Critical Habitats

This section examines the status of designated critical habitat affected by the proposed action by examining the condition and trends of essential physical and biological features (PFBs) throughout the designated areas. Critical habitat expected to be adversely affected by the proposed action in the action area includes PS Chinook salmon. PS steelhead critical habitat is not designated within the action area and the magnitude of the action's effects on PS Chinook salmon is not expected to translate to measurable effects to SRKW critical habitat PBFs (effects to PS Chinook salmon discussed in section 2.3.5). As described previously (section 1.3.1) PS/GB rockfish critical habitat that overlaps with the open water disposal site was evaluated in a 2015 NMFS Biological Opinion and is considered as part of the environmental baseline for the purposes of this Opinion.

Based on the natural history of PS/GB bocaccio and their habitat needs, NMFS identified two physical or biological features, essential for their conservation: (1) Deepwater sites (>30 meters) that support growth, survival, reproduction, and feeding opportunities; and (2) Nearshore juvenile rearing sites with sand, rock and/or cobbles to support forage and refuge. NMFS has determined that there are no effects to rockfish critical habitat in the action area in deep-water habitats that are not already addressed by the 2015 opinion (NMFS 2015). Critical habitat features associated with nearshore juvenile rearing are not present in the action area.

Salmon and Steelhead Critical Habitat

For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each listed species they support. The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS's critical habitat analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area (NOAA Fisheries 2005). Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or if it serves another important role (e.g., obligate area for migration to upstream spawning areas).

The physical or biological features of nearshore marine areas that would be affected by the proposed action include, ample forage, areas free of artificial obstructions, sufficient natural cover, and adequate water quality and quantity to support adult growth, sexual maturation, and migration as well as nearshore juvenile rearing. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow juvenile fish to grow and mature before migrating to the ocean.

<u>CHART Salmon and Steelhead Critical Habitat Assessments</u>: The CHART for each recovery domain assessed biological information pertaining to occupied habitat by listed salmon and steelhead, determine whether those areas contained PCEs essential for the conservation of those species and whether unoccupied areas existed within the historical range of the listed salmon and steelhead that are also essential for conservation. The CHARTs assigned a 0- to 3-point score for the PCEs in each HUC5 watershed for:

- Factor 1: Quantity,
- Factor 2: Quality—Current Condition,
- Factor 3: Quality—Potential Condition,
- Factor 4: Support of Rarity Importance,
- Factor 5: Support of Abundant Populations, and
- Factor 6: Support of Spawning/Rearing.

Thus, the quality of habitat in a given watershed was characterized by the scores for Factor 2 (quality—current condition), which considers the existing condition of the quality of PCEs in the HUC5 watershed; and Factor 3 (quality—potential condition), which considers the likelihood of achieving PCE potential in the HUC5 watershed, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility.

<u>Puget Sound Recovery Domain</u>: Critical habitat has been designated in Puget Sound for PS Chinook salmon, PS steelhead, and Hood Canal Summer Run chum salmon (HCSRC). Major tributary river basins in the Puget Sound basin include the Nooksack, Samish, Skagit, Sauk, Stillaguamish, Snohomish, Lake Washington, Cedar, Sammamish, Green, Duwamish, Puyallup, White, Carbon, Nisqually, Deschutes, Skokomish, Duckabush, Dosewallips, Big Quilcene, Elwha, and Dungeness rivers and Soos Creek.

Critical habitat for PS Chinook salmon was designated on September 2, 2005 (70 FR 52630). Critical habitat includes 1,683 miles of streams, 41 square mile of lakes, and 2,182 miles of nearshore marine habitat in Puget Sounds. The Puget Sound Chinook salmon ESU has 61 freshwater and 19 marine areas within its range. Of the freshwater watersheds, 41 are rated high conservation value, 12 low conservation value, and eight received a medium rating. Of the marine areas, all 19 are ranked with high conservation value.

Critical habitat for PS steelhead was designated on February 24, 2016 (81 FR 9252). Critical habitat includes 2,031 stream miles. Nearshore and offshore marine waters were not designated for this species. There are 66 watersheds within the range of this DPS. Nine watersheds received a low conservation value rating, 16 received a medium rating, and 41 received a high rating to the DPS. Critical habitat for PS steelhead includes freshwater spawning sites, freshwater rearing sites, and freshwater migration corridors.

Critical habitat is designated for PS Chinook salmon in estuarine and nearshore areas. Designated critical habitat for PS steelhead does not include nearshore areas, as this species does not make extensive use of these areas during juvenile life stage.

The following discussion is general to salmon and steelhead critical habitat in the Puget Sound basin. More specific information for each individual species' critical habitat is presented after the general discussion.

Landslides can occur naturally in steep, forested lands, but inappropriate land use practices likely have accelerated their frequency and the amount of sediment delivered to streams. Fine sediment from unpaved roads has also contributed to stream sedimentation. Unpaved roads are widespread on forested lands in the Puget Sound basin, and to a lesser extent, in rural residential areas. Historical logging removed most of the riparian trees near stream channels. Subsequent agricultural and urban conversion permanently altered riparian vegetation in the river valleys, leaving either no trees, or a thin band of trees. The riparian zones along many agricultural areas are now dominated by alder, invasive canary grass and blackberries, and provide substantially reduced stream shade and large wood recruitment (SSPS 2007).

Diking, agriculture, revetments, railroads and roads in lower stream reaches have caused significant loss of secondary channels in major valley floodplains in this region. Confined main channels create high-energy peak flows that remove smaller substrate particles and large wood. The loss of side-channels, oxbow lakes, and backwater habitats has resulted in a significant loss of juvenile salmonid rearing and refuge habitat. When the water level of Lake Washington was lowered 9 feet in the 1910s, thousands of acres of wetlands along the shoreline of Lake Washington, Lake Sammamish and the Sammamish River corridor were drained and converted to agricultural and urban uses. Wetlands play an important role in hydrologic processes, as they store water that ameliorates high and low flows. The interchange of surface and groundwater in complex stream and wetland systems helps to moderate stream temperatures. Forest wetlands are estimated to have diminished by one-third in Washington State (FEMAT 1993; Spence et al. 1996; SSPS 2007).

Loss of riparian habitat, elevated water temperatures, elevated levels of nutrients, increased nitrogen and phosphorus, and higher levels of turbidity, presumably from urban and highway runoff, wastewater treatment, failing septic systems, and agriculture or livestock impacts, have been documented in many Puget Sound tributaries (SSPS 2007).

Peak stream flows have increased over time due to paving (roads and parking areas), reduced percolation through surface soils on residential and agricultural lands, simplified and extended drainage networks, loss of wetlands, and rain-on-snow events in higher elevation clear cuts (SSPS 2007). In urbanized Puget Sound, there is a strong association between land use and land cover attributes and rates of coho spawner mortality likely due to runoff containing contaminants emitted from motor vehicles (Feist et al. 1996). Recent studies have shown that coho salmon show high rates of pre-spawning mortality when exposed to chemicals that leach from tires (McIntyre et al. 2015). Researchers have recently identified a tire rubber antioxidant as the cause (Tian et al. 2020). Although Chinook salmon did not experience the same level of mortality, tire leachate is still a concern for all salmonids. Traffic residue also contains many unregulated toxic chemicals such as pharmaceuticals, polycyclic aromatic hydrocarbons (PAHs), fire retardants, and emissions that have been linked to deformities, injury and/or death of salmonids and other fish (Trudeau 2017; Young et al. 2018).

Dams constructed for hydropower generation, irrigation, or flood control have substantially affected PS salmon and steelhead populations in a number of river systems. The construction and operation of dams have blocked access to spawning and rearing habitat (e.g., Elwha River dams block anadromous fish access to 70 miles of potential habitat) changed flow patterns, resulted in elevated temperatures and stranding of juvenile migrants, and degraded downstream spawning and rearing habitat by reducing recruitment of spawning gravel and large wood to downstream areas (SSPS 2007). These actions tend to promote downstream channel incision and simplification (Kondolf 1997), limiting fish habitat. Water withdrawals reduce available fish habitat and alter sediment transport. Hydropower projects often change flow rates, stranding and killing fish, and reducing aquatic invertebrate (food source) productivity (Hunter 1992).

Juvenile mortality occurs in unscreened or inadequately screened diversions. Water diversion ditches resemble side channels in which juvenile salmonids normally find refuge. When diversion head gates are shut, access back to the main channel is cut off and the channel goes dry. Mortality can also occur with inadequately screened diversions from impingement on the screen, or mutilation in pumps where gaps or oversized screen openings allow juveniles to get into the system (WDFW 2009). Blockages by dams, water diversions, and shifts in flow regime due to hydroelectric development and flood control projects are major habitat problems in many Puget Sound tributary basins (SSPS 2007).

The nearshore marine habitat has been extensively altered and armored by industrial and residential development near the mouths of many of Puget Sound’s tributaries. A railroad runs along large portions of the eastern shoreline of Puget Sound, eliminating natural cover along the shore and natural recruitment of beach sand (SSPS 2007).

Degradation of the near-shore environment has occurred in the southeastern areas of Hood Canal in recent years, resulting in late summer marine oxygen depletion and significant fish kills. Circulation of marine waters is naturally limited, and partially driven by freshwater runoff, which is often low in the late summer. However, human development has increased nutrient loads from failing septic systems along the shoreline, and from use of nitrate and phosphate fertilizers on lawns and farms. Shoreline residential development is widespread and dense in many places. The combination of highways and dense residential development has degraded certain physical and chemical characteristics of the near-shore environment (HCCC 2005; SSPS 2007).

In summary, critical habitat for salmon and steelhead throughout the Puget Sound basin has been degraded by numerous management activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large wood, intense urbanization, agriculture, alteration of floodplain and stream morphology (i.e., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, logging, and mining. Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common limiting factors in areas of critical habitat. As mentioned above, development of shoreline and estuary areas of Puget Sound is expected to continue to adversely impact the quality of marine habitat for PS salmonids. Projected changes in nearshore and estuary development based on documented rates of developed land cover change in Bartz et al. (2015) show that between 2008 and 2060, an additional 14.7 hectares of development of shoreline areas and 204 hectares of estuary development can be expected.

Chinook salmon critical habitat

The PS recovery domain CHART for PS Chinook salmon (NOAA Fisheries 2005) determined that only a few watersheds with PCEs for Chinook salmon in the Whidbey Basin (Skagit River/Gorge Lake, Cascade River, Upper Sauk River, and the Tye and Beckler rivers) are in good-to-excellent condition with no potential for improvement. Most HUC5 watersheds are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or a high potential for improvement (Table 8).

Table 8. Puget Sound Recovery Domain: Current and potential quality of HUC5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon and Hood Canal summer-run chum salmon (NOAA Fisheries 2005). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC$_5$ Code(s)	Listed Species	Current Quality	Restoration Potential
Strait of Georgia and Whidbey Basin #1711000xxx			
Skagit River/Gorge Lake (504), Cascade (506) & Upper Sauk (601) rivers, Tye & Beckler rivers (901)	CK	3	3
Skykomish River Forks (902)	CK	3	1
Skagit River/Diobsud (505), Illabot (507), & Middle Skagit/Finney Creek (701) creeks; & Sultan River (904)	CK	2	3
Skykomish River/Wallace River (903) & Skykomish River/Woods Creek (905)	CK	2	2
Upper (602) & Lower (603) Suiattle rivers, Lower Sauk (604), & South Fork Stillaguamish (802) rivers	CK	2	1
Samish River (202), Upper North (401), Middle (402), South (403), Lower North (404), Nooksack River; Nooksack River (405), Lower Skagit/Nookachamps Creek (702) & North Fork (801) & Lower (803) Stillaguamish River	CK	1	2
Bellingham (201) & Birch (204) bays & Baker River (508)	CK	1	1
Whidbey Basin and Central/South Basin #1711001xxx			
Lower Snoqualmie River (004), Snohomish (102), Upper White (401) & Carbon (403) rivers	CK	2	2
Middle Fork Snoqualmie (003) & Cedar rivers (201), Lake Sammamish (202), Middle Green River (302) & Lowland Nisqually (503)	CK	2	1
Pilchuck (101), Upper Green (301), Lower White (402), & Upper Puyallup River (404) rivers, & Mashel/Ohop(502)	CK	1	2
Lake Washington (203), Sammamish (204) & Lower Green (303) rivers	CK	1	1
Puyallup River (405)	CK	0	2
Hood Canal #1711001xxx			
Dosewallips River (805)	CK/CM	2	1/2
Kitsap – Kennedy/Goldsborough (900)	CK	2	1
Hamma River (803)	CK/CM	1/2	1/2
Lower West Hood Canal Frontal (802)	CK/CM	0/2	0/1
Skokomish River (701)	CK/CM	1/0	2/1
Duckabush River (804)	CK/CM	1	2
Upper West Hood Canal Frontal (807)	CM	1	2
Big Quilcene River (806)	CK/CM	1	1/2
Deschutes Prairie-1 (601) & Prairie-2 (602)	CK	1	1
West Kitsap (808)	CK/CM	1	1
Kitsap – Prairie-3 (902)	CK	1	1
Port Ludlow/Chimacum Creek (908)	CM	1	1
Kitsap – Puget (901)	CK	0	1
Kitsap – Puget Sound/East Passage (904)	CK	0	0
Strait of Juan de Fuca Olympic #1711002xxx			
Dungeness River (003)	CK/CM	2/1	1/2
Discovery Bay (001) & Sequim Bay (002)	CM	1	2
Elwha River (007)	CK	1	2
Port Angeles Harbor (004)	CK	1	1

As mentioned previously, numerous factors have led to the decline of PS Chinook salmon including overharvest, freshwater and marine habitat loss, hydropower development, and hatchery practices, as mentioned in Section 2.2.1, above. Adjustments can, and have been made in the short term to ameliorate some of the factors for decline. Harvest can be adjusted on yearly or even in-season basis. Since PS Chinook salmon were listed, harvest in state and federal fisheries has been reduced in an effort to increase the number of adults returning to spawning grounds. Likewise, hatchery management can, and has been adjusted relatively quickly when practices are detrimental to listed species. To address needed improvements in hydropower, NMFS has issued biological opinions with reasonable and prudent alternatives to improve fish passage at existing hydropower facilities. Unlike the other factors, however, loss of critical habitat quality is much more difficult to address in the short term. Once human development causes loss of critical habitat quality, that loss tends to persist for decades or longer. The condition of critical habitat will improve only through active restoration or natural recovery following the removal of human infrastructure. As noted throughout this Opinion, future effects of climate change on habitat quality throughout Puget Sound are expected to be negative.

Habitat utilization by Chinook salmon and steelhead in the Puget Sound area has been historically limited by large dams and other manmade barriers in a number of drainages, including the Nooksack, Skagit, White, Nisqually, Skokomish, and Elwha river basins (Appendix B in NMFS (2015a)). In addition to limiting habitat accessibility, dams affect habitat quality through changes in river hydrology, altered temperature profile, reduced downstream gravel recruitment, and the reduced recruitment of large woody debris. Such changes can have significant negative impacts on salmonids (e.g., increased water temperatures resulting in decreased disease resistance) (Spence et al. 1996; McCullough 1999). However, over the past several years modifications have occurred to existing barriers, which have reduced the number of basins with limited anadromous access to historical habitat. The completion of the Elwha and Glines Canyon Dam removals occurred in 2014. The response of fish populations to this action is still being evaluated. It is clear; however, that Chinook salmon and steelhead are accessing much of this newly available habitat. Passage operations have begun on the North Fork Skokomish River to reintroduce steelhead above Cushman Dam, although juvenile collection efficiency is still relatively low, and further improvements are anticipated. Similarly, improvements in the adult fish collection facility at Mud Mountain Dam (White River basin) are near completion, with the expectation that improvements in adult survival will facilitate better utilization of habitat above the dam (NMFS 2014b). The recent removal of the diversion dam on the Middle Fork Nooksack Dam (16 July 2020) and the Pilchuck River Dam (late 2020) will provide access to important headwater salmonid spawning and rearing habitats. Similarly, the proposed modification of Howard Hanson Dam for upstream fish passage and downstream juvenile collection in the longer term (NMFS 2019f) will allow winter steelhead to return to historical habitat (Ford, in press).

2.3 Environmental Baseline

The “environmental baseline” refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

2.3.1 Current Status of Puget Sound

Puget Sound can be generally described as nearshore and deep-water areas. NMFS has identified the several nearshore and deep water physical or biological features essential to conservation for salmonids, and rockfish in Section 2.2.2.

The nearshore is the zone where marine water, fresh water, and terrestrial landscapes interact in a complex mosaic of habitats and processes. The nearshore encompasses the shoreline from the top of the upland bank or bluff on the landward side down to the depth of water that light can penetrate and where plants can photosynthesize (photic zone). The upper extent of the nearshore covers the terrestrial upland that contributes sediment, shade, organic material like leaf litter, and even the insects that fish eat. The lower range of the photic zone depends on water clarity; in Puget Sound, underwater vegetation can be found to depths of 30 to 100 feet below Mean Lower Low Water (MLLW) (Williams and Thom 2001). The nearshore includes a variety of environments: marine shallows, eelgrass meadows, kelp forests, mudflats, beaches, salt marshes, rocky shores, river deltas, estuaries, barrier islands, spits, marine riparian zones, and bluffs. This wide range of habitats supports many species. The nearshore forms the basis for the biologic productivity of the Puget Sound basin. Shoreline modification can cause fragmentation of the landscape that disrupts connectivity and reduces the productivity and biological diversity of Puget Sound watersheds. These impacts leave ecosystems less resilient.

Throughout Puget Sound, the nearshore areas have been modified by human activity, disrupting the physical, biological, and chemical interactions that are vital for creating and sustaining the diverse ecosystems of Puget Sound. There are approximately 503,106 acres of overwater structure in the nearshore of Puget Sound (Schlenger et al. 2011). Currently, 27 percent of Puget Sound's shorelines are armored (Simenstad et al. 2011; Meyer el al. 2010). The shoreline modifications are usually intended for erosion control, flood protection, sediment management, or for commercial, navigational, and recreational uses. Seventy-four percent of shoreline modification in Puget Sound consists of shoreline armoring (Simenstad et al. 2011), which usually refers to bulkheads, seawalls, or groins made of rock, concrete, or wood. Other modifications include jetties and breakwaters designed to dissipate wave energy, and structures such as tide gates, dikes, and marinas, overwater structures, including bridges for railways, roads, causeways, and artificial fill. An analysis conducted in 2011 though the Puget Sound Nearshore Ecosystem Restoration Project (Fresh et al, 2011; Simenstad et al 2011) found that since 1850, of the approximately 2,470 miles of Puget Sound shoreline:

- Shoreline armoring has been installed on 27 percent of Puget Sound shores (Table 9).
- One-third of bluff-backed beaches are armored along half their length. Roads and nearshore fill have each affected about 10 percent of the length of bluff-backed beaches.
- Forty percent of Puget Sound shorelines have some type of structure that impacts habitat quality (shoreline armoring included).

- Overwater structures cover more than 506,103 acres of Puget Sound nearshore habitat
- There has been a 93 percent loss of freshwater tidal and brackish marshes. The Duwamish and Puyallup rivers have lost nearly all of this type of habitat.
- A net decline in shoreline length of 15 percent as the naturally convoluted and complex shorelines were straightened and simplified. This represents a loss of 1,062 km or 660 miles of overall shoreline length.
- Elimination of small coastal embayments has led to a decline of 46 percent in shoreline length in these areas.
- A 27 percent decline in shoreline length in the deltas of the 16 largest rivers and a 56 percent loss of tidal wetlands in the deltas of these rivers.

The distribution and sizes of over water structures (OWS) in the nearshore[14] are detailed further in Schlenger et al. (2011) and (Simenstad et al. 2011).

Table 9. Length of shoreline armored as a percent of total shoreline length (Simenstad et al. 2011) by marine basin (Beechie et al. 2017).

Marine Basin	Armoring (miles)	Shoreline Length (miles)	Percent Armored
Hood Canal	63.9	359.7	17.7%
North Puget Sound	103.3	720.4	14.3%
South Central Puget Sound	397.0	832.6	47.7%
Strait of Juan de Fuca	33.0	210.3	15.7%
Whidbey Basin	68.3	343.4	19.9%
Grand Total	**665.3**	**2466.3**	**27.0%**

Puget Sound nearshore and deep marine waters are fundamental to many life histories of salmon and steelhead and particularly crucial for PS Chinook salmon juvenile (parr, fry, sub-yearling), and sub adult life stages. Juvenile salmon use nearshore habitat extensively during the early marine period (Duffy et al. 2005), a critical time for salmon growth, as larger, faster-growing fish have increased probabilities of surviving to adulthood (Beamish et al. 2004; Duffy and Beauchamp 2011). As mentioned in section 2.2.1 above, the loss of nearshore habitat is considered a factor in the loss of PS Chinook salmon abundance and productivity. Reduction in nearshore habitat quality has reduced survival at multiple life stages. Marine survival rates of PS Chinook salmon in Puget Sound have declined drastically since 1980 (Ruggerone and Goetz 2004, Sharma et al. 2012, Ruff et al. 2017). Smolt-to-adult survival rates for hatchery-reared sub-yearling Chinook salmon within Puget Sound have averaged less than one percent over the past three decades (Kilduff et al. 2014).

There is also evidence that loss of nearshore habitat quality may be eliminating PS Chinook salmon life history strategies that make use of nearshore areas during the early life stages.

[14] The nearshore area includes the area from the deepest part of the photic zone (approximately 10 meters below Mean Lower Low Water [MLLW]) landward to the top of shoreline bluffs, or in estuaries upstream to the head of tidal influence (Clancy et al. 2009).

Campbell et al. (2017) found less than three percent of adults returning to the Green and Puyallup Rivers to exhibit the fry migrant life history concurrent with approximately 95 percent of their estuary habitat having been eliminated. The converse was true from the Skagit and Nooksack estuaries where approximately 50 percent of the estuary remained in a natural state (Beechie et al. 2017) and 36 and 24 percent of the adult population we examined returned from small fry sized fish, respectively.

From 2005 to 2011, in Puget Sound an average of 1.1 miles per year of new shoreline armoring was permitted in and 2.3 miles per year of replacement armoring was permitted (Johannessen et al. 2014). These figures do not include unpermitted structures, which can exceed those constructed with permits. For example, in the Green/Duwamish River Watershed (Water Resources Inventory Area 9), permitted structures comprised only 38 percent of all the armoring physically surveyed in 2012 and 2013 (King County 2014).

Residential parcels make up 57 percent of Puget Sound shorelines and 48 percent of these are armored. In some areas, armoring is even more prevalent: more than 50 percent of the residential parcels are armored in King, Kitsap, Pierce, Snohomish, Mason, and Thurston counties. Overall, 26 percent of residential parcels are in forage fish spawning grounds and 58 percent of those are armored (PSMNGP 2014). In a survey of HPAs issued by WDFW in Puget Sound between January 2005 and December 2010 the data recorded the installation of 6.5 miles of new armor and 14.45 miles of replacement armor. This starkly contrasts with data from that same time period that shows only 0.61 miles of armor were removed (Carman et al 2011). More recent studies have suggested a less dramatic rate of new armoring, but those studies were limited in their geographic scope and types of shoreline modification.[15] The studies have, however, corroborated that the bulk of permitted shoreline armoring activities continue to be repair and replacement. This demonstrates that the lifecycle of structures that includes the repair or replacement of aging armoring and other in- or over-water structures in Puget Sound extends the duration of degraded baseline conditions and retains limits on habitat features and corresponding carrying capacity.

The duration of impairment of habitat condition and function that derive from decades of persistent anthropogenic changes in the amount of and character of estuarine habitat, is made more detrimental due to the compounding nature of these effects, occurring because: (1) regulatory and permitting measures do not avoid all impacts and largely fail to include methods to rectify unavoidable impacts; (2) development pressure continues to impact habitat in the marine and freshwater portion of the range; (3) improvements in human use patterns to minimize resource impacts are slow at best; and (3) few of the 2020 improvement targets identified by the Puget Sound Partnership (PSP)[16] have been reached (Puget Sound Partnership 2018). In more detail, this most recent report points out the following issues:

- Chinook salmon, steelhead and SRKW: ongoing decline.
- Herring stocks: declining

[15] Shoreline Permitting through TACT (Spring 2015) (TACT is an acronym for: Trouble-Shooting, Action Planning, Course Correction, and Tracking and Monitoring).

[16] The PSP Action Agenda is an EPA-approved recovery plan under the National Estuary Program.

- Loss of non-federal forested land cover to developed land cover: continuing. Loss of 1,196 acres of non-federal forested land per year between 2006 and 2011.
- Shoreline armoring: Stable between 2011 and 2014. No recent net increase, restoration actions balance out increase from private shoreline armoring. However, this could be related to poor economic conditions. More years of data are needed to determine trends.
- Accelerated conversion/loss of vegetation cover on ecologically important lands: 0.18 percent loss for 2011-2016. This is even more loss than the cautious 2020 Target: Basin-wide loss of vegetation cover on ecologically important lands under high pressure from development does not exceed 0.15 percent of the total 2011 baseline land area over a 5-year period.
- Marine water quality: Overall, trends have been getting worse with closures of beaches and shellfish harvest in some bays. While there has been some increase between 2011 and 2014 in the amount of shellfish beds open to harvest, about 19 percent are still closed. PCB levels in fish are still high.
- Native Eelgrass (*Z. marina*) abundance seems stable comparing 2011 to 2013 data to baseline from 2000 to 2008. This does not account for losses that occurred prior to 2000.
- Human Sound Behavior Index: No change in average behavior. Thus, an increase in human population is likely to continue to degrade habitat quality. (The Sound Behavior Index tracks 28 human use practices[17] that likely affect habitat and water quality and quantity).
- Over Water Structure (OWS): not assessed by PSP. Current percent of nearshore coverage is 0.63 percent for all of Puget Sound, as detailed below.

The PSP concludes the overall decline in habitat conditions and native species abundance in the Puget Sound has been caused by development and climate change pressures. Over the last 150+ years, 4.5 million people have settled in the Puget Sound region. With the level of infrastructure development associated with this population growth the Puget Sound nearshore has been altered significantly. Major physical changes documented include the simplification of river deltas, the elimination of small coastal bays, the reduction in sediment supplies to the foreshore due to beach armoring, and the loss of tidally influenced wetlands and salt marsh (Fresh et al. 2011).

In addition to beach armoring, other shoreline changes including OWS, marinas, roads, and railroads reduce habitat quality. The amount of these changes varies, and their source varies by region, generally correlating with development, but overall is substantial (Simenstad et al. 2011). The simplification of the largest river deltas has caused a 27 percent decline in shoreline length compared to historical (pre-1890s) conditions. Of 884 historic small embayments, 308 have been eliminated. About 27 percent of PS's shorelines are armored and only 112 of 828 shoreline segments remain in properly functioning condition. The loss of tidal wetlands in the largest deltas averages 26 percent (Fresh et al. 2011). Each of these habitat changes is related to development and overall reduces the quality and quantity of PS Chinook salmon in the Puget Sound nearshore.
Existing shoreline armoring on nearshore and intertidal habitat function has diminished sediment supply, diminished organic material (e.g. woody debris and beach wrack) deposition, diminished

[17] Human use practices include among others: (a) Number of residents with native vegetation on banks of waterways; (b) number of residents using pump stations for boat wastewater; (c) residents using herbicides and pesticides; and (d) pasture practices for residents with livestock.

overwater (riparian) and nearshore in-water vegetation (SAV), diminished prey availability, diminished aquatic habitat availability, diminished invertebrate colonization, and diminished forage fish populations (see Toft et al. 2007; Shipman et al. 2010; Sobocinski et al. 2010; Morley et al. 2012; Toft et al. 2013; Munsch et al. 2014; Dethier et al. 2016). In some locations shoreline armoring has caused increased beach erosion waterward of the armoring, which, in turn, has created beach lowering, coarsening of substrates, increases in sediment temperature, and reductions in invertebrate density (Fresh et al. 2011; Morley et al. 2012; Dethier et al. 2016).

Shoreline armoring has reduced suitable habitat for forage species (Pacific sand lance and surf smelt) spawning and likely has reduced their abundance and productivity. Bulkheads alter habitat conditions for the duration that they are present and simultaneously diminish or eliminate intertidal habitat for forage species including sand lance, an obligate upper intertidal spawner (Whitman et al. 2014). As stated in Fresh et al. (2011) "we can only surmise how much forage fish spawning habitat we have lost because we lack comprehensive historical data on spawning areas." Considering that these forage fish are an essential food source for salmon, beach armoring has multiple negative effects on salmon including reductions in prey and reductions in access to shallow water rearing habitat and refuge (Davis et al. 2020).

<u>Marine Vessels</u>

Commercial, recreational, military, and public ferry vessel traffic occurs throughout Puget Sound. Vessels range in size from massive commercial shipping container ships to kayaks. Vessels can access Puget Sound through the Strait of San Juan de Fuca, the Strait of Georgia, ports, public and private marinas, naval bases, single-family piers, public boat ramps, and freshwater piers and marinas. Several studies have shown fish to respond physiologically and biologically to increased noise (Mueller 1980; Scholik and Yan 2002; Picciulin et al. 2010). Xie et al. (2008) report that adult migrating salmon avoid vessels by swimming away. Graham and Cooke (2008) studied the effects of three boat noise disturbances (canoe paddling, trolling motor, and combustion engine (9.9 horsepower) on the cardiac physiology of largemouth bass (*Micropterus salmoides*). Exposure to each of the treatments resulted in an increase in cardiac output.

Vessels are subject to existing federal regulations prohibiting approach closer than 200 yards or positioning in the path of the whales within 400 yards (with exemptions for vessels lawfully engaged in commercial or treaty Indian fishing that are actively setting, retrieving, or closely tending fishing gear). State regulations also mandate protections for SRKWs (see RCW 77.15.740, mandating 300 to 400-yard approach limits, 7 knots or less speed within ½ nautical mile of the whales). NMFS and other partners have outreach programs in place to educate vessel operators on how to avoid impacts to whales. The average number of vessels with the whales decreased in 2018, 2019 and 2020 likely due to decreased viewing effort on SRKWs by commercial whale watching vessels, with an average of 10, 9, and 10.5 vessels with the whales at any given time, respectively (Frayne 2021). NMFS initiated scoping in 2019 to evaluate the need to revise existing federal regulations.

Stormwater

Mackenzie et al. 2018 found that stormwater is the most important pathway to Puget Sound for most toxic contaminants, transporting more than half of the Sound's total known toxic load (Ecology & King County 2011). During a robust Puget Sound monitoring study, toxic chemicals were detected more frequently and at higher concentrations during storm events compared with base flow for diverse land covers, pointing to stormwater pollution (Ecology 2011). The Puget Sound basin has over 4,500 unnatural surface water and stormwater outfalls, 2,121 of which discharge directly into the Sound (WDNR 2014).

In general, the pollutants in the existing stormwater discharge are diverse. The discharge itself comes from rainfall or snowmelt moving over and through the ground, also referred to here as "runoff." As the runoff travels along its path, it picks up and carries away natural and anthropogenic pollutants (U.S. EPA 2016b). Pollutants in stormwater discharge typically include

- Excess fertilizers, herbicides, insecticides and sediment from landscaping areas.
- Chemicals and salts from de-icing agents applied on sidewalks, driveways, and parking areas.
- Oil, grease, PAHs and other toxic chemicals from roads and parking areas used by motor vehicles.
- Bacteria and nutrients from pet wastes and faulty septic systems.
- Metals (arsenic, copper, chromium, lead, mercury, and nickel) and other pollutants from the pesticide use in landscaping, roof runoff (WDOE 2014), decay of building and other infrastructure, and as airborne particles from street and tire wear.
- Atmospheric deposition from surrounding land uses.
- Erosion of sediment and attached pollutants due to hydromodification.

(Buckler and Granato 1999; Colman et al. 2001; Driscoll et al. 1990; Kayhanian et al. 2003; Van Metre et al. 2005).

Landscape overview

When considered at the landscape scale, the baseline condition of Puget Sound nearshore habitat is degraded, with reduced water quality, reduced forage and prey availability, reduced quality of forage and prey communities, reduced amount of estuarine habitat, reduced quality of nearshore and estuarine habitat, and reduced condition of migration habitat due to structures noise and vessel perturbations. Each of these conditions of the baseline exerts downward pressure on all populations of each listed species considered in the Opinion for the duration of their time in the action area. Loss of production of Chinook salmon from habitat degradation reduces available forage for SRKWs. The baseline currently constrains the carrying capacity of the action area and limits its potential for serving recovery of these species. Overall, the nearshore is impacted in many areas by the degradation from coastal development and pollution. The status of deep-water habitat is impacted by remaining derelict fishing gear and degraded water quality among other factors. The input of pollutants affects water quality, sediment quality, and food resources in the nearshore and deep-water areas of critical habitat.

NMFS's management strategy for conservation and recovery of listed salmonids in the West Coast has long been premised on reducing adverse effects among all of the "4 Hs" namely, Hatcheries, Hydropower, Harvest, and Habitat. Each has had a role in the factors for decline of West Coast salmonids, each has been the subject of section 7 consultations, and each has been found to have continuing negative influence on species' viability. Example dams such as White River Dam, previously operated by Puget Sound Energy, Mud Mountain Dam (NMFS 2014a) operated by the USACE for the purpose of flood control operations, and as needed to facilitate maintenance activities at the downstream White River diversion dam, and Howard Hanson Dam (NMFS 2019c) operated by the USACE for downstream flood damage reduction, have each been found to jeopardize ESA listed fish, and in the case of Mud Mountain and Howard Hanson dams, jeopardy to PS Chinook salmon posed a secondary threat of jeopardy to SRKW.

The outcomes of those jeopardy opinions include the surrender of the White River FERC license. Puget Sound Energy retired the hydro project in 2004. Cascade Water Alliance purchased it from the company in 2009 and intends to complete a habitat conservation plan for its water. Passage improvements at Mud Mountain Dam have already reduced fish mortality, and while a new passage is being designed for Howard Hanson Dam, the USACE is evaluating modifications to its retention and release schedule of water to benefit egg in spawning areas downstream of the dam. In each case, modifications to avoid jeopardizing listed species are being undertaken.

On November 9, 2020, NMFS issued a biological opinion on 39 proposed projects in the nearshore of Puget Sound (WCRO-2020-01361). The 39 individual consultations proposed to construct new overwater or shoreline armoring structures or repair or replace existing in- or overwater or armoring structures, and were consolidated together by NMFS into a single biological opinion based on the locations of the proposed projects and their similar impacts on ESA-listed species and their critical habitat designated under the ESA. In this opinion, we determined the Corps' proposed action, to permit the 39 projects, was likely to jeopardize the continued existence of listed PS Chinook salmon and SRKW. We also concluded the proposed action was likely to adversely modify those species' designated critical habitats. We also determined that the proposed action was not likely to jeopardize listed PS steelhead, PS/Georgia Basin bocaccio rockfish, yelloweye rockfish, or Hood Canal Summer-run chum salmon or adversely modify designated critical habitat for those four species. Our conclusion was based on:

- PS Chinook populations are far from meeting recovery goals and trends in abundance and productivity are mostly negative.
- Nearshore habitat quality is insufficient to support conservation of this ESU. SRKW prey is at a fraction of historical levels. Under the current environmental baseline, nearshore habitat in Puget Sound cannot support the biological requirements of PS Chinook salmon.
- Fewer populations of PS Chinook salmon contributing to SRKW's prey base will reduce the representation of diversity of life histories, resiliency in withstanding stochastic events, and redundancy to ensure there is a margin of safety for the salmon and SRKWs to withstand catastrophic events.
- The condition of the environmental baseline is such that additional impacts on the quality of nearshore habitat is likely to impair the ability of that habitat to support conservation of these species.
- The proposed actions would further reduce the quality of nearshore habitat in Puget Sound.

- The proposed actions would also exacerbate habitat limiting factors identified by the PS Chinook salmon and SRKW recovery plans and are inconsistent with recovery action listed in these plans. Due to demand for future human development cumulative effects on nearshore habitat quality are expected to be mostly negative.

The 2020 jeopardy opinion included an RPA with five elements, including on site habitat improvements; offsite habitat improvements; funding from a habitat restoration sponsor; purchase of credits from a conservation bank in-lieu fee program, or crediting provider; and, project modifications.

The environmental baseline would also include the projected effects of climate change for the time period commensurate with the effects of the proposed actions. Mauger et al (2015) predict that circulation in Puget Sound is projected to be affected by declining summer precipitation, increasing sea surface temperatures, shifting streamflow timing, increasing heavy precipitation, and declining snowpack. While these changes are expected to affect mixing between surface and deep waters within Puget Sound, it is unknown how these changes will affect upwelling. Changes in precipitation and streamflow could shift salinity levels in Puget Sound by altering the balance between freshwater inflows and water entering from the North Pacific Ocean. In many areas of Puget Sound, variations in salinity are also the main control on mixing between surface and deep waters. Reduced mixing, due to increased freshwater input at the surface, can reduce phytoplankton growth, impede the supply of nutrients to surface waters, and limit the delivery of dissolved oxygen to deeper waters. Patterns of natural climate variability (e.g., El Niño/La Niña) can also influence Puget Sound circulation via changes in local surface winds, air temperatures, and precipitation.

All three ESA-listed Puget Sound salmonids were classified as highly vulnerable to climate change in a recent climate vulnerability assessment (Crozier et al. 2019). In estuarine environments, the two greatest concerns associated with climate change are rates of sea-level rise and temperature warming (Wainwright and Weitkamp 2013, Limburg et al. 2016). While the effects of climate change-induced ocean acidification on invertebrate species are well known, the direct exposure effects on salmon remains less certain (Crozier et al. 2019).

The world's oceans are becoming more acidic as increased atmospheric CO_2 is absorbed by water. The North Pacific Ocean is already acidic compared to other oceans, making it particularly susceptible to further increases in acidification (Lemmen et al. 2016). Laboratory and field studies of ocean acidification show it has the greatest effects on invertebrates with calcium-carbonate shells, and relatively little direct influence on finfish; see reviews by Haigh et al. (2015) and Mathis et al. (2015). Consequently, the largest impact of ocean acidification on salmon is likely to be its influence on marine food webs, especially its effects on lower trophic levels, which are largely composed of invertebrates such as pteropods, larval crabs, and krill, which play a significant role in some salmon diets (Haigh et al. 2015, Mathis et al. 2015, Wells et al. 2012). Marine invertebrates fill a critical gap between freshwater prey and larval and juvenile marine fishes, supporting juvenile salmon growth during the important early-ocean residence period (Daly et al. 2009, 2014).

Physiological effects of acidification may also impair olfaction, which could hinder homing ability (Munday et al. 2009), along with other developmental effects (Ou et al. 2015). Although a recent review of ocean acidification studies on fish has called into question many of the behavioral effects of ocean acidification (Clark et al. 2020). Using the criteria of Morrison et al. (2015) for scoring, PS Chinook salmon, HC Chum salmon, and PS steelhead had low-to-moderate sensitivity to ocean acidification (Crozier et al. 2019).

The same document states that "sea level rise is projected to expand the area of some tidal wetlands in Puget Sound but reduce the area of others, as water depths increase and new areas become submerged. For example, the area covered by salt marsh is projected to increase, while tidal freshwater marsh area is projected to decrease. Rising seas will also accelerate the eroding effect of waves and surge, causing unprotected beaches and bluffs to recede more rapidly. The rate of sea level rise in Puget Sound depends both on how much global sea level rises and on regionally-specific factors such as ocean currents, wind patterns, and the distribution of global and regional glacier melt. These factors can result in higher or lower amounts of regional sea level rise (or even short-term periods of decline) relative to global trends, depending on the rate and direction of change in regional factors affecting sea level" (Mauger et al. 2015).

2.3.2 Current Status of Commencement Bay

Industrial development of Commencement Bay began in the late 19th century (Corps et al. 1993) and fragmented estuarine habitats by altering shorelines with vertical or steeply sloping bulkheads and piers (Kerwin 1999). By 1917, several waterways, including the Blair Waterway, had been constructed by dredging and filling mudflats in the Puyallup River delta and Commencement Bay. Side channels, sloughs, and saltwater transition zones historically used by anadromous fish have largely been eliminated. Chemical contamination of sediments within Commencement Bay has compromised the suitability of the remaining habitat (Corps et al. 1993; USFWS & NOAA 1997; Collier et al. 1998). Despite extensive alterations to the natural habitat within Commencement Bay, some species still use the remaining habitat (USFWS & NOAA 1997).

Historically, intertidal mudflats covered an estimated 2,100 acres of Commencement Bay. In 1992, approximately 180 acres remained (Corps et al. 1993). Dredging, diking, and other anthropogenic activity within Commencement Bay are responsible for this change in habitat. Since 1993 several habitat mitigation and restoration sites have been established and approximately 292 additional acres of marine and estuarine habitat within the action area has been restored[18]. The majority of the remaining mudflat habitat is located near the mouth of the Puyallup River, within the Hylebos, Middle, Milwaukee, St. Paul, and Wheeler-Osgood Waterways (Corps et al. 1993; USFWS & NOAA 1997).

The action area within Commencement Bay, has been highly developed and numerous overwater structures and extensive shoreline armoring exist within the vicinity of the project. The natural shoreline has been almost completely replaced by impervious surfaces and nearshore riparian vegetation is absent. The shorelines of Commencement Bay have been highly altered using

[18] Quantity provided by Jennifer Stebbings, Port of Tacoma on January 10, 2022 via a preliminary draft review comment.

riprap, and other materials to provide bank protection. The Port of Tacoma waterways were developed for industrial and commercial operations and the upland areas are heavily industrialized. Blair Waterway comprises seven percent of the total of armored shoreline that covers 71 percent of the length of the Commencement Bay shoreline. Commencement Bay contains dense industrial, commercial, and residential development and is a major shipping route for containerized and bulk cargo, which is consequently subject to high volumes of marine traffic.

Aquatic portions of the project area are composed of intertidal and subtidal habitats. Intertidal habitat along the shorelines of the project area is limited by shoreline armoring and overwater structures. Commencement Bay has been highly modified by industrial development with large areas of fill, dredging, stabilization, and infrastructure (Simenstad 2000). Overwater structures in the form of piers for ship loading are prevalent along the shorelines of the project area. Based on shoreline surveys and aerial photo interpretation of the area, approximately five miles, or 20 percent of the Commencement Bay shoreline, is covered by wide over-water structures (Kerwin 1999). This shading affects the community of the subtidal organisms that serve as fish food or habitat structure in the form of eelgrass and kelp (Nightingale and Simenstad 2001). Piers and other overwater structures can inhibit juvenile salmon migration as physical barriers, shading that causes avoidance, and increased susceptibility to predation (Simenstad et al. 1982).

The depth of sea floor in most of Commencement Bay (30-100 meters; 98-330 feet) and the Blair Waterway (-51 MLLW) is not commonly habitat that salmonids select for feeding or refuge. Some estuarine and marine fish and sub-tidal marine invertebrates inhabit and feed at deeper subtidal elevations within the action area. Additionally, the invertebrates inhabiting the substrate of the Blair Waterway, such as polychaete and nematode worms, do not contribute significantly to the salmonid food chain (Hiss and Boomer 1986). The Blair Waterway has artificial side slopes of 2H:1V throughout most of the waterway.

Baseline conditions include regular disruptions on a daily basis when large shipping vessels transit the channel and displace fish and wildlife due to underwater noise and physical presence. Tacoma Harbor already receives calls from the 14,000 twenty-foot equivalent unit (TEU) capacity Thalassa Axia, which began calling in November 2018. The Thalassa Axia is the largest ship calling at Tacoma Harbor as of December 2019.

2.3.3 Current Status of Blair Waterway

The Blair Waterway, a congressionally authorized federal navigation channel, is a permanent component of the integrated Port system. The Blair Waterway was artificially created and generally has a 2H:1V side slope and piers with varying degrees of slope strengthening (e.g., bulkheads, piles, and riprap) along the length of the channel (28,566 linear feet). The federal navigation channel, infrastructure/facilities, and vessel traffic, within the Blair Waterway are included as part of the environmental baseline considered in this Opinion.

The Blair Waterway was first constructed prior to 1920 by private interests. Over the last 100 years, at least 14 different dredge/cleanup projects have shaped the waterway to its current configuration. It has been at its current length since the mid-1960s. In the last 25 years, there have been several deepening actions, some conducted as part of the Commencement Bay

Nearshore/Tideflats (CB/NT) Superfund cleanup; at least five different cutback actions for widening the waterway; bridge abutment fill removal; slip fills; and pier realignments. During this same 25-year period, there have been numerous pier redevelopments, realignments, expansions, and new construction. The Blair Waterway comprises seven percent of the total armored shoreline within Commencement Bay.

The Blair Waterway has a long history as an integral structure to support marine cargo shipping in the Puget Sound. Since its creation, the Blair Waterway has been actively operated, managed, and maintained as an industrial and commercial navigable waterway. From its initial construction prior to 1920 to 1956, the Blair Waterway (first named Wapato Waterway and then Port Industrial Waterway), was incrementally deepened, widened, and lengthened through actions under the River and Harbors Act of 1935, and the Rivers and Harbors Act of 1954. In 1956, the waterway was approximately 800 feet wide, and -30 feet MLLW, from the mouth to approximately Lincoln Avenue. Following the Rivers and Harbors and Flood Control Act of 1962, the waterway was lengthened to its present configuration (approximately 2.6 miles) and a turning basin was added at the head of the navigation channel. The project was completed in 1969 and the waterway was renamed the Blair Waterway.

In 1983-1984, investigations showed concentrations of arsenic, copper, lead, and zinc in surface water runoff from the area exceeded federal and state marine water quality criteria. In the mid-1990s, the Blair Waterway navigation channel and berth areas were dredged as part of the Sitcum Waterway Remediation Project under the CB/NT Superfund cleanup. The waterway was deepened from -30 feet to approximately -48 feet MLLW from the mouth to approximately 1,000 feet upstream of Lincoln Avenue, and to approximately -45 feet MLLW for the remainder of the waterway, including the turning basin. However, after cleanup, concentrations of metals (arsenic and lead) in soil exceeded MTCA (Model Toxics Control Act) Method A cleanup levels for industrial sites. In addition, arsenic concentrations in stormwater exceeded water quality criteria (surface water runoff at the site discharges to the Blair Waterway). When an environmental covenant exists for a cleanup site, The Washington Department of Ecology (Ecology) reviews site conditions about every five years to ensure the long-term effectiveness of the cleanup action. Ecology inspected the site on April 3, 2019, and investigated current conditions of the cap and the stormwater collection system. Conditions of the cap continues to prevent direct contact with contaminated soil and prevent stormwater from contacting or infiltrating the capped soils.

Sediment within the Blair Waterway have been classified by Ecology as Waters of Concern (Category 2) for hexachlorobenzene and sediment bioassays. A small section of the waterway has also been classified as impaired waters that do not require a TMDL (Category 4b) for sediment bioassays. Soil, groundwater, and nearshore sediment in the uplands around the Blair Waterway are potentially contaminated with residual hazardous materials including total petroleum hydrocarbons, metals, volatile organic compounds (VOCs), semi-volatile organic compounds, and polychlorinated biphenyls (PCBs).

In 1999, the Corps evaluated the Blair Waterway and determined deepening the navigation channel from -48 feet and -45 feet MLLW to -51 feet MLLW in its entirety would eliminate navigation inefficiencies for post-Panamax shipping vessels and would not result in significant environmental impacts. The entire Blair Waterway navigation channel was dredged in 2000 to its current depth of -51 feet MLLW. Two pier realignments and two maintenance dredges have occurred in the Blair Waterway in the last 15 years. First, 600 feet of the Blair Terminal was demolished, the bank cutback to align with the Washington United Terminal (WUT) and 600 feet of new pier was added to the south end of WUT. A small maintenance dredge (approximately 3,300 cubic yards) was performed at WUT in 2009. Next, a maintenance dredge was conducted at Husky Terminal (approximately 42,100 cubic yards) around 2011 to remove high spots from shoaling and sloughed material. Most of Pier 4 at Husky Terminal was demolished and the bank cutback to align with Pier 3 starting in 2014. Part of that action was conducted as an emergency cleanup coordinated by the EPA due to very high levels of Tributyltin found during sediment characterization. Finally, the Corps estimates operation and maintenance dredging occurs within the Blair Waterway approximately every 25 years and removes roughly 30,000 cubic yards of material to maintain navigability of the congressionally authorized channel.

Sediments within the Blair Waterway are predominantly fine-grained, and generally consist of sand and silty sand, as well as organic sediments that enter the action areas from the Puyallup River and Wapato Creek. High turbidity is a major factor within the Blair Waterway, primarily due to propeller wash from vessel activities and turbidity from the Puyallup River, which can enter the waterways during high tides. High levels of turbidity in inner Commencement Bay occur routinely due to the naturally high turbidity of the Puyallup River. In deep-water areas, turbidity is generally lower than surface turbidity.

With the exception of mitigation/restoration sites, the Blair Waterway shoreline is armored along its entire length with riprap, bulkheads (sheetpile or secant walls), or wooden piles. The extent of armoring depends on the location, and ranges from riprap from at least +10 feet above mean lower low water (MLLW) to -2 MLLW, to extensive overwater structures such as piers and docks. In many places armoring goes all the way to the bottom of the water (-51 MLLW) and below to a rock key. A rock key is part of the riprapped slope that extends below the mudline at the bottom of the slope. The proposed action would expand the channel width at various points along the length of the channel and as a result require slope stabilization measures (see Figure 2 in section 1.3.2). Currently, all four locations are stabilized with small to medium sized angular rocks at a 2:1 slope (Figure 7).

The Blair Waterway, in its current congressionally authorized state, lacks high quality nearshore habitat that would provide adequate ecological function necessary to continuously support the ESA-listed species evaluated in this Opinion. The highly developed state and channelized nature of the waterway precludes utilization of the area by most species. The lack of shallow water habitats, suitable substrate, submerged aquatic vegetation, and natural cover and the intense industrial use inhibit species from using these areas as feeding, growth, and reproductive opportunities.

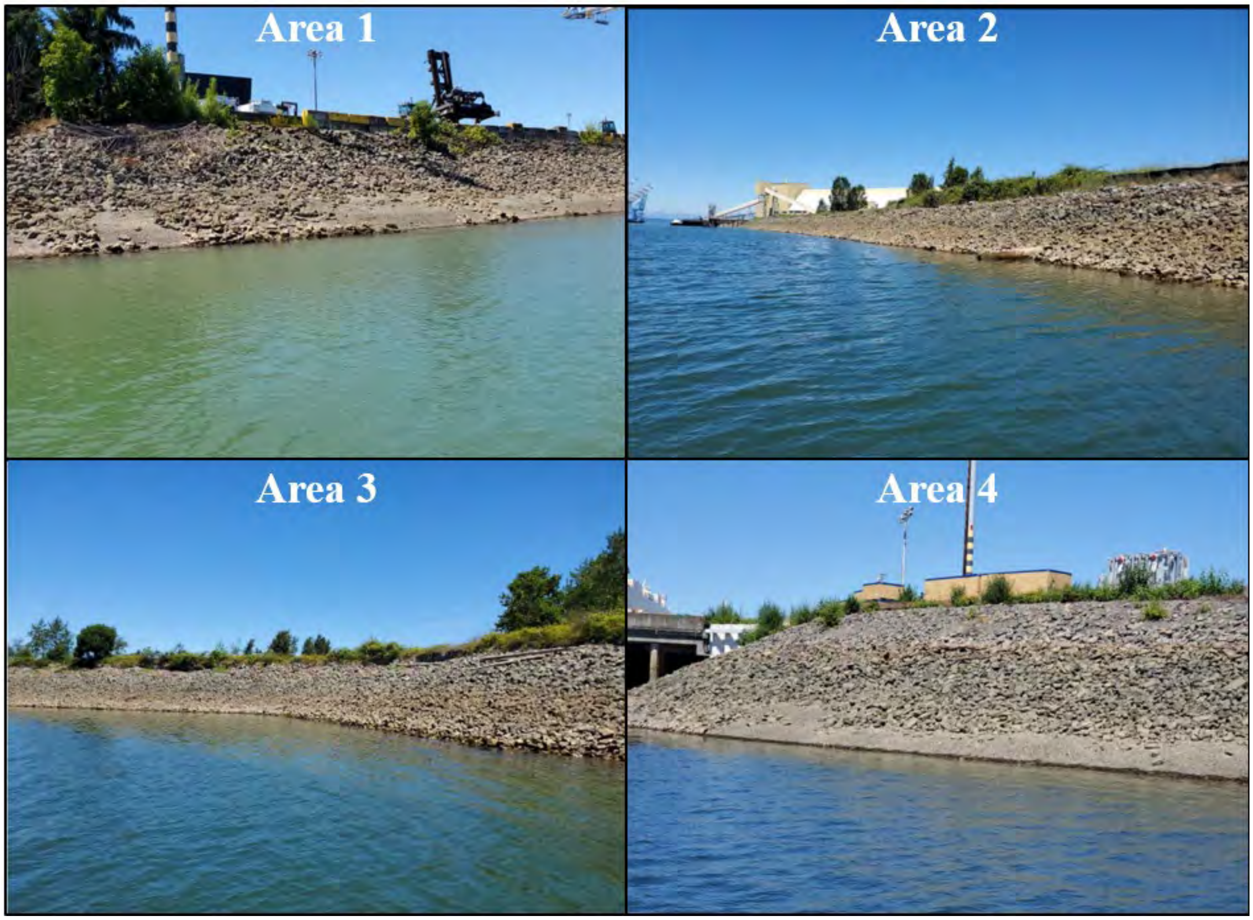

Figure 7. Current habitat conditions of Areas 1- 4 within Blair Waterway proposed added shoreline stabilization as a result of proposed channel widening. Currently, the 2:1 slopes are stabilized by riprap. Areas 1 and 4 are proposed to be stabilized using riprap. Areas 2 and 3 are proposed to be stabilized with secant wall armoring.

2.3.4 Current Status of Saltchuk

The Saltchuk site is located approximately one mile north of Blair Waterway along the shoreline. Within Saltchuk, habitat is degraded due to development of Commencement Bay and previous log storage at the site. Wood waste has accumulated over approximately 100 years and is not known to be chemically treated, and thus not a suspected source of hazardous, toxic, or radioactive waste (HTRW). Three primary locations accounting for approximately 13 percent of the total 64-acre Saltchuk site were observed to contain wood waste during a 1999 dive survey. One large area of wood waste was observed from shore during a low tide event (GeoEngineers 2014a, as cited in GeoEngineers 2015) extending from the lower shore zone to a depth of approximately -30 MLLW. The site contains approximately 53 acres of deep subtidal zone habitat (below -10 MLLW). The majority of the deep subtidal habitat at the site consists of brown and black silt with wood waste over gray clay.

Macroalgae in the lower shore zone is largely composed of sea lettuce (Ulva ssp.) and was observed at approximately the MLLW line. One patch of eelgrass was identified to the southeast of the project area near Hylebos Waterway at depths of approximately -6 feet to -10 MLLW during an August 2014 underwater video survey. Lower shore zone (LSZ) habitat (from +5 to -10 MLLW) is composed of a coarse substrate that transitions to sand and silt near MLLW.

2.3.5 Species in the Action Area

Species considered in this Opinion likely to be present during construction in Commencement Bay, Blair Waterway, or Saltchuk site include PS Chinook salmon, PS steelhead, and PS/GB rockfish (yelloweye and bocaccio).

Regular presence of either PS Chinook salmon or steelhead within Blair Waterway in high numbers is unlikely. However, based on the proximity of Blair Waterway to the Puyallup River, Hylebos Creek, and Wapato Creek, some ESA-listed Chinook salmon or PS steelhead may be present in the area during construction. Specific salmon and steelhead populations likely to be present Commencement Bay during construction include Puyallup River, Carbon River, and White River.

The Puyallup River enters Puget Sound via Commencement Bay west of Blair Waterway. Nine anadromous salmonids have been documented in the Puyallup River basin including winter steelhead, bull trout, coastal cutthroat trout, and spring/fall Chinook, fall chum, coho, sockeye, and odd-year pink salmon (Dames and Moore 1981; NWIFC 2019). Rearing and foraging by juvenile salmonids occurs along the limited shoreline areas that are shallow or retain natural structural diversity. Juvenile salmonids may use the nearshore reaches and Commencement Bay to transition into marine waters. Returning adult salmon typically congregate at the mouth of the Puyallup River prior to upstream migration.

Puyallup, Carbon, and White River salmon and steelhead are also expected to be present in Commencement Bay during construction. Puyallup River (including Carbon River fish) native-origin fall Chinook salmon abundance has been in steady decline since 2000 (Figure 8) and productivity has consistently failed to meet recovery goals since the late 1990’s (Figure 9). A similar trend has been documented in the White River spring Chinook salmon population. White River spring Chinook salmon are of significant importance because they are the only remaining spring Chinook salmon stock in the south/central Puget Sound region (Marks et al. 2018). The other concerning trend is the ratio of wild to hatchery spawners in the Puyallup Basin. Since the late 1990’s native-origin fall Chinook salmon abundance in the Puyallup River and spring Chinook salmon in the White River have been declining, meaning that populations are highly reliant on hatchery supplementation (Figure 10). PS steelhead abundance and productivity in the Puyallup Basin has slowly been improving since the mid 2000’s (Figure 11 and Figure 12). However, abundance remains well below recovery goals; the five-year geometric mean abundance is 136 compared to a recovery goal of 4,500 (Ford, in press).

Adult Chinook salmon would only hold temporarily within the waters of Blair Waterway before migrating to the Puyallup Basin, although, are not likely to be present for an extended period of time. Furthermore, Chinook salmon use of Blair Waterway is up to three times greater near the mouth of the waterway than near the head, where they are found in very low numbers (Duker et al. 1989). Similarly, juvenile Chinook salmon are not expected to spend significant time within the Blair Waterway, but could potentially rear within the nearshore waters of Commencement

Bay. No part of the waterway provides suitable spawning habitat for Chinook salmon, as the waterway is in a marine environment.

Blair Waterway has some suitable habitat for migrating adults and out-migrating juvenile PS steelhead. PS steelhead have been documented in Blair Waterway, Wapato Creek[19] (via the Blair Waterway), Hylebos Creek (via Hylebos Waterway), and Commencement Bay (SalmonScape[20]). Adult and juvenile steelhead most likely use the waterways as holding areas before they enter migration corridors. Outmigration of juveniles typically occurs between approximately the middle of March through the middle of July, and rearing juveniles could be present in Commencement Bay or adjacent waters of Puget Sound at any time of the year, including in Blair Waterway.

Hylebos Creek is a large independent drainage to the Puyallup Basin and flows from its headwaters near Federal Way into Commencement Bay via Hylebos Waterway (Figure 3). The area surrounding Hylebos Creek has been intensely developed and habitat quality is generally poor. Chinook salmon and steelhead have both been observed spawning within Hylebos Creek, although annual abundance is generally low. This suggests that a proportion of the salmon and steelhead exposed to project effects would originate from Hylebos Creek.

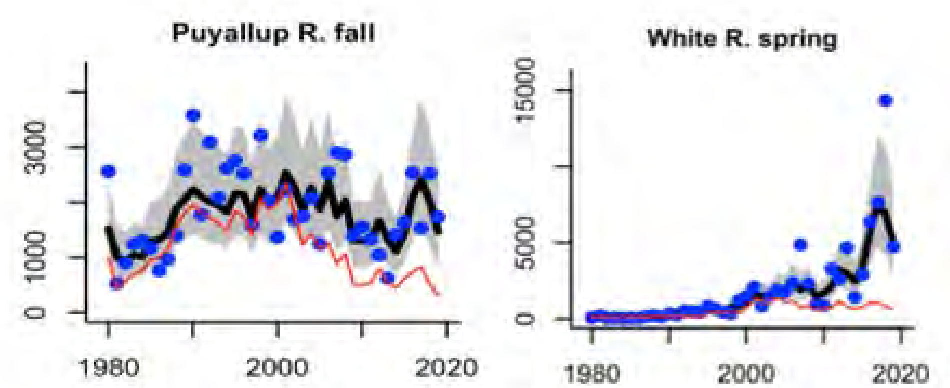

Figure 8. Smoothed trends in estimated total (hatchery and natural origin) (thick black line, with 95% confidence interval in grey) and natural (thin red line) abundance of Puyallup River fall Chinook salmon (left) and White River spring Chinook salmon (Adapted from Ford, in press).

[19] PS steelhead have not been documented in Wapato Creek for at least 20 years.
[20] http://apps.wdfw.wa.gov/salmonscape/map.html

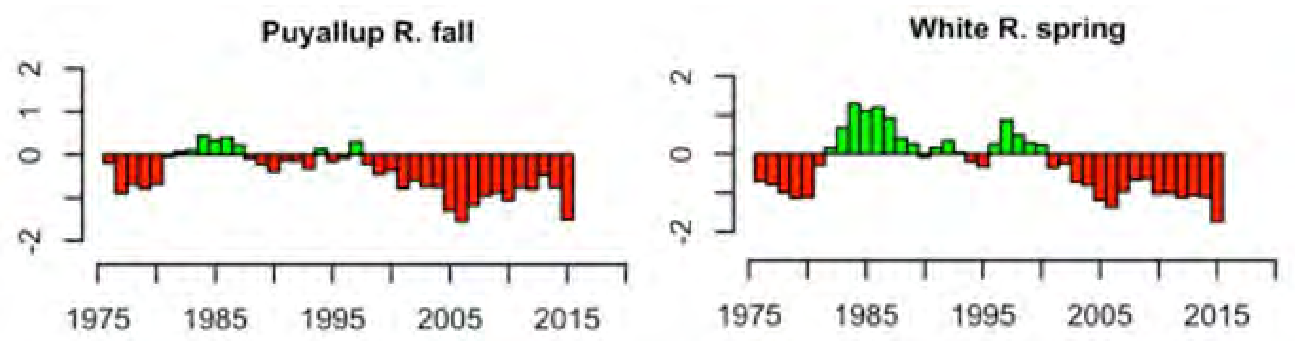

Figure 9. Annual trends in population productivity calculated as the difference of the log of the smoothed natural origin spawning abundance in year *t* and the smoothed natural origin spawning abundance in year *t* – 4 for Puyallup River fall Chinook salmon and White River spring Chinook salmon (Adapted from Ford, in press).

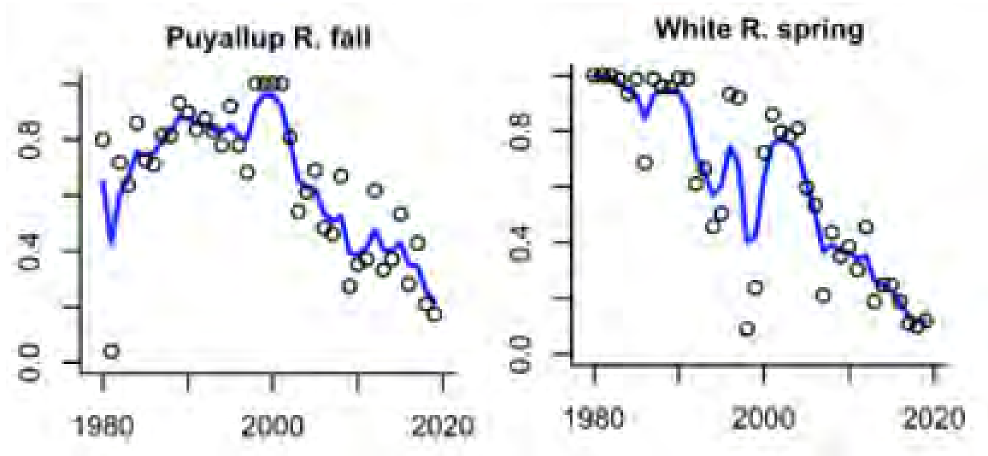

Figure 10. Smoothed trend in estimated fraction of natural-origin spawner abundances (blue line), and annual raw fraction of wild estimates (points) of Puyallup River fall Chinook salmon (left panel) and White River spring Chinook salmon (right panel) (Adapted from Ford, in press).

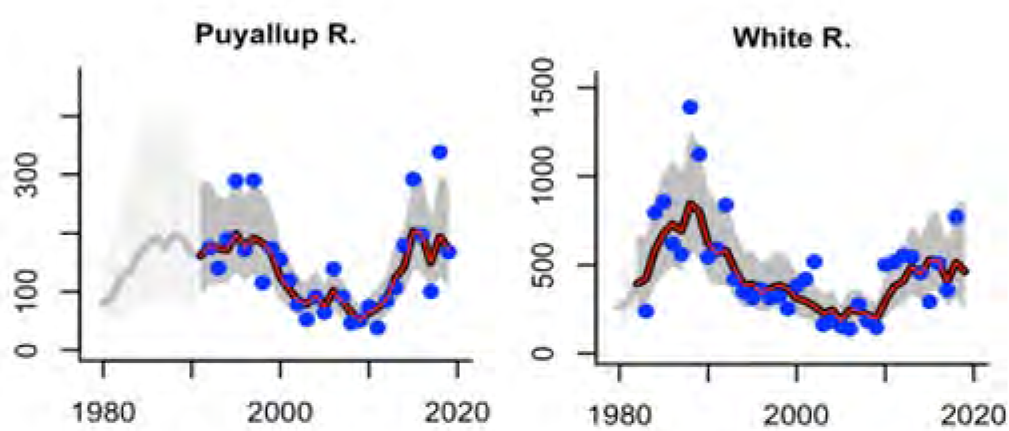

Figure 11. Smoothed trends in estimated total (thick black line, with 95% confidence interval in grey) and natural (thin red line) abundance of Puyallup River (left) and White River steelhead (Adapted from Ford, in press).

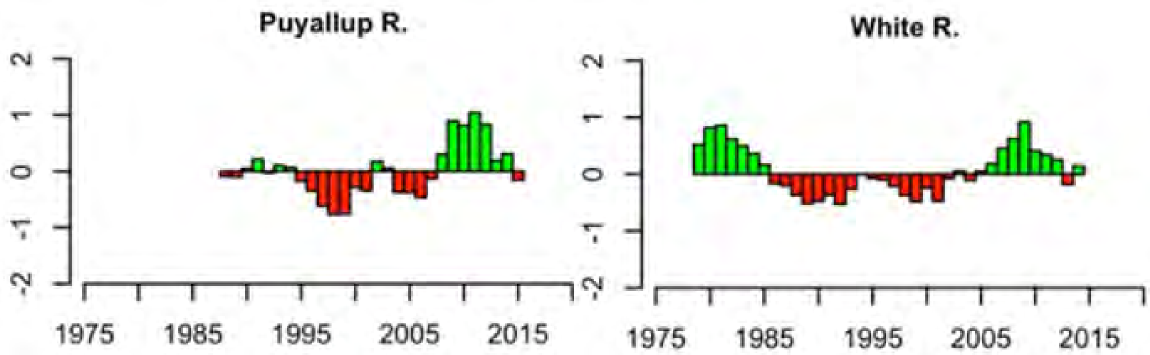

Figure 12. Annual trends in population productivity calculated as the difference of the log of the smoothed natural origin spawning abundance in year *t* and the smoothed natural origin spawning abundance in year *t* – 4 for Puyallup and White River steelhead (Adapted from Ford, in press).

Less information exists regarding the use of Commencement Bay and surrounding areas by PS/GB rockfish. The south Puget Sound Basin is within their historical range, however data is lacking to determine historical presence and abundance within the immediate project area. Adult rockfish are highly mobile and typically utilize deep water areas with large rocks and cover. Larval bocaccio and yelloweye drift for long periods before moving into rockier and deeper habitat once their swimming ability is full developed. Given the overlap of the work window with the second rockfish spawning event and the duration of time larvae drift it is likely that larval rockfish would be in the project area during construction. Larval rockfish have been documented throughout all major basins of Puget Sound (Greene and Godersky 2012).

2.3.6 Distinguishing Baseline from Effects of the Action

As described in more detail in Sections 2.3 and 2.4, the effects of an action are the consequences to listed species or critical habitat that would not occur but for the proposed action and are reasonably certain to occur. The environmental baseline refers to the condition of the listed species or its designated critical habitat in the action area without the consequences caused by the proposed action (50 CFR 402.02).

Relative to this consultation, we must distinguish the impacts from the existing operation and configuration of the congressionally authorized federal navigation channel as the baseline (which is not within the Corps' discretion to alter) compared to the time, place, and manner of the proposed construction to alter the proposed channel, any effects caused by the deepening and widening of the channel, the reduction in intermittent effects caused by marine vessels, and the beneficial use of dredge material placement at Saltchuk, all of which are within the Corps' discretion. The Blair Waterway is congressionally authorized and it is not within the Corps' discretion to modify its current configuration. Therefore, effects associated with the proposed action include those that would not occur but for the proposed action; in this case the deepening and widening of the existing federally authorized waterway, reducing vessel traffic, and placing dredged materials at the Saltchuk site.

With that understanding, the effects of the proposed action are evaluated relative to the current conditions, which include the infrastructure, shipping traffic, and regular maintenance associated with the Blair Waterway. Without the inherent infrastructure and maintenance, the federal channel would fail to operate in its current condition. The ongoing consequences to the environment resulting from the presence and operation of the facilities and structures in the federal navigation channel under the current configuration constitute the environmental baseline. These effects compromise habitat quality for listed species. Under the current environmental baseline, the federal navigation channel within the Blair Waterway would remain a highly developed area incapable of providing quality habitat for listed species.

While maintaining the current configuration of the federal channel is outside of the Corps' discretion, the manner and timing in which that maintenance occurs does fall within Corps' authority. That means the timing and methods used to maintain the proposed width and depth of the Blair Waterway is determined by the Corps and is therefore subject to future ESA Section 7 consultations. Effects of future maintenance dredging and repairs to infrastructure would be evaluated in a future consultation.

2.4 Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action (see 50 CFR 402.02). A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

The proposed action is reasonably certain to cause temporary, intermittent and enduring effects. Temporary effects include: (1) reductions in water quality from increased suspended sediment, turbidity, and contaminants; (2) increased underwater noise resulting from dredging; and (3) entrainment or strike of fish during dredging operations. These effects are likely to occur for the next four years when construction is proposed to be completed within Blair Waterway. Most effects would be expected to be localized and temporary. The proposed action is reasonably certain to cause intermittent effects, including a beneficial reduction in vessel traffic. We also evaluated the effects of an increase in vessel size for impacts to listed species. Specifically, we evaluated the potential for a change in noise, ship strikes, and wake effects on Puget Sound shorelines resulting from the proposed action. NMFS found no information that supported an increase in negative impacts to listed fish or marine mammals. Enduring effects include reductions in available benthic and forage prey resulting from disturbed benthic habitats after channel deepening and widening; however, the deposition of sediments at Saltchuk is likely to increase subtidal and intertidal habitat for juvenile salmon and juvenile bocaccio.

2.4.1 Temporary Effects during Construction

The proposed dredging project would cause direct temporary effects on the fish and habitat that are present during in-water work through exposure to dredging-related elevated noise, bucket strike or entrainment, degraded water quality, and propeller wash. The proposed dredging would also cause indirect effects on fish and habitat through forage contamination and altered benthic habitat. While we classify the following effects as temporary, we expect the effects to persist for the entirety of the annual in-water work window given that dredging work would occur nearly 24 hours a day. The continuous nature of in-water work would ensure that degraded habitat conditions would not abate until the end of the in-water work window each year (August 16 – February 15) or once the project is completed after four years. Finally, certain aspects of species and habitat recovery would not occur until after construction is completed and temporary effects cease (i.e., benthic habitat).

Water Quality

Water quality is likely to be affected during in-water work associated with mechanical dredging, shoreline stabilization, and associated vessel operation within the Blair Waterway and sediment deposition at Saltchuk. Effects to water quality during construction include increased turbidity, decreased DO, and re-suspension of unsuitable materials.

<u>*Turbidity and Dissolved Oxygen*</u>

Dredging, vessel operation, and material placement would result in increased turbidity and decreased dissolved oxygen due to suspended sediments. Coarser sediments are likely to redeposit close to the dredge location, while finer particles are likely to travel with currents and remain in suspension for longer periods of time. We expect the low current velocity in the Blair Waterway would limit the distance fine particles would travel from dredging site. Resuspension occurs with much greater severity when subsurface debris is encountered. This is due to the dredging bucket not being able to close fully (often because it is obstructed by debris) before removing sediments to the surface. A different type of clamshell bucket (environmental clamshell), which encloses unsuitable sediments is described below.

The dredging BMPs included in the proposed action (see Section 1.3.4) are expected to reduce the amount of suspended sediments to some degree. However, some resuspension of unsuitable material during dredging is unavoidable, even with implementation of BMPs. Propeller wash from vessels may also spread turbidity during construction and transport of dredged materials. Turbidity is expected to extend radially from the path traveled by the vessel but not outside of the action area based on suspended sediment plumes observed from the adjacent Puyallup River.

Suspension of anoxic sediment compounds during in-water work can result in reduced DO in the water column within the mixing zone area as the sediments oxidize. Some dredged material may contain sediment with biological and chemical oxygen demand that could temporarily lower local ambient DO levels during dredging. The upper portion of sediment is classified as loam to silt loam while native sediments are sand to loamy sand. Infaunal and benthic organisms inhabit the upper sediment, thus the likelihood of finding much anaerobic sediment in this stratum of sediment is low. Deeper sediment within the dredge prism is more likely to include anoxic compounds. Based on a review of six studies on the effects of suspended sediment on DO levels, LaSalle (1988) concluded that, when relatively low levels of suspended material are generated and counterbalancing factors such as flushing exist, anticipated DO depletion around in-water work activities would be minimal. High levels of turbidity are also expected to cause reductions in DO within the same affected area.

Clamshell dredging, material placement at Saltchuk, and installation of shoreline stabilization measures are expected to result in short-term increases in turbidity and decreases in DO in a linear plume down current from the activity. The small patch of eelgrass near the mouth of the Hylebos Waterway would be at a small risk of becoming buried under fine sediment during material placement at Saltchuk. However, water quality BMP measures described in the BA and additionally in Section 1.3.3, which limit impacts to eelgrass, would be used (e.g., turbidity curtains). The Corps has proposed to monitor turbidity while dredging to adhere to state water quality requirements outlined in the project's Water Quality Certification and would adjust construction actions based on monitoring results to remain in compliance with Washington State water quality standards.

Re-suspended Contaminants
Any sediments determined to be unsuitable for aquatic disposal would be hauled off-site to an appropriate upland disposal site (see Section 2.3.2 for a discussion on chemicals found in the waterway historically). While this removes potentially toxic sediment from the aquatic environment, some amount of resuspension would occur during the dredging process. Bioaccumulated toxins have appeared in fish tissues collected throughout the Puget Sound region, especially in urban areas (Puget Sound Action Team 2007). Concentrations of PCBs and other bioavailable contaminants in biota may increase during dredging, material placement, and installation of shoreline stabilization structures in the Blair Waterway. We anticipate that the increase in contamination concentrations in biota would be a temporary effect due to low concentration levels, which may persist until the cessation of dredging. However, longer term bioaccumulation of some contaminants in higher trophic species, such as PS Chinook salmon and SRKW are possible without strict adherence to BMPs.

Construction Contaminants
Barges and tugs would be used for dredging and material placement. Minor discharges of hydraulic fluid, oils, or fuels from construction equipment is likely to result from the proposed action. The operation of vessels at each location is likely to cause small incidental discharges caused by drippage from engines, which would introduce very small amounts of fuels, oils, or lubricants into the water. Incidental discharge of oils or fuels, and polycyclic aromatic hydrocarbons (PAHs) may also result from exhaust from these kinds of construction vessels, or from accidental introduction of oils or fuels from equipment in contact with water. Best management practices include inspecting all equipment daily for fluid leaks and each vessel would be equipped with a spill kit at all times and would minimize incidental events (see Section 1.3.4 for a list of BMPs). We expect these PAHs and other contaminants to be introduced into the water column during and immediately following the proposed activity. Because these materials can disperse quickly, they can become quite widespread at very low concentration. The environmental fate of each type of PAH depends on its molecular weight. In surface water, PAHs can volatilize, photolyze, oxidize, biodegrade, bind to suspended particles or sediments, or accumulate in aquatic organisms, with bioconcentration factors often in the 10-10,000 range. PAHs can have persistent negative effects on listed species and their critical habitats and are discussed in more detail in Sections 2.4.4 and 2.4.5. Due to the proposed BMPs, no major discharges of PAHs or other contaminants is expected to occur.

Elevated In-water Noise

Noise is expected as a short-term consequence from construction activities during in-water work to dredge and to stabilize the shoreline within Blair Waterway and placement of materials at Saltchuk. Background noise conditions within the waterway are already higher than other marine areas given the intense industrial use associated with the surrounding area.

Noise generated by clamshell dredges is characterized as continuous, since the elevated sound pressure occurs over several seconds (not milliseconds, as is the case with pulsed noise). It is assumed that clamshell dredging would generate noise levels lower than 125 dB_{RMS}. Several pieces of equipment would be operating and producing underwater noise for up to 24 hours per day during the in-water work window for up to four years. It is assumed only one dredge would be operating at a time, but would be running nearly continuously. One to two tugboats for towing barges would be transiting between the waterway and the open-water disposal site and would increase the amount of noise in an area surrounding each construction site and their transit paths. Tugboats have a dominant frequency range of 100-500Hz with a peak output at 170d_{BRMS}. A survey vessel would slowly transit the area to measure dredging progress. Since the aquatic habitat in the waterway is 200 to 250 meters wide (650 to 820 feet wide), even when the dredge is in the center of the channel, there would be a large area available for avoidance of harassment noise levels. Construction generated sound would be attenuated by the surrounding land limiting the radial extent of the elevated noise. Additionally, given that listed species are only expected to be in the Blair Waterway in very low abundances only a small number of fish would be at risk or exposure.

Elevated noise would also occur during installation of shoreline stabilization structures. Secant walls would be installed using augering methods as opposed to impact or vibratory methods, so as to minimize noise during installation. Drilling (augering) is considered a continuous, non-impulsive noise source (NMFS 2020). Dazey et al. (2012) compared vibratory and auger drilling methods and found no significant difference between the two methods. The Corps found as part of a previous evaluation in the Blair Waterway that noise levels were not expected to exceed 160 dB_{RMS} when driving 12-24 inch concrete piles using vibratory methods (BergerADAM 2012). This suggests that augering would result in less noise than alternative methods and remain well below noise thresholds harmful to fish. Area 2 and 3 are located well within the waterway, which would contain drilling noise to the immediate vicinity of the installation site. Site 2, the area closest to the mouth of the Blair Waterway where marine mammals (especially those listed under the ESA) are more likely to be present than inside the waterway, is about 2,200 meters from the mouth of the waterway. Finally, the current 2H:1V riprap slope would attenuate drilling noise as dredging and slope regrading would occur after secant walls are installed. Placement of riprap at areas 1 and 4 is not expected to generate significant noise. Given the high background noise associated with the waterway, the level of noise expected during augering, the amount of time required for installation, and proposed locations within the waterway we do not expect noise to reach harmful levels or to extend outside of the waterway into Commencement Bay.

Forage and Prey Reduction

Removing bottom substrate in Blair Waterway would simultaneously remove the benthic communities that live within those sediments and reduce prey availability in the footprint of the dredge. Among prey fishes, short-term and intermittent exposure to reduced water quality could result in minor reductions in forage species via gill damage of forage fishes. Suspended sediment would eventually settle in the area adjacent to the dredge prism, which can disrupt benthic prey species, and if the sediments are contaminated, then sublethal toxicity of benthic prey species could occur. These prey then can become a source of bioaccumulation when exposed to toxins, which can degrade the quality of the prey species for salmonids and SRKW. Prey is expected to be reduced in total abundance and in quality during and following construction, and this diminishment would persist for weeks to months after dredging is completed.

Placement of dredged material at the Saltchuk site would likely kill invertebrates present where the bulk of material lands. Negative effects of disposal events include increased turbidity and burial. While turbidity increases dramatically during deposition events, the effects are expected to be transitory (Roegner et al. 2021) and larger organisms would generally be able to flee the area. Sediments would be a similar type and coarseness as what is already present at the site; generally fine grained and silty sand (see section 2.3.2). Other areas with wood waste or fine material would be covered by native material. Covering the wood waste with native material may initially harm habitat during early consolidation because any infauna and epifauna would be exposed to the pore water forced upwards from the wood waste below. Depending on the nature of the disposal material, and the wood waste being covered, this may be a transient, short-lived effect. The overall depth of the area would be reduced to provide shallow water habitat for juvenile salmonids and rockfish. In a relatively short period, organisms from adjacent non-disturbed areas would reestablish in the placement area.

Entrainment and Strike

In this context, entrainment refers to the uptake of aquatic organisms by dredge equipment. Dredge buckets entrain slow-moving and sessile benthic epifauna along with burrowing infauna that are removed with the sediments as well as algae and aquatic vegetation. There is little evidence of mechanical dredge entrainment of mobile organisms such as fish. In order to be struck by or entrained in a dredge bucket, an organism must be directly under the bucket when it drops. The small size of the bucket, compared against the distribution of the organisms across the available habitat make this situation unlikely. That likelihood would decrease after the first few bucket cycles, because mobile organisms are most likely to move away from the disturbance. Further, dredges move very slowly during dredging operations, with the excavator typically staying in one location for many minutes to several hours, while the bucket is repeatedly lowered and raised within an area limited to the range of the crane arm.

Fish that become captured within a digging bucket (entrainment) or that are struck by the bucket as it descends would likely be killed. However, the documented occurrence of these events for mobile fish species are extremely rare. In the Southeast Region of the US, where closely monitored heavy dredging operations occur regularly in areas inhabited by sturgeon and sea turtles, only two live sturgeon (NMFS 2012) and two live sea turtles (NMFS 2011) are known to have been entrained by clamshell dredging since 1990. However, in recent (2019) dredging in Grays Harbor, Washington, a shark or skate was entrained and killed during hydraulic hopper dredging (USACE 2021b). Hydraulic hopper dredging is different than other dredge methods in that the hopper dredge operates for prolonged periods, generating continuous fields of suction forces around and under the dragheads as they are pulled along the substrate at relatively high speeds (NMFS 2018b). Due to differences in methodology the likelihood of entrainment or strike during mechanical dredging is unlikely; small bucket footprint, operation from a stationary crane position, and slow vertical bucket movements decrease risk of entrainment.

2.4.2 Intermittent Effects

Reduced Vessel Traffic

During consultation, NMFS identified current vessel use associated with the existing operation and configuration of the federal navigation channel as part of the environmental baseline (See Section 2.3). Because the deepening of the channel would allow larger vessels to use the Blair Waterway with fewer overall vessel trips, the proposed action would result in a reduction of vessel traffic throughout the action area. A reduction in vessel traffic would result in positive impacts in the Port, Commencement Bay and the shipping channels of Puget Sound. These positive effects, include a reduction of: (a) water quality impacts from vessel use; (b) reduced noise from vessel operation; (c) reduced scour from vessel operation; and (d) a reduction in risk of marine mammal strikes.

The proposed action is estimated to result in about 27% fewer vessel trips to transport the forecasted cargo in 2030 (Table 3). A similar reduction in vessel trips is predicted for 2035 (28%). Reduction is vessel trips would mean reduced underwater noise throughout the central and northern half of Puget Sound on a daily basis, year-round. Specifically, fewer Post Panamax and Super Post-Panamax vessels would call to the Blair Waterway once channel deepening and widening is completed (Table 3). Ultra Post and New Post Panamax vessel calls would remain the same after the channel deepening and widening action is completed. However, it is unclear how long this beneficial effect would last because human population in the Puget Sound and along the west coast is expected to continue to grow and would likely cause shipping demands to increase. In fact, according to the analysis of vessel traffic completed by the Corps, traffic is expected to increase, regardless of channel depth, by 8% from 2030 to 2035. This suggests that over the 50-year period analyzed here vessel traffic could increase by nearly 75% by 2080 (assuming an annual increase of 8% every 5 years). However, based on the Corps' analysis this level of growth would also occur under current channel conditions. The proposed action would cause fewer vessels to be used despite the increased shipping demands. This is discussed in more detail in the Cumulative Effects section (2.5).

As explained above, because the action will enlarge the existing channel, we expect larger vessels to use the waterway, which will result in a decrease the overall number of vessels. We evaluated whether a shift to larger vessels may cause effects on species or habitat, including the potential for a change in noise, ship strikes, and wake effects on Puget Sound shorelines and concluded it would not. We reviewed Coast Guard guidance and regulations governing the safe passage of these vessels (USCG 2019), along with other available information. We found insufficient data to indicate that the larger vessels would cause an increase in negative impacts to listed fish or marine mammals. Therefore, we conclude that any impacts resulting in noise, vessel strikes on marine mammals, and wave height impacts to shorelines will not change compared with the current baseline conditions.

In summary, the proposed action would widen and deepen the federal navigation channel in the Blair Waterway. The action would allow larger vessels, which are capable of carrying more cargo than smaller vessels, to call at the Port of Tacoma. As a result, vessel trips are expected to decrease, at least through 2035. At the same time, vessel traffic overall is expected to increase as a result of increasing demand for products and commodities in the Pacific Northwest. However, that increase does not result from the proposed action, and is expected to be smaller than it would be without the proposed action.

2.4.3 Enduring Effects

Several enduring effects are expected to result from the proposed action including disruption of benthic and shoreline margin productivity within Blair Waterway and improved nearshore habitat quantity and quality at Saltchuk.

Disrupted Habitat Processes – Channel Deepening

The existing channel depth is -51 feet MLLW (environmental baseline), and the proposed action will deepen the Blair Waterway to a depth of -57 feet MLLW. Substrate composition includes sand and silt intermixed with gravel. The proposed dredging of 6 feet is not expected to alter substrate composition or sizes of those materials. However, areas where sediment is removed by dredging will greatly reduce benthic prey communities. The speed of recovery by benthic communities is affected by several factors, including the intensity of the disturbance, with greater disturbance increasing the time to recovery. Additionally, the ability of a disturbed site to recolonize is affected by whether or not adjacent benthic communities are nearby that can recolonize the affected area, and the composition of the species that recolonize the area may differ from a less frequently perturbed area, as disturbances caused by dredging may lead to a decline in sensitive species, to be subsequently replaced by more tolerant species (Ceia et al. 2013). The available information to describe ecosystem responses to dredging indicates that little recovery occurs during the first seven months after dredging. After that, early successional fauna would begin to dominate over the next six months (Jones and Stokes 1998). During that time, the resulting loss of benthic invertebrates reduces the availability of their larvae, as well as the availability of copepods, daphnids, and larval fish that prey on them, which in turn are prey for juvenile salmon (NMFS 2006a).

Disrupted Habitat Processes – Channel Widening

Other than the temporary loss of benthic invertebrates, the proposed widening of the federal navigation channel is not expected to reduce habitat quality for salmonids or rockfish. This is because the navigation channel is not nearshore habitat and under the current environmental baseline, could not return to nearshore habitat. Increasing the depth of deep-water habitat that might provide marginal migration and foraging areas for salmon and rockfish does not result in a loss of habitat quality.

Disrupted Habitat Processes – Shoreline Stabilization

Approximately 2,500 feet (762 meters), around 8% of the shoreline in the federal navigation channel, would require replacement shoreline stabilization to support channel widening efforts. Areas 1 and 4 would require rock-toe riprap armoring and areas 2 and 3 would require secant wall armoring (Figure 2 and Figure 7). Currently, all four areas are armored with riprap and slopes are approximately 2H:1V (Figure 2 and Figure 7). Installation of replacement riprap at areas 1 and 4 would modify slopes to 1.5H:1V and secant wall installation at areas 2 and 3 would maintain 2:1 slopes waterward of the new secant walls. The impacts of hard armor along shorelines are well documented. Armoring of the nearshore can reduce or eliminate shallow water habitats via two distinct mechanisms. First, bulkheads cause a higher rate of beach erosion waterward of the armoring because there is higher wave energy, compared to a natural shoreline. This leads to beach lowering, coarsening of substrates, increases in sediment temperature, leading to reductions in primary productivity and invertebrate density within the intertidal and nearshore environment (Bilkovic and Roggero 2008; Fresh et al. 2011; Morley et al. 2012; Dethier et al. 2016). As a result of deepening of the intertidal zone adjacent to the bulkhead, as well as increased wave energy, bulkheads also reduce SAV (Patrick et al. 2014). Reduced SAV can reduce spawning habitat (i.e., eelgrass) for Pacific herring, another forage species of Chinook salmon and juvenile PS/GB bocaccio. Reduced SAV also diminishes habitat for juvenile rockfish, which in their pelagic stage rely on SAV for prey and cover for several months. Under baseline conditions, SAV is very limited within the channel and implementation of the proposed shoreline stabilization is unlikely to further reduce SAV density or abundance from its current state. Additionally, shoreline armoring under the proposed action is unlikely to erode current shorelines in the Blair Waterway because those slopes are already heavily armored under the current Congressional authority.

Second, shoreline armoring located within the intertidal zone (below HAT) prevent upper intertidal zone and natural upper intertidal shoreline processes such as accumulation of beach wrack (Sobocinski et al. 2010; Dethier et al 2016). This is an additional mechanism that reduces primary productivity within the intertidal zone and diminishes invertebrate populations associated with beach wrack (Sobocinski et al. 2010; Morley et al. 2012; Dethier et al. 2016). Reductions in forage from shoreline armoring then affects primary productivity and invertebrate abundance in both the intertidal and nearshore environments. Invertebrates are an important food source for juvenile PS/GB bocaccio and PS Chinook salmon and for forage fish prey species of salmonids. However, in this case these natural tidal processes and primary productivity are already severely diminished given the intense industrial development and use within and surrounding the channel.

Commonly, beach erosion is increased by wave energy adjacent to shoreline armoring structures, which prevents the delivery of upland sediment from reaching the beach and erodes sediment waterward of armoring structures. Finer material like gravel and sand provide important spawning substrate for sand lance and surf smelt. Therefore, a reduction of this substrate type within the intertidal and nearshore zone as a result of armoring would reduce potential spawning habitat availability and fecundity of both species (Rice 2006; Parks et al. 2013), which are both important prey species for ESA-listed salmonids. Thus, the loss of material below armoring, together with the loss of upland sources of material from above the armoring, over time, can affect the migration and growth of juvenile salmonids (primarily PS Chinook salmon) by reducing the amount of available shallow habitat that juveniles rely on for food and cover, and by preventing access to habitat upland of armoring at high tides. Both salmonids and juvenile bocaccio are affected by the loss of prey communities. However, current shoreline habitat in the Blair Waterway is fully developed and would not deliver suitable forage fish spawning habitat if the proposed action were not to occur.

Along with the physical loss of habitat, the impacts of nearshore modification commonly include the loss of functions such as filtration of pollutants, floodwater absorption, shading, sediment sources, and nutrient inputs. Shoreline armoring generally reduces the sediment available for transport by disconnecting the sediment source, e.g. a feeder bluff, from the drift cell, potentially causing loss of beach width and height as transport of material outpaces supply. This can occur at the site of the structure or down the drift cell. Structures in the intertidal zone change the hydrodynamics of the waves washing up on the beach. Hard structures reflect waves without dissipating their energy the way a natural beach would, especially if vegetation is present. This energy can lower the beach, make it steeper, and wash away fine sediments. Dikes and fill reduce estuarine wetlands and other habitat for salmon, forage fish, and eelgrass.

When the physical processes are altered, there is also a shift in the biological communities. The number and types of invertebrates, including shellfish, can change; forage fish lose spawning areas; and juvenile salmon and forage fish lose the feeding grounds that they use as they migrate along the shore (Shipman et al. 2010). Native shellfish and eelgrass have specific substrate requirements and altered geomorphic processes can leave shellfish beds and eelgrass meadows with material that is too coarse or with too much clay exposed. Shoreline armoring can also physically bury forage fish spawning beaches when structures are placed in or too close to the intertidal zone. When shoreline development removes vegetation, the loss of shading and organic material inputs can increase forage fish egg mortality (Penttila 2007). Surf smelt, for example, use about 10 percent of Puget Sound shorelines for spawning and many bulkheads are built in forage fish spawning habitat, threatening their reproductive capacity (Penttila 2007). The effects of nearshore modification cascade through the Puget Sound food web. The consequences can be seen in the population declines of a variety of species that depend on these ecosystems, from shellfish, herring, and salmon to orcas, great blue heron, and eelgrass.

Habitat conditions within the federal navigation channel are poor and provide little utility for salmonids or rockfish. However, the proposed stabilization measures would further degrade habitat relative to current conditions. Specifically, shoreline slopes would become steeper as a result of the action in areas 1 and 4, where slopes would increase to 1.5H:1V from 2H:1V. Increased slopes would result in reduced wave attenuation and increased energy and erosion rates. Wave attenuation would decrease along riprap armored shore and would reduce habitat for benthic invertebrates by increasing scour along the shoreline.

Improved Habitat Quantity and Quality at Saltchuk

Beneficial use of dredged material at Saltchuk is expected restore nearshore intertidal and subtidal habitat substrate conditions. Based on the capacity of Saltchuk, the quantity estimated for nearshore placement is approximately 1.8 million cubic yards from the Blair Waterway, to convert approximately 40.9 acres of deep zone (DZ) habitat to lower shore zone (subtidal and intertidal habitat). At full build-out, the shallow subtidal bench would start at approximately -10 MLLW and slope gradually up to approximately -6 MLLW across the bench. Eelgrass may establish in this area naturally from the nearby eelgrass patch. Increasing eelgrass habitat would increase potential spawning habitat for Pacific herring and create important nursery habitat for other marine species including ESA-listed salmonids and rockfish. Target species to benefit from the material placement include juvenile and adult Chinook salmon, adult and juvenile PS steelhead, and larval and juvenile PS/GB bocaccio as well as other ESA-listed species, like bull trout.

Although a relatively long-term and enduring benefit, the sediment placement at Saltchuk is only proposed during the four years of proposed dredging. For the purposes of this analysis, NMFS assumes that over time the benefits would likely diminish as sediment is transported to other areas via currents and tidal fluctuations. The beneficial effects of placing materials at the Saltchuk site would slowly diminish over time under erosion pressures from vessel traffic and natural wave energy if not maintained to a point that natural processes are self-sustaining[21]. As described in Section 1.3.2, NMFS assumes that a fully developed Saltchuk site plan is reasonably likely to occur in collaboration with NMFS and the non-federal sponsor; however, insofar as the project details are unavailable for analysis, we assume that the deposit of beneficial use sediment will occur at the Saltchuk site, but we do not assume that the site will remain for more than 50 years or develop into a fully restored site without future efforts.

2.4.4 Effect on Critical Habitat

Critical habitat for PS Chinook salmon is designated within the action area and would be impacted by temporary and enduring effects of the proposed action. Critical habitat for PS steelhead, PS/GB bocaccio and PS/GB Yelloweye rockfish has not been designated in the Blair Waterway or at the Saltchuk site. NMFS reviews the proposed actions effect on critical habitat by examining how the PBFs of critical habitat would be altered, the duration of such changes, and the influence of these changes on the potential for the habitat to serve the conservation values for which it was designated.

PBFs of nearshore habitat for PS Chinook salmon include complexity, absence of artificial obstructions, natural cover, adequate water, and high water-quality. The nearshore environment supports various life stages of PS Chinook salmon including growing and sexually maturing adults, migrating spawners, and rearing and growing juveniles.

The proposed action would occur for four years between August 16 and February 15. Dredging, shoreline stabilization, and material placement at Saltchuk would disturb bottom substrates, causing temporary effects to the following PBFs of critical habitat for PS Chinook salmon:

1. Estuarine areas free of obstruction and excessive predation with: water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater;
2. Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and
3. Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Intermittent and enduring effects to PS Chinook salmon critical habitat include reduced vessel traffic and increased nearshore habitat quantity and quality at Saltchuk, respectively. Other than the temporary loss of benthic invertebrates, the proposed widening and deepening of the federal navigation channel is not expected to reduce habitat quality for salmonids. This is because the

[21] Further modeling and analysis during PED may provide additional information to inform this assumption. Moreover, monitoring of the site would provide important data on how the site changes over time and whether sediment remains in place.

navigation channel is not currently nearshore habitat, and under the current environmental baseline, could not return to nearshore habitat. Increasing the depth of deep-water habitat that might provide marginal migration and foraging areas for salmon does not appreciably result in a loss of habitat quality; and widening the channel actually provides more habitat that can be occupied by salmon and rockfish, albeit that habitat is of very limited quality.

Water Quality

Turbidity and Dissolved Oxygen
Dredging would degrade water quality in the Blair Waterway surrounding the area actively being dredged by temporarily elevating suspended sediments and turbidity and decreasing DO. We do not expect water quality degradation to extend past the 3-mile radius that would be affected by dredging, disposal, and construction. Similar water quality degradations are expected at Saltchuk during material placement. Dredging in Blair Waterway and material placement at Saltchuk is not expected to cause measurable changes in water temperature and salinity. Turbidity, suspended sediments, and DO are expected to return to baseline within a matter of days after work ceases. However, given that the dredging equipment is expected to operate continuously throughout the in-water work window (August 16 – February 15) water quality would remain degraded for a significant portion of the year and likely preclude fish access to Blair Waterway and Saltchuk by disrupting passage until construction is completed each year. As such, elevated turbidity and reduced DO would force any fish utilizing the Blair Waterway or Saltchuk restoration site to seek suitable habitat elsewhere. These sites are unlikely to return to baseline conditions until after work ceases in February at the conclusion of each construction year and fish would not be expected to return until baseline conditions return. The Corps would work with the Washington Department of Ecology for certification under Section 401 of the Clean Water Act to ensure the project meets state water quality standards and area of mixing are minimized to less than 300-feet.

Suspended Contaminants
Contaminants held in benthic sediments unsuitable for aquatic disposal would be re-suspended into the water column during dredging activities. This aspect of water quality degradation would temporarily impair the value of critical habitat for growth and maturation of juvenile salmonids during the in-water work window (August 16 – February 15) by exposing them to pollutants with both immediate and latent health effects, and could incrementally impair forage/prey communities that are exposed to the contaminants, delaying the speed that these communities re-establish after being physically disrupted by dredging. This impairment of the water quality PBF is also expected to persist for the duration of annual in-water work due to the continuous operation of dredging and construction equipment. Even though suspended contaminants typically resettle in the benthos after a short period of time (hours to days depending on currents) the continuous operation of dredging and construction equipment would ensure that benthic sediments and any associated contaminants remain suspended until sufficient time has passed following cessation of construction to allow contaminants to redeposit in benthic sediments. This temporary impairment results in adverse effects to water quality PBFs for PS Chinook salmon.

Forage and Prey

Designated critical habitat for PS Chinook salmon would experience temporary declines in forage and prey communities.

Dredging and material placement would disturb sediment, and consequently disrupt the benthic communities that live within those sediments, reducing prey availability in the footprint of the dredging area and adjacent areas where suspended sediment settles out. Among prey fishes, short-term and intermittent exposure to reduced water quality could result in minor reductions in juvenile salmonid prey species via gill damage to forage fishes. Suspended sediment would eventually settle out in the area adjacent to dredged sites, which can smother benthic prey species. Additionally, if the sediments are contaminated, then sublethal toxicity effects of benthic prey species may occur.

Dredging activities cause short-term changes in the characteristics of the benthic in-faunal biota, of which the majority are expected to recover within a few months to two years after dredging is completed. For example, Romberg et al. (2005), studying a subtidal sand cap placed to isolate contaminated sediments in Elliott Bay, identified 139 species of invertebrates five months after placement of the cap. The benthic community reached its peak population and biomass approximately two and one-half years after placement of the cap, while the number of species increased to 200 (Wilson and Romberg 1996).

In this case, because dredging within Blair Waterway is expected to take four years, as is the associated placement of dredged material at Saltchuk, recovery of benthic communities within the impacted areas to baseline conditions is unlikely to begin until after the project is completed. This means that full recovery may not occur until two years after completion of the project. While disruption of the benthic environment in the Blair Waterway would be temporary and recover to baseline in a manner of months to years after the project is completed, the benthic communities would be impaired during that time resulting in adverse effects to the forage and prey PBF of salmon critical habitat.

Conversely, over months to one year, material placement at Saltchuk is expected to improve critical habitat conditions for benthic communities and forage fish, providing a positive impact on the quality of PS Chinook salmon critical habitat at Saltchuk (discussed in more detail in the Effect on Species section below). Overtime, the beneficial use of dredged materials at Saltchuk would increase prey base, increase forage opportunities, create new rearing habitat and cover opportunities, and improve migratory pathways for juveniles and adults. While benefits may be realized within months of material placement, it would take several years with additional restoration to be fully functional. Additional restoration measures, such as establishing aquatic vegetation or supplementing the sediment through time, would be necessary to achieve full restoration potential of the Saltchuk site. Without additional maintenance and restoration measures, we expect the benefits of material placement at Saltchuk to diminish during the 50-year period analyzed in this Opinion as sediment is transported by currents and tidal fluctuations.

Degraded Shoreline Habitat

Bank armoring degrades sediment conditions, forage base, and access to shallow water waterward of the structures. Armoring also prevents access to forage and shallow water habitat upland of the structures during high tides. Shoreline armoring is extensive in urban areas worldwide, but the ecological consequences are poorly documented. A study by Morley et al. (2012) mapped shoreline armoring along the Duwamish River estuary and evaluated differences in temperature, invertebrates, and juvenile salmon diet between armored and unarmored intertidal habitats. Epibenthic invertebrate densities were over tenfold greater on unarmored shorelines and taxa richness double that of armored locations. Over 66 percent of the Duwamish shoreline is armored, similar to much of south and central Puget Sound, the impacts from armoring, and denying access to potential food sources, can effect overall fish health, growth, and survival.

As described above, shoreline armoring typically coarsens sediments waterward of shoreline armoring by concentrating marine energy and washing away finer sediments. Because armoring located within the intertidal zone (below HAT) would typically prevent upper intertidal zone and natural upper intertidal shoreline processes such as deposition and accumulation of beach wrack from occurring a reduction of primary productivity within the intertidal zone and diminish invertebrate populations would be expected (Sobocinski et al. 2010; Morley et al. 2012; Dethier et al. 2016). Reductions in forage may result from armoring effects on primary productivity and invertebrate abundance in the intertidal and nearshore environments. Invertebrates provide an important food source for juvenile PS Chinook salmon and for forage fish prey species of salmonids. Under the degraded and industrialized condition of the Blair Waterway, both physical and biological conditions are unlikely to be severely changed as a result of the proposed action.

The loss of marine shoreline material, over time, can affect the migration areas of juvenile salmonids by reducing the amount of available shallow habitat that juveniles, both by steepening shore areas waterward of armoring, and, particularly during high tides, creating a physical barrier that obstructs water from reaching high shore areas.

While the amount of shoreline habitat providing any value to listed species in the navigation channel is extremely limited, the installation of shoreline armoring would degrade shoreline areas further by slightly increasing channelization and erosion. The riprap may provide some substrate for macroinvertebrates, cover and forage opportunities for juvenile salmonids and rockfish, and the shallower slope reduces predation risk. The proposed 1.5H:1V riprap armoring at areas 1 and 4 would not change habitat conditions substantially from current conditions. In summary, the degraded and industrialized baseline condition of the Blair Waterway is unlikely to change physical and biological conditions as a result of the proposed action, although these actions will continue to prolong recovery of listed populations in the action area.

Summary of Effects to Critical Habitat

Impairment to PS Chinook salmon PBFs would result from temporary adverse effects to water quality, including turbidity, low DO, and re-suspending unsuitable sediments. Within months to one year, material placement at Saltchuk is expected to improve critical habitat conditions for PS Chinook salmon PBF. Over a period of years to a few decades, the beneficial use of dredged materials at Saltchuk would increase prey base, increase forage opportunities, create new rearing habitat and cover opportunities, and improve migratory pathways for juveniles and adults.

2.4.5 Effects on Species

Effects on listed species is a function of (1) the numbers of animals exposed to habitat changes or effects of an action; (2) the duration, intensity, and frequency of exposure to those effects; and (3) the life stage at exposure.

As noted above, the project has temporary, intermittent, and enduring effects. Our exposure and response analysis identifies the multiple life stages of listed species that use the action area, and whether they would encounter these effects, as different life-stages of a species may not be exposed to all effects, and when exposed, can respond in different ways to the same habitat perturbations.

Period of Exposure and Species Presence

Dredging would occur throughout the in-water work window of August 16 through February 15 for up to four years to achieve target depths. The in-water work window co-occurs with the presence of various PS Chinook salmon and PS steelhead life stages in Commencement Bay and its tributaries including the Puyallup River, Hylebos Creek, and Wapato Creek (Table 10).

Table 10. Expected use of the Commencement Bay and Blair Waterway action areas by listed species. Spring Chinook salmon are exclusive of the White River, while fall Chinook salmon and winter steelhead are widely dispersed throughout the greater Puyallup River basin.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
IWWW												
Spring Chinook			Adult Migration									
	Juvenile Migration											
Fall Chinook						Adult Migration						
	Juvenile Migration											
Winter Steelhead	Adult Migration											
			Juvenile Migration									
Rockfish			Juveniles					Juveniles				

<u>Chinook salmon</u>
Two distinct populations of Chinook salmon are present in the Puyallup River Basin: White River spring Chinook and Puyallup River fall Chinook salmon. White River spring Chinook salmon are the only remaining spring stock in the south/central Puget Sound region (Marks et al. 2018, Ruckelshaus et al. 2002, NWFSC 2015, and Ford, in press). Adult spring Chinook salmon migrate through Commencement Bay to the Puyallup River as early as March or April, while adult fall Chinook salmon generally enter the Puyallup River June through early November on their way to spawning habitat (Marks et al. 2018) (Table 10). Adults are expected to occur in the

deep, open-water areas around the Blair Waterway and in Commencement Bay during the winter of their upstream spawning migration. Adult fish would typically be oriented to the outflow of the Puyallup River. The work window avoids spring Chinook salmon presence, but does not avoid all exposure in the fall (between August 15 and November).

Juvenile Chinook salmon typically use shallow water marine habitat to rear, grow, and feed. These components were mostly eliminated by the industrial development and use of the estuary. Juvenile salmonid trapping by the Puyallup Tribal Fisheries Department observed juvenile Chinook salmon emigrating from the lower Puyallup River (River Mile 10.6) as early as January and as late as August, although the peak outmigration is typically late May (Marks et al. 2018) (Table 10). Historic beach seine sampling (1980-1995) in the Blair Waterway generally captured juvenile Chinook salmon after mid-February and before mid-August, with a peak around the end of May (Pacific International Engineering 1999). Additionally, data suggests that Chinook salmon fry and sub-yearlings that out-migrate past the Puyallup River before June spend more time in the lower Puyallup River to become acclimated to the salinity, and fish that move into Commencement Bay before reaching 55 mm have a higher mortality than larger juveniles later in the season (Marks et al 2018). The proposed dredging to occur in January and February would have limited overlap with early-migrating juvenile Chinook salmon because many would still be rearing in the lower Puyallup River. The proposed work window would minimize overlap of temporary construction effects with outmigrating and rearing juvenile Chinook salmon in the Blair Waterway and Commencement Bay, but would not avoid all exposure.

<u>PS Steelhead</u>

Two distinct populations of steelhead occur in the Puyallup Basin: 1) Puyallup/Carbon winter steelhead and 2) White River winter steelhead (Hard et al. 2015; WDFW 2015). These populations typically enter the river in January and then hold throughout the river until moving to spawning grounds between March and June (NMFS 2005b) (Table 10). However, a few summer-run strays, likely from the Green or Skykomish rivers, are caught annually during August and September in the lower Puyallup (Marks et. al 2014). Mainstem spawning occurs as low as RM 10 in the Puyallup River and RM 3 on the Carbon River (Pierce County 2013). Adults are expected to occur in the deep, open-water areas around the Blair Waterway during the winter of their upstream spawning migration, and would be oriented to the outflow of the Puyallup River.

Juvenile steelhead outmigration in the Puyallup River system generally occurs between April and July (Berger et al. 2011) (Table 10). However, steelhead smolts have been found in low abundances in the marine nearshore, outside of their natal estuary, between May and August (Brennan et al. 2004), which overlaps about 2 weeks with the in-water work window. Juveniles are not anticipated to be in the nearshore zone of the project area in large numbers because the majority of steelhead smolts migrate directly to the open ocean and do not rear extensively in the estuarine or coastal environments (Burgner et al. 1992; Goetz et al. 2015). The proposed work window would minimize overlap of temporary construction effects with the presence in nearshore habitat of juvenile PS steelhead in the action area, but would not avoid all exposure.

Rockfish
Larval rock fish presence peaks twice in the spawning period, once in spring and once in late summer (Table 10). As described in the Species Status section (2.2.1) PS/GB bocaccio frequently utilize nearshore environments during larval and juvenile life stages. Studies have observed rockfish larvae at the Commencement Bay open-water disposal site during the proposed in-water work window (August 16 through February 15), suggesting larvae may be present during dredging and material placement at Saltchuk (Greene and Godersky 2012; NMFS 2015). The in-water work window avoids the earliest and largest density peaks of rockfish in April and August. Observations of rockfish larvae density at the Commencement Bay open water disposal site between April 2011 and February 2012 reached 150 larvae per 1,000 cubic meters in May, 100 larvae per 1,000 cubic meters, and fell to zero in the winter (Greene and Godersky 2012) (Figure 13).

The presence of adult PS/GB bocaccio and yelloweye rockfish in the action area is extremely low. Suitable habitat is extremely limited in the work area for is this life stage as preferred habitat depths and features such as rugosity are lacking. Adult rockfish are not expected to occur in Blair Waterway given that the channel contains shallow sandy-bottom habitat and is not near typical rockfish spawning locations. However, given the ability of this species to move throughout the marine environment, we cannot preclude that they would not occasionally enter in the Blair Waterway. It is likely that adult rockfish would be present in Puget Sound shipping lanes associated with the Port of Tacoma (Figure 1), but it would be unlikely that they would be exposed to project effects due to the depth of habitat they typically occupy.

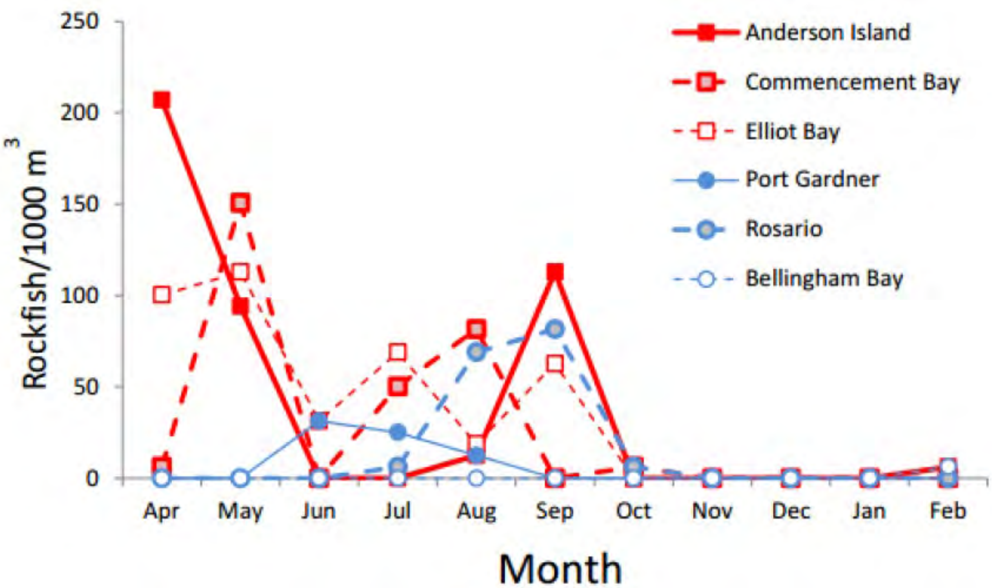

Figure 13. Rockfish density per 1,000 cubic meters at six sediment disposal sites in the Puget Sound from April 2011 through February 2012. (Adapted from Green and Godersky 2012).

Temporary Effects

Response to Degraded Water Quality
The proposed in-water work would temporarily affect water quality through increased turbidity and mobilized unsuitable sediments during dredging and material disposal at Saltchuk. It may also temporarily reduce DO. NMFS estimates that all detectable water quality impacts would be limited to the extent of the project-related turbidity, up to 3-miles radially, and would return to background levels shortly after the end of construction (hours to days).

Turbidity and Dissolved Oxygen
Dredging and project-related tugboat propeller wash would mobilize bottom sediments and cause turbidity plumes with relatively low concentrations of total suspended sediments (TSS). The intensity of turbidity is typically measured in Nephlometric Turbidity Units (NTU) that describe the opacity caused by the suspended sediments, or by the concentration of TSS as measured in milligrams per liter (mg/L). A strong positive correlation exists between NTU values and TSS concentrations. Depending on the particle sizes, NTU values roughly equal the same number of mg/L for TSS (i.e. 10 NTU = ~ 10 mg/L TSS, and 1,000 NTU = ~ 1,000 mg/L TSS) (Campbell Scientific Inc. 2008; Ellison et al. 2010). Therefore, the two units of measure are easily compared.

Water quality is considered adversely affected by suspended sediments when turbidity is increased by 20 NTU over background conditions for a period of 4 hours or more (Berg and Northcote 1985; Robertson et al. 2007). The effects of turbidity on fish are somewhat species and size dependent. In general, severity typically increases with sediment concentration and duration of exposure, and decreases with the increasing size of the fish. Bjornn and Reiser (1991) report that adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that may be mobilized during storm and snowmelt runoff episodes. However, empirical data from numerous studies report the onset of minor physiological stress in juvenile and adult salmon after one hour of continuous exposure to suspended sediment concentration levels between about 1,100 and 3,000 mg/L, or to three hours of exposure to 400 mg/L, and seven hours of exposure to concentration levels as low as 55 mg/L (Newcombe and Jensen 1996). The authors reported that serious non-lethal effects such as major physiological stress and reduced growth were reported after seven hours of continuous exposure to 400 mg/L and 24 hours of continuous exposures to concentration levels as low as about 150 mg/L.

Mechanical dredging in areas containing high levels of fine-grained material is likely to cause suspended sediment plumes that could extend 200 to 500 feet down-current from the point of dredging, and may take hours after work has stopped to return to background levels. LaSalle et. al. (1991) reported suspended sediment concentrations of about 700 mg/L at the surface, and 1,100 mg/L near the bottom, about 300 feet from clamshell dredging in areas containing high levels of fine-grained material. During monitored clamshell dredging of inner Grays Harbor, the suspended sediment concentrations exceeded 500 mg/L in 23 of 600 samples, and seven of those samples were for tests of ambient conditions (COE 2011b). The single highest reported concentration was 3,000 mg/L when the ambient TSS concentration was 700 mg/L. The dredging contractors would be required to monitor and limit turbidity according to the water quality monitoring plan. State water quality standards require that turbidity not exceed 5 NTUs above background when ambient conditions are less than 50 NTUs; and no more than 10 NTUs above background when ambient conditions are above 50 NTUs.

Tugboat propeller wash would also mobilize bottom sediments. The intensity and duration of the resulting turbidity plumes are uncertain, and would depend on a combination of the tugboat's thrust, the water depth under it, and the type of substrate. The higher the thrust and the finer the sediment, the more sediment that is likely to be mobilized. Fine material (silt) remains mobilized longer than coarse material (sand). The shallower the water, the more thrust energy that would reach the substrate. A recent study described the turbidity caused by large tugboats operating in Navy harbors (ESTCP 2016). At about 13 minutes, the plume extended about 550 yards (500 m), where the TSS concentration was about 80 mg/L. The plume persisted for hours and extended far from the event, but the TSS concentration fell to 30 mg/L within 1 hour and to 15 mg/L within 3 hours. At its highest concentration, the plume was below the concentrations required to elicit physiological responses reported by Newcombe and Jensen (1996). The exact extent of turbidly plumes from tugboat operations for this project are unknown, but it is extremely unlikely that would exceed those described above. Based on that information, and on the consultations for similar projects in the region, sediment mobilization from tugboat propeller wash would likely consist of relatively low-concentration plumes that could extend to about 300 feet from the site, and last a low number of hours after the disturbance. However, work-related tugboat turbidity would be indistinguishable from the turbidity caused by the high levels of routine vessel operations in and around the project site. Shipping traffic throughout the action areas routinely disturbs sediments. Any temporary increase in turbidity as a result of the proposed action is not anticipated to measurably exceed levels caused by normal periodic increases due to this industrial traffic or highly turbid water from the Puyallup River within the waterways. The generally slow velocity of water movement within the navigation channel would also greatly minimize the potential negative effects of temporarily increased turbidity.

Elevated suspended sediments affect ESA-listed species in several ways, including: (1) reduction in feeding rates and growth, (2) physical injury, (3) physiological stress, (4) behavioral avoidance, and (5) delayed migration. Laboratory studies have consistently found that the 96-hour median lethal concentration of fine sediments for juvenile salmonids is above 6,000 mg/L (Stober et al. 1981) and 1,097 mg/L for 1 to 3-hour exposure (Newcombe and Jensen 1996). Lethal concentrations and duration of exposure are not likely to occur for several reasons. LaSalle et al. (1991) determined that, within 300 feet of bucket dredging fine silt or clay, the expected concentrations of suspended sediment would be about 700 and 1,100 mg/L at the surface and bottom of the water column, respectively. Studies have shown that salmonids have an ability to detect and distinguish turbidity and other water quality gradients (Quinn 2005; Simenstad 1988), and that larger juvenile salmonids are more tolerant to suspended sediment than smaller juveniles (Servizi and Martens 1991; Newcombe and Jensen 1996).

In addition to this behavioral response, however some exposure to suspended sediments is likely and can elicit an array of responses. Even moderate levels of suspended sediment exposure not associated with gill damage can affect the respiratory ability of salmonids (Waters, 1995) and trigger an acute stress response (Michel et al., 2013). Some sediment-associated stress responses include elevated plasma glucose and plasma cortisol (Redding et al. 1987, Servizi and Martens, 1992), increased cardiac output (Bunt et al., 2004), and changes in hematological parameters (Lake and Hinch, 1999, Michel et al., 2013). Suspended solids are also known to impact fish's feeding ability (e.g. due to impaired spotting of prey), routine activity, and stress levels (Berg and Northcote, 1985, Sweka and Hartman, 2001, De Robertis et al., 2003, Robertson et al., 2007, Awata et al., 2011). Behavioral responses (e.g., alarm reaction and avoidance of the plume) can occur with only six minutes of exposure (Newcombe and Jensen 1996). Physiological effects (e.g., gill flaring and coughing) may occur with 15 minutes of exposure, temporary reduced feeding rates and success with 1 hour of exposure, and moderate levels of stress with 3 hours of exposure (Newcombe and Jensen 1996).

Disposal of sediment at the Saltchuk site would also expose juvenile salmonids and juvenile and larval rockfish to elevated turbidity and associated adverse effects. While we expect juvenile/larval rockfish presence to be low, we cannot rule out the possibility of individuals occupying the site. For periods when larval rockfish and dredge disposal co-occur, determining the extent of effect is dependent upon the frequency of disposal, estimated sediment concentrations, and the relative abundance of ESA-listed rockfish. Furthermore, the concentrations and duration of suspended sediments within the water column depends upon the depth, currents, and composition of the material, and concentrations would injure or kill them or alter their feeding rate. A number of studies have assessed suspended sediment effects on Pacific herring larvae, as well as other marine fish. Larval herring death rates ranged from 82.8 to 99.4%, compared to 23.6% of the control group when they were exposed to suspended sediment levels of 10,000, 5,000, and 500 mg/l for four days (Morgan and Levings 1989). Larval herring had abraded yolk sacs that increased relative to the concentration when exposed for 24 hours to suspended sediment concentrations of up to 8,000 mg/l (Boehlert 1984), and their feeding rates were observed to maximize when concentrations reached 500 mg/l, and decreased at higher concentrations (Boehlert and Morgan 1985). When exposed to 10,000, 5,000, and 500 mg/l for ten days, larval lingcod death rates ranged from 90 to 98%, compared to 18% in a control group (Morgan and Levings 1989). None of the aforementioned studies replicate the short term but very high concentrations of suspended sediment that would result from sediment disposal at Saltchuk.

Given the extreme fragility of larval rockfish, some fish within the water column at Saltchuk would be injured or killed by ruptured capillaries, maceration of highly vascular organs and internal bleeding. As an example of their fragility, larval rockfish were observed to be injured by strong flowing water in laboratory-rearing environments (Canino and Francis 1989). We do not expect juvenile Chinook salmon or steelhead or juvenile rockfish to be nearly as susceptible to the effects from sediment disposal as larval rockfish, due to the swimming abilities of juveniles being more advanced than the larval lifestage. However, we do expect proportional or exposed juveniles to be harmed and or killed as a result of sediment disposal at Saltchuk. Therefore, we find the effects of sediment disposal in the form of elevated turbidity to be adverse.

Mobilization of anaerobic sediments can decrease dissolved oxygen levels (Hicks et al., 1991; Morton 1976). The impact on dissolved oxygen is a function of the oxygen demand of the sediments, the amount of material suspended in the water, the duration of suspension, and the water temperature (Lunz and LaSalle 1986). Reduced dissolved oxygen can affect salmonid swimming performance (Bjornn and Reiser 1991), as well as cause avoidance of water with low dissolved oxygen levels (Hicks 1999).

Despite being present during a small portion of the work window, juvenile PS steelhead are not nearshore dependent and are not expected to be in the nearshore in large numbers. Juvenile steelhead (smolts) are between 150 – 250 mm upon entering the marine environment and are considered agile swimmers. Those present are expected to be only briefly in the area where elevated suspended sediment would occur (within a 150- to 300-foot radius to account for the point of compliance for aquatic life turbidity criteria) and to have strong capacity as larger juveniles to avoid areas of high turbidity. In the event that there is a contemporary decrease in DO within sediment plumes, we do not anticipate a significant behavioral response from steelhead to reduced DO because we expect that they would have only brief exposure to the affected area. Therefore, we consider temporary exposure to low DO would not be sufficient to cause any injury or harmful behavioral response to juvenile PS steelhead.

Juvenile PS Chinook salmon are likely to be present during in-water construction activities and likely to be exposed to the temporary construction effects, most notably elevated levels of suspended sediment. Turbidity and TSS levels would return to background levels quickly and be localized to the in-water construction areas (150- to 300-foot radius turbidity mixing zone). Again, decreased DO is expected to be contemporaneous with and in the same footprint of the suspended sediment. While juvenile PS Chinook salmon may encounter these areas, they can detect and avoid areas of high turbidity, and exposure is expected to be brief. Thus, duration and intensity of exposure of juvenile PS Chinook salmon is also unlikely to cause injury or a harmful response. Those that engage in avoidance behaviors or with raised cortisol levels may have decreased predator detection and avoidance increasing the likelihood of predation.

Larval yelloweye and bocaccio rockfish would be present at the project site because they passively drift and distribute with prevailing currents, although we find the likelihood of a large abundance of individuals to be relatively low (see section 2.4.5 – Period of Exposure and Species Presence) (Greene and Godersky 2012). However, larval rockfish, given their limited swimming abilities may be disproportionally exposed to effects from the resulting plume and harmed by the high turbidity and low DO conditions. Because the Blair Waterway lacks deep water, suitable rocky substrate, and preferred aquatic vegetation (kelp and eelgrass), the likelihood of adult and juvenile rockfish presence is low. The turbidity plume and low DO expected resulting from dredging the sandy substrate of Blair Waterway may have sublethal effects such as gill irritation, and would cause juvenile rockfish to flee the area or find refuge in clearer water outside of the dredging footprint. While we expect abundance to be low, larval or juvenile rockfish that are exposed to high turbidity and associated degraded DO are likely to be harmed or killed as a result.

Re-suspended Contaminants

Dredging within Blair Waterway and material disposal at the Saltchuk site would re-suspend toxic contaminants. Saltchuk exists within the Commencement Bay, Nearshore/Tide Flats Superfund site, although there are no HTRW sites that overlap with Saltchuk. The Blair Waterway was historically considered a Superfund site, although it was delisted in 1996. Both sites have the potential to harbor contaminants in stored in sediments. A feasibility-level sediment characterization regarding the potential suitability of up to 2.5 million cubic yards (cy) of dredged material from the Blair Waterway for open-water disposal at the Commencement Bay disposal site or for potential beneficial use was summarized in an advisory memorandum (DMMP 2019). Concentrations of PAHs and PCBs in the sediments within the project area were quite low in the advisory characterization (DMMP 2019). PCBs exceeded the DMMP screening level (SL) in only one location, which was a sideslope area near Washington United Terminal. A screening level of 2,000 µg/kg was used for determining potential for beneficial use of sediment based on a 2014 NMFS proposed total PAH SL[22]. There were no SL exceedances for any individual or summed PAHs in any of the samples. The proposed action would cause chemicals such as PAHs to be re-suspended into the water column. There are two pathways for PAH exposure to listed fish species in the action area, direct uptake through the gills and dietary exposure (Lee and Dobbs 1972; Neff et al. 1976; Karrow et al. 1999; Varanasi et al. 1993; Meador et al. 2006; McCain et al. 1990; Roubal et al. 1977). Fish rapidly uptake PAHs through their gills and food but also efficiently remove them from their body tissues (Lee and Dobbs 1972; Neff et al. 1976). Juvenile Chinook salmon prey, including amphipods and copepods, uptake PAHs from contaminated sediments (Landrum and Scavia 1983; Landrum et al. 1984; Neff 1982). Varanasi et al. (1993) found high levels of PAHs in the stomach contents of juvenile Chinook salmon in the Duwamish estuary. The primary response of exposed salmonids, from both uptake through their gills and dietary exposure, are immunosuppression and reduced growth. Karrow et al. (1999) characterized the immunotoxicity of creosote to rainbow trout (*O. mykiss*) and reported a lowest observable effect concentration for total creosote of 17 µg/l or 611.63 ng/l PAHs. Varanasi et al. (1993) found greater immune dysfunction, reduced growth, and increased mortality compared to control fish. In order to isolate the effects of dietary exposure of PAHs on juvenile Chinook salmon, Meador et al. (2006) fed a mixture of PAHs intended to mimic those found by Varanasi et al. (1993) in the stomach contents of field-collected fish. These fish showed reduced growth compared to the control fish. Of the listed fish exposed to PAHs and other contaminants, all are likely to have some degree of immunosuppression and reduced growth, which, generally, increases the risk of death.

The number of years that detectable amounts of contaminants would be biologically available at the site is uncertain. Similarly, the annual numbers of juvenile PS Chinook salmon and juvenile PS steelhead that may be exposed to construction-related contaminated forage are uncertain and likely to be highly variable, as are the amounts of contaminated prey that individual fish may consume, or the intensity of effects that exposed individuals may experience. We expect that some individual listed fish species would experience sublethal effects from elevated turbidity, low DO, and re-suspended contaminants such as stress and reduced prey consumption, some may respond with avoidance behaviors, and some may be injured. We expect sediment impacts would adversely affect PS Chinook salmon and PS steelhead at multiple life stages, and juvenile and larval PS/GB yelloweye and bocaccio rockfish.

Response to Entrainment and Strike During Dredging

In this context, entrainment refers to the uptake of aquatic organisms by dredge equipment (i.e., the dredge bucket). Dredge buckets entrain slow-moving and sessile benthic epifauna along with burrowing infauna that are removed with the sediments. They also entrain algae and aquatic

[22] The National Marine Fisheries Service (NMFS) proposed a screening level of 2,000 µg/kg total PAH for the protection of fish at the Regional Sediment Evaluation Team annual meeting in November 2014 (DMMP 2019).

vegetation. Fish that become captured within a digging bucket or that are struck by the bucket as it descends would likely be killed. However, the documented occurrence of these events for mobile fish species are extremely rare. In the Southeast Region of the US, where closely monitored heavy dredging operations occur regularly in areas inhabited by sturgeon and sea turtles, only two live sturgeon (NMFS 2012) and two live sea turtles (NMFS 2011) are known to have been taken by clamshell dredging since 1990. However, recently dredging in Grays Harbor, Washington a shark was killed after it was entrained by a hopper dredge (USACE 2021b).

The rarity of these occurrences is likely due to a combination of factors. In order to be entrained in a clamshell bucket, a fish must be directly under the bucket when it drops. The relatively small size of the bucket, compared against the scattered and low-density distribution of the fish across the available habitat within the project area strongly suggest that the potential for overlap between fish and bucket presence is very low, and that potential would decrease after the first few bucket cycles because mobile organisms such as salmon are likely to move quickly away from the noise and turbid water. Further, mechanical dredges typically stay within an area limited to the range of the crane/excavator arm for many minutes to several hours before moving to an adjacent area. The risk of bucket strike and entrainment would lowered further by conducting the work within a full-depth sediment curtain that would act as a fish exclusion device. Therefore, based on the best available information, in the very unlikely event that listed fish would be present during in-water work, it would be extremely unlikely that any individuals would be struck by or entrained in the clamshell bucket.

Adult PS Chinook salmon and PS steelhead may pass through the area during migration to their natal streams. Adult PS Chinook salmon and adult PS steelhead are strong swimmers that are likely to avoid the noise and activity, which would reduce the likelihood of entrainment or strike. Similarly, juvenile PS Chinook and PS steelhead are unlikely to be entrained or struck by construction equipment for the same reasons and are unlikely to be in the area in appreciable number further reducing the encounter potential. Based on the best available information described above, NMFS considers the risk of entrainment or strike occurring to adult and juvenile PS Chinook salmon PS steelhead to be low. Risk to adult rockfish, yelloweye and bocaccio, is also low because they are unlikely to be present in the dredging areas. Juvenile rockfish are also at low risk of entrainment because they would respond to the initial disturbance and avoid the area. Entrainment and strike risk is higher for larval rockfish given their lack of mobility.

While the risk of entrainment is very low, we cannot rule out the possibility of fish being entrained or struck while dredging is occurring and any individual fish harmed or killed as a result of being entrained or struck by a dredge constitutes an adverse effect.

Response to Reduced Forage and Prey Communities

The effect of dredging activities on macrofauna assemblage recovery depends on the methods used, duration and frequency of dredging, the area and amount of material to be dredged, substrate characteristics, resulting sedimentary profile of the affected seabed, local hydrology, seasonal effects (Barrio Froján et al., 2011, Newell et al., 1998) and biotic interactions (Ólfasson et al., 1994). Areas where sediment is removed by dredging would diminish benthic prey communities. In areas where suspended sediment settles on the bottom, some smothering can occur which also disrupts the benthic communities. The speed of recovery by benthic communities is affected by several factors, including the intensity of the disturbance, with greater disturbance increasing the time to recovery (Dernie et al., 2003). Additionally, the ability of a disturbed site to recolonize is affected by whether or not adjacent benthic communities are nearby that can recolonize the affected area, and the composition of the species that recolonize the area may differ from a less frequently perturbed area, as disturbances caused by dredging may lead to a decline in sensitive species, to be subsequently replaced by more tolerant species (Ceia et al. 2013). Lastly, suspended sediment would eventually settle in the area adjacent to the dredge prism, which can disrupt benthic prey species, and if the sediments are contaminated, then sublethal toxicity of benthic prey species could occur. These prey then can become a source of bioaccumulation, which degrades the quality of the prey.

We expect only the cohorts of PS Chinook salmon and PS steelhead that are present in Blair Waterway and Saltchuk to be exposed to this temporary reduction of prey. Therefore, feeding, growth, development, and fitness of the exposed individuals would be affected during the months of construction activity. We consider the temporary effects of reduced forage on any juvenile PS Chinook salmon and PS steelhead in the action area to be unlikely to cause injury at the population scale.

On the other hand, juvenile PS/GB bocaccio feed on the young of other rockfish, surfperch, and jack mackerel in nearshore areas (Love et al. 1991; Leet et al. 1992). Juveniles also eat all life stages of copepods and euphausiids (MacCall et al. 1999). Because juvenile rockfish are less able to access adjacent areas compared with salmon species, reductions in benthic prey communities, and in SAV from disturbance in work areas would reduce available forage for PS/GB bocaccio in their nearshore settlements, reducing growth and fitness of affected individuals.

Response to Elevated In-water Noise

The effects to fish caused by exposure to noise vary with the hearing characteristics of the fish, the frequency, intensity, and duration of the exposure, and the context under which the exposure occurs. At low levels, effects may include the onset of behavioral disturbances such as acoustic masking (Codarin et al. 2009), startle responses and altered swimming (Neo et al. 2014), abandonment or avoidance of the affected area (Mueller 1980; Picciulin et al. 2010; Sebastianutto et al. 2011; Xie et al. 2008) and increased vulnerability to predators (Simpson et al. 2016). At higher intensities and longer exposure durations, effects may include temporary hearing damage (a.k.a. temporary threshold shift or TTS, Scholik and Yan 2002) and increased stress (Graham and Cooke 2008). At even higher levels, exposure may lead to physical injury that can range from the onset of permanent hearing damage (i.e., permanent threshold shift or PTS) and mortality. The best available information about the auditory capabilities of the fish considered in this Opinion suggest that their hearing capabilities are limited to frequencies below 1,500 Hz, with peak sensitivity between about 200 and 300 Hz (Hastings and Popper 2005; Picciulin et al. 2010; Scholik and Yan 2002; Xie et al. 2008).

NMFS uses two metrics to estimate the onset of injury for fish exposed to high intensity impulsive sounds (Stadler and Woodbury 2009). The metrics are based on exposure to peak sound level and sound exposure level (SEL), respectively. Both are expressed in decibels (dB). The metrics are: 1) exposure to 206 dB_{peak}; and 2) exposure to 187 dB SEL_{cum} for fish 2 grams or larger, or 183 dB SEL_{cum} for fish under 2 grams. Further, any received level (RL) below 150 dB_{SEL} is considered "Effective Quiet". The distance from a source where the RL drops to 150 dB_{SEL} is considered the maximum distance from that source where fishes can be affected by the noise, regardless of accumulation of the sound energy (Stadler and Woodbury 2009). Therefore, when the range to the 150 dB_{SEL} isopleth exceeds the range to the 187 dB SEL_{CUM} isopleth, the distance to the 150 dB_{SEL} isopleth is the range at which detectable effects would begin, with the 187 dB SEL_{CUM} isopleth identifying the distance within which sound energy accumulation would intensify effects. However, when the range to the 150 dB_{SEL} isopleth is less than the range to the 187 dB SEL_{CUM} isopleth, only the 150 dB_{SEL} isopleth would apply because fish would be extremely unlikely to detect or be affected by the noise outside of the 150 dB_{SEL} isopleth.

The above-discussed criteria specifically address fish exposure to impulsive sound. Stadler and Woodbury (2009) make it clear that the thresholds likely overestimate the potential for impacts on fish from non-impulsive sounds (e.g., vibratory pile driving). Non-impulsive sounds have less potential to cause adverse effects in fish than impulsive sounds. Impulsive sources cause short bursts of sound with very fast rise times and the majority of the energy in the first fractions of a second. Whereas, non-impulsive sources cause noise with slower rise times and sound energy that is spread across an extended period of time; ranging from several seconds to many minutes in duration. Therefore, application of the criteria to non-impulsive sounds is also likely to overestimate the potential effects in fish. However, these criteria represent the best available information. Therefore, to avoid underestimating potential effects, this assessment applies these criteria to provide a conservative measure of the potential effects that fish may have experienced due to exposure to project-related sounds.

The estimated in-water source levels (SL, sound level at 1 meter from the source) used in this assessment are based on the best available information, as described in a recent acoustic assessment for a similar project (NMFS 2016a), and in other sources (Blackwell and Greene 2006; COE 2011a; Dickerson et al. 2001; Reine et al. 2014; Richardson et al. 1995). The best available information supports the understanding that all of the SLs would be below the 206 dB_{peak} threshold for the onset of instantaneous injury in fish.

In the absence of location-specific transmission loss data, variations of the equation RL = SL – #Log(R) are often used to estimate the received sound level at a given range from a source (RL = received level (dB); SL = source level (dB, 1 m from the source); # = spreading loss coefficient; and R = range in meters (m). Numerous acoustic measurements in shallow water environments support the use of a value close to 15 for projects like this one (CalTrans 2015). This value is considered the practical spreading loss coefficient, and was used for all sound attenuation calculations in this assessment.

Application of the practical spreading loss equation to the expected SLs suggests that noise levels above the 150 dB_{SEL} threshold could extend to 72 feet (22 m) around tugboats, and about 13 feet (4 m) around dredging work (Table 11). Individual fish that are beyond the 150 dB_{SEL} isopleth for any of these sources would be unaffected by the noise. However, fish within the 150 dB_{SEL} isopleth are likely to experience a range of impacts that would depend on their distance from the source and the duration of their exposure.

Several pieces of equipment would be operating and producing underwater noise for up to 24 hours per day during the in-water work windows, for up to four years. Tugboats have a dominant frequency range of 100-500Hz with a peak output at 170dB_{RMS}. However, their frequent movement is expected to preclude any concern for impacts on fish from accumulated sound energy. Grading the slope to the appropriate channel depth would have in-water noise effects similar for dredging. Although in-water dredging would be source of continuous noise during the project, is extremely unlikely that any fish would remain within 13 feet of that work long enough for accumulated sound energy to have an effect. Further, the full-depth sediment curtain that would surround the project site would act as a fish exclusion device that would be installed more than 13 feet from the dredging area. Additionally, these sound sources are very unlikely to have any additive effects with each other due the differences in the frequencies and other characteristics of their sound. At most, the combination of the various types of equipment noise during any given day would cause fish-detectable in-water noise levels across the entire workday.

Adult salmon and steelhead are unlikely to be affected by noise caused by dredging, installation of shoreline stabilization measures, and material placement at Saltchuk because noise levels would be well below the 150 dB_{RMS} threshold for behavioral effects and essentially the same as the background noise level in the Port. Displacement of adults may occur on a minor scale as the dredge operates in a small area compared to the entire width of the navigation channel and aquatic habitat available. Larval yelloweye rockfish and larval and juvenile PS/GB bocaccio would also be exposed in uncertain numbers. During the in-water work window, all exposed PS Chinook salmon and PS steelhead individuals would be at least two grams, which reduces the likelihood of lethal response. Larval rockfish and younger juvenile PS/GB bocaccio would be less than two grams, making them more vulnerable to die.

Table 11. Estimated in-water source levels for the loudest project-related activities and the associated distances thresholds are expected to attenuate.

Source	Acoustic Signature	Source Level (dBSEL)	Threshold (dBSEL; meters)
Tugboat Propulsion	< 1 kHz Combination	170	150; 22
Dredge Bucket Strike	< 370 Hz Impulsive	167	150; 4

Intermittent Effects

<u>Response to Reduced Vessel Traffic</u>
Vessel traffic is expected to decrease as a result of the proposed action because load capacity per vessel would increase as a result of the increased depth of Blair Waterway. Less vessel traffic translates to a reduction in underwater noise, associated pollution, and disruption of benthic prey. This would likely result in a slight increase in growth rates, carrying capacity, and survival of juvenile and adult listed PS steelhead, PS Chinook salmon, PS/GB yelloweye rockfish, and PS/GB bocaccio. We also evaluated the effects of an increase in vessel size for impacts to listed species. Specifically, we evaluated the potential for a change in noise, ship strikes, and wake effects on Puget Sound shorelines resulting from the proposed action. NMFS found no

information that supported an increase or a decrease in negative impacts to listed fish or marine mammals from larger vessels in Puget Sound.

Enduring Effects

<u>*Response to channel deepening and widening*</u>
The proposed dredging of 6 feet (plus two feet of over-depth) is not expected to alter substrate composition or sizes of those materials. Although areas where sediment is removed by dredging will greatly reduce benthic prey communities in the near-term, the speed of recovery by benthic communities is likely to occur within two years (NMFS 2006a). Other than the temporary loss of benthic invertebrates, the proposed widening and deepening of the federal navigation channel is not expected to reduce habitat quality for salmonids or rockfish. This is because the navigation channel is not nearshore habitat and, under the current environmental baseline, could not return to nearshore habitat. Increasing the depth of deep-water habitat that might provide marginal migration and foraging areas for salmon and rockfish does not result in a loss of habitat quality as we expect benthic organisms to recolonize within two years.

<u>*Response to Modified Shoreline*</u>

The shoreline of the Blair Waterway, in its current state, is highly industrialized and lacks high quality nearshore habitat and does not provide the ecological function necessary to sustain the ESA-listed species evaluated in this Opinion. The lack of shallow water habitats, suitable substrate, submerged aquatic vegetation, and natural cover and the intense industrial use precludes ESA-listed rockfish and salmonids species from using most of these areas as feeding, growth, and reproductive opportunities. Due to current Congressional authorization, the Corps is required to maintain the current condition and functionality of the channel, meaning the current depth, width, and quantity of shoreline armoring would be maintained in its current state without implementation of the proposed action (see section 2.3.3). We do not expect adverse effects to occur as a result of the proposed shoreline stabilization measures because conditions would not appreciably change from current conditions. However, the proposed shoreline armoring at all four locations would prolong the recovery of the species considered in this Opinion as conditions would remain degraded as a result.

<u>*Response to Improved Nearshore Conditions at Saltchuk*</u>
The proposed action would add approximately 1.8 million cubic yards of dredged materials at the 64-acre Saltchuk site, increasing productive intertidal and subtidal habitat (Figure 1). Over the long term, improved habitat conditions at Saltchuk are expected to increase feeding and rearing opportunities for juvenile salmonids including PS Chinook salmon, PS steelhead, and bull trout. These benefits may take many years to be fully realized, but would be expected to benefit juveniles in the nearshore, likely increasing abundance, survival, and growth rates as long as the dredged material remains on site and suitable habitat remains. Habitat complexity would likely slowly develop, providing important cover and refugia from piscivorous fish and avian predators. Commencement Bay carrying capacity would also slightly increase as a result of the improved nearshore habitat. Juvenile PS Chinook salmon are most likely to benefit from the proposed improvements to the nearshore given their reliance on nearshore habitats during their marine growth and rearing life stage. These positive effects would likely attenuate over time, as

placement of material and the site would not result in a permanent improvement in habitat without maintenance and additional restoration actions under consideration by the Corps (COE 2021a).

Summary of Effects to Species

Based on the low but not insignificant probability that juvenile and adult PS Chinook salmon and PS steelhead and larval and juvenile PS/GB bocaccio and PS/GB yelloweye rockfish may be present during temporary and localized effects of construction, this project may affect and is likely to adversely affect individuals via degraded water quality (high turbidity, low DO, suspended contaminants), equipment entrainment and strike, reduced forage and prey communities, and elevated in-water noise, but it will not measurable affect populations. Conversely, over the long-term the project may benefit these species through reduced vessel traffic, and improved nearshore habitat at Saltchuk. NMFS did not find literature supporting positive or negative effects to listed species in Puget Sound as a result of large vessel size. The proposed widening and deepening of the federal navigation channel is not expected to reduce habitat quality for salmonids or rockfish.

Effects to Population Viability

We assess the importance of habitat effects in the action area to the species by examining the relevance of those effects to the characteristics of VSP. The characteristics of VSPs are sufficient abundance, population growth rate (productivity), spatial structure, and diversity. While these characteristics are described as unique components of population dynamics, each characteristic exerts significant influence on the others. For example, declining abundance can reduce spatial structure of a population; and when habitats are less varied, then diversity among the population declines. We expect a temporary negative effect from the proposed action on the survival of juvenile PS Chinook salmon, juvenile steelhead, and larval and juvenile PS/GB rockfish. We expect populations from the Puyallup River basin to be present in the action area and impacted by the proposed action.

Abundance: As discussed in Section 2.3.2, the Blair Waterway and its associated facilities have degraded and industrialized the estuarine and marine nearshore environment. Effects to individual fishes from the proposed action would not appreciably increase the effects of the two Chinook salmon populations that use the action area. While we cannot quantify these long-term structure-related effects, we believe them to be limited and proportional to the size of affected habitat. Because PS juvenile steelhead do not commonly reside in the estuarine or marine nearshore habitat, we do not expect the proposed project to notably affect the abundance of PS steelhead. We do expect larval and juvenile rockfish abundance to be incrementally affected each year of construction given their limited swimming ability and general fragility to disturbance. PS/GB bocaccio are likely to be affected at a larger magnitude compared to yelloweye rockfish given their greater reliance on nearshore area during juvenile/larval life stages.

Productivity: Productivity is likely to be negatively impacted over the short-term, but increase over the long-term once construction is complete due to a slight increase in nearshore habitat area and quality at Saltchuk. The resulting slight increase in nearshore habitat area and quality is expected to slightly increase PS Chinook salmon and PS/GB rockfish productivity and carrying capacity by creating more feeding/foraging opportunities as well as natural cover. A slight increase in nearshore habitat is not likely to improve steelhead productivity because of their limited use of the nearshore environment.

Spatial Structure: We expect the proposed project to marginally affect the spatial structure of the PS Chinook salmon ESU, and PS/GB bocaccio DPS as the majority of impacts would be isolated to the Blair Waterway and Saltchuk site. The addition of beneficial material at the Saltchuk site will improve spatial structure for juvenile Chinook salmon and bocaccio by increasing access to productive habitat and refugia from predators.

Diversity: Salmon have complex life histories and changes in the estuarine environment would have a greater effect on specific life history traits that make prolonged use of this habitat. This would likely result in a slight, proportional to the limited habitat alteration, decline in PS Chinook salmon diversity by differentially affecting specific populations that encounter the developed area in greater frequency during their early estuarine life history. We do not expect the proposed project to affect the diversity of PS steelhead, PS/GB bocaccio, or PS/GB yelloweye rockfish.

2.5 Cumulative Effects

"Cumulative effects" are those effects of future State or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation (50 CFR 402.02 and 402.17(a)). Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline vs. cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described earlier in the discussion of environmental baseline (Section 2.3).

Future actions in the nearshore and along the shoreline of Puget Sound are reasonably certain to include port and ferry terminal expansions, residential and commercial development, shoreline modifications, road and railroad construction and maintenance, and agricultural development. Some of these developments will occur without a federal nexus, however, activities that occur waterward of the OHWM (freshwater) or HTL (marine water) require a Corps permit and therefore involve federal activities. Such activities may include additional berth deepening and widening within federal navigation waterways and modifications at Saltchuk.

The repair, replacement, construction and removal of shoreline armoring that may not require federal authorization will continue. However, based on current trends, there could continue to be a net reduction in the total amount of shoreline armoring in Puget Sound (PSP 2018). Changes in tributary watersheds that are reasonably certain to affect the action area include reductions in water quality, water quantity, and sediment transport. Future actions in the tributary watersheds whose effects are reasonably certain to extend into the action area include operation of hydropower facilities, flow regulations, timber harvest, land conversions, disconnection of floodplain by maintaining flood-protection levees, effects of transportation infrastructure, and growth-related commercial and residential development.

All future non-federal actions in the nearshore as well as in tributary watersheds will cause long-lasting environmental changes and will continue to harm ESA-listed species and their critical habitats. Especially relevant effects include the loss or degradation of nearshore habitats, pocket estuaries, estuarine rearing habitats, wetlands, floodplains, riparian areas, and water quality. We consider human population growth to be the main driver for most of the future negative effects on salmon and steelhead and their habitat.

As mentioned above, human populations are expected to increase within the Puget Sound region, and if population growth trends remain relatively consistent with recent trends, we can anticipate future growth at approximately 1.5 percent per year.[23] The human population in the PS region increased from about 1.29 million people in 1950 to about 3.84 million in 2014, and is expected to reach nearly 5 million by 2040 (Puget Sound Regional Council 2020). As of the date of this Opinion, the human population in the Puget Sound Region is 4.2 million, slightly exceeding projections. Thus, future private and public development actions are reasonably certain to continue in and around PS. As the human population continues to grow, demand for agricultural, commercial, and residential development and supporting public infrastructure is also reasonably certain to grow. We believe the majority of environmental effects related to future growth will be linked to these activities, in particular land clearing, associated land-use changes (i.e., from forest to impervious, lawn or pasture), increased impervious surface, and related contributions of contaminants to area waters. Land use changes and development of the built environment that are detrimental to salmonid habitats are reasonably certain to continue under existing regulations. Though the existing regulations minimize future potential adverse effects on salmon habitat, as currently constructed and implemented, they still allow systemic, incremental, additive degradation to occur.

In June 2005, the Shared Strategy presented its recovery plan for PS Chinook salmon and the Hood Canal Coordinating Council presented its recovery plan for Hood Canal summer-run chum salmon to NMFS who adopted and expanded the recovery plans to meet its obligations under the ESA. Together, the joint plans comprise the 2007 PS Chinook and Hood Canal Summer-run Chum Recovery Plan (Shared Strategy 2007; NMFS 2006). Many tribes, not-for-profit organizations and local, state and federal agencies are implementing recovery actions identified in these recovery plans.

The cumulative effects associated with continued development in the action area are reasonably certain to have ongoing adverse effects on all the listed species populations addressed in this Opinion. Only improved, low-impact development actions together with increased numbers of restoration actions, watershed planning, and recovery plan implementation would be able to address growth related impacts into the future. To the extent that non-federal recovery actions are implemented and offset ongoing development actions, adverse cumulative effects may be minimized, but will probably not be completely avoided.

[23] https://www.psrc.org/whats-happening/blog/region-adding-188-people-day

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

The species considered in this Opinion have been listed under the ESA, based on declines from historic levels of abundance and productivity, loss of spatial structure and diversity, and an array of limiting factors as a baseline habitat condition. Each species would be affected over time by cumulative effects, some positive—as recovery plan implementation and regulatory revisions increase habitat protections and restoration, and some negative—as climate change and unregulated or difficult to regulate sources of environmental degradation persist or increase. Overall, to the degree that habitat trends are negative, as described below, effects on viability parameters of each species are also likely to be negative. In this context we consider the effects of the proposed action's effect on individuals of the listed species at the population scale. The action area provides critical habitat for nearshore marine life histories of PS Chinook salmon, although at a degraded state.

PS Chinook salmon and PS steelhead are both listed as threatened, based on declines from historic levels of abundance and productivity, loss of spatial structure and diversity, and an array of limiting factors. Both species would be affected over time by cumulative effects, some positive—as recovery plan implementation and regulatory revisions increase habitat protections and restoration, and some negative—as climate change and unregulated or difficult to regulate sources of environmental degradation persist or increase. Overall, to the degree that habitat trends are negative, the effects on viability parameters of each species are also likely to be negative. In this context we consider how the proposed action's impacts on individuals would affect the listed species at the population and ESU/DPS scales.

2.6.1 PS Chinook Salmon

PS Chinook salmon are currently listed as threatened with generally negative recent trends in status. Widespread negative trends in natural-origin spawner abundance across the ESU have been observed since 1980. Productivity remains low in most populations, and hatchery-origin spawners are present in high fractions in most populations outside of the Skagit watershed. Available data now shows that most populations have declined in abundance over the last evaluation period (NWFSC 2015; Ford, in press)). Most populations are consistently below the spawner-recruit levels identified by the recovery plan for this ESU.

The environmental baseline within the project area has been degraded by the effects of shoreline development and vessel activities. The baseline has also been degraded by nearby industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance. The environmental baseline includes the current congressionally authorized federal navigation channel in the Blair Waterway. Absent a change in the authorization, the federal navigation channel and Blair Waterway cannot return to a condition that would provide high-quality habitat for salmon.

The timing of the proposed construction and dredging overlaps with adult PS Chinook salmon holding and upstream migration through Commencement Bay. The timing avoids the peak migration of juvenile Chinook salmon downstream from the Puyallup River toward Commencement Bay. However, over the next several decades, low numbers of out-migrating juveniles that pass through Commencement Bay would be exposed to low levels of contaminated forage and other altered habitat conditions, that both individually and collectively, would cause some combination of altered behaviors, reduced fitness, and mortality. The annual numbers of individuals that would be detectably affected by action-related stressors would be extremely low.

As described in Section 2.2, the Puyallup Basin supports several populations critical for recovery of the PS Chinook ESU. PS Chinook salmon were recently evaluated by Ford (in press) to be at moderate risk of extinction. Impacts to Puyallup Basin populations may disproportionately affect recovery efforts and VSP characteristics of the PS Chinook salmon ESU. Early returning White River spring Chinook salmon and Puyallup and Carbon River fall Chinook salmon are the populations that would be impacted by the temporary, intermittent, and enduring effects of the proposed action. White River spring Chinook salmon are the most genetically distinct population of Chinook salmon in the central and south Puget Sound and are the last existing early returning spring Chinook salmon population in the southern Puget Sound basin (NMFS 2007). Currently, White River spring Chinook salmon escapement is well below historical averages and failing to meet recovery goals outlined in the 2007 recovery plan (geometric mean of 4,500) (NMFS 2007). While adult escapement has been high in recent years (see Section 2.3.4 Figure 4), productivity and natural origin abundance has been negative and in perpetual decline, respectively (see Section 2.3.4, Figures 5 and 6). Given the importance of White River spring Chinook salmon relative to the diversity of the PS Chinook salmon ESU even small impacts at the population level from the proposed action could impair recovery of the ESU. The restoration measures included in the proposed action at that Saltchuk site is likely to benefit White River spring Chinook salmon over the long-term, although it remains to be seen at what scale benefits would affect abundance, productivity, or carrying capacity.

Based on the best available information, the scale of the direct and indirect negative effects of the proposed action, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause detectable effects on any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for the affected PS Chinook salmon populations. Despite the slight increase in beneficial habitat improvements at Saltchuk, the degraded baseline of habitat conditions at the Port of Tacoma largely negates improvements to population viability. In addition, since its construction, the Blair Waterway has not provided important rearing habitat for PS Chinook salmon juveniles and the widening and deepening of the channel is unlikely to worsen habitat conditions in any appreciable measure once completed. Furthermore, the in-water work window avoids peak migration periods for both juvenile and adult Chinook salmon further minimizing effects. The proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species because:

- the effect of the dredging proposed to widen and deepen the federal navigation channel are temporary and likely to affect only a few cohorts of the Puyallup Basin populations of PS Chinook salmon;
- the widening and deepening of the federal navigation channel would not cause any meaningful reduction in habitat quality for PS Chinook salmon; and
- the effect at the Saltchuk site would improve the habitat quality for a minimum of several years.

2.6.2 PS Steelhead

The long-term abundance trend of the PS steelhead DPS is negative, especially for native-origin spawners. The extinction risk for most DPSs is estimated to be moderate to high, and the DPS is currently considered "not viable." Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat due to land use activities appear to be the greatest threats to the recovery of PS steelhead. Fisheries activities also continue to impact this species.

The PS steelhead populations most likely to occur in the project area would be winter-run fish from the Puyallup/Carbon River and White River DPSs. Adults are expected to occur in the deep, open-water areas adjacent to the Blair Waterway during the winter of their upstream spawning migration, and juveniles may occur in the shallow nearshore zone during typical outmigration periods in the spring and early summer. Adult fish would typically be oriented to the outflow of the Puyallup River. Historical information suggests that PS steelhead utilized Wapato Creek (drains into Blair Waterway) for rearing and spawning, but recent information suggest current use is low or non-existent.

As described in Section 2.2, the Puyallup Basin supports several populations critical for recovery of the PS steelhead DPS. PS steelhead were recently evaluated by Ford (in press) to at moderate risk of extinction. Impacts to these populations may disproportionately affect recovery efforts and VSP characteristics of the PS steelhead DPS. The Puyallup, Carbon, and White River winter steelhead populations are an integral component to the core MPG of the southern Puget Sound ESU (NMFS 2019). The Green, Puyallup, and Nisqually River basins contain important diverse stream habitats to support core populations. Current abundance of Puyallup/Carbon River and White River winter steelhead remain well below recovery goals and significant recovery efforts would be needed to attain recovery of these populations. Specific measures include reconnecting side channels, wetlands, and floodplains, removing bank armoring and reducing confinement throughout the Puyallup River basin. The proposed action does little to promote steelhead recovery in the Puyallup Basin but also does not result in effects likely to significantly reduce population viability.

The environmental baseline within the project area has been degraded by the effects of shoreline development and vessel activities. The baseline has also been degraded by nearby industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance. Absent a change in the authorization, the federal navigation channel and Blair Waterway cannot return to a condition that would provide high-quality habitat for steelhead.

It is unlikely that juvenile PS steelhead would be directly exposed to the proposed dredging and material placement at Saltchuk. However, over the next several years, low numbers of out-migrating juveniles that pass close to the project site would be exposed to low levels of reduced or contaminated forage that, both individually and collectively, would cause some combination of altered behaviors, reduced fitness, and mortality in some of the exposed individuals. The numbers of individuals that would be detectably affected by action-related stressors would be extremely low.

Based on the best available information, the scale of the direct and indirect effects of the proposed action, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause detectable effects on any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for the affected PS steelhead DIPs. Therefore, the proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species.

2.6.3 Rockfish

PS/GB bocaccio are listed as endangered and abundance of this species likely remains low. PS/GB yelloweye rockfish are listed as threatened but likely persist at abundance levels somewhat higher than bocaccio. In Puget Sound, catches of PS/GB yelloweye rockfish have declined as a proportion of the overall rockfish catch (see Figure 2 and Figure 3, from Drake et al. 2010). Lack of specific information on rockfish abundance in Puget Sound makes it difficult to generate accurate abundance estimates and productivity trends for these two DPSs. Available data suggest that total rockfish declined at a rate of 3.1 to 3.8 percent per year from 1977 to 2014 or a 69 to 76 percent total decline over that period (Tonnes et al. 2016). The two listed DPSs declined over-proportionally compared to the total rockfish assemblage.

Juvenile yelloweye rockfish are not typically found in nearshore habitat and adults are found solely in deep water areas of Puget Sound. Juvenile and larval bocaccio and larval yelloweye rockfish are found in nearshore areas and would likely be exposed to the short-term effects of the proposed construction. However, the proposed actions would only result in short-term impacts to a few cohorts of rockfish over the course of the proposed construction. Given the low overall level of impact, the proposed action would not have any meaningful effect on the numbers, reproduction, or distribution of yelloweye or bocaccio rockfish. Simply stated, the proposed action would affect far too few individuals to have any meaningfully effect on the two rockfish DPSs. Restoration efforts at Saltchuk may improve productivity and abundance of juvenile rockfish; although the scale at which those benefits may occur is unclear as limited data exists to evaluate the long-term benefit of material placement within nearshore environments.

2.6.4 Critical Habitat

At the designation scale, the quality of PS Chinook salmon critical habitat is generally poor with only a small amount of freshwater and nearshore habitat remaining in good condition. Most critical habitat for these species is degraded but nonetheless maintains a high importance for conservation of the species, based largely on its restoration potential. Loss of freshwater and nearshore critical habitat quality is a limiting factor for this species. Development of shoreline and estuary areas of Puget Sound is expected to continue to adversely impact the quality of critical habitat PBFs for PS Chinook salmon.

Modification of nearshore habitat in Puget Sound has resulted in a substantial decrease in critical habitat quality for PS Chinook salmon. As noted in Section 2.3, shoreline development is the primary cause of this decline in habitat quality. Development includes shoreline armoring, filling of estuaries and tidal wetlands, and construction of overwater structures. Currently, 27-30 percent of Puget Sound's shorelines are armored (Meyer el al. 2010; Simenstad et al. 2011).

Given the rate of expected population growth in the Puget Sound area, cumulative effects are expected to result in mostly negative impacts on critical habitat quality. While habitat restoration and advances in best management practices for activities that affect critical habitat could lead to some improvement of PBFs, adverse impacts created by the intense demand for future development is likely to outpace any improvements. Current state and local regulations do not prevent much of the development that degrades the quality of nearshore critical habitats. There is no indication these regulations are reasonably certain to change in the foreseeable future Once human development causes loss of critical habitat quality, that loss tends to persist for decades or longer. The condition of critical habitat will improve only through active restoration or natural recovery following the removal of human infrastructure. As noted throughout this Opinion, future effects of climate change on habitat quality throughout Puget Sound are expected to be negative.

In summary, the status of critical habitat for PS Chinook salmon is poor, particularly in the Blair Waterway. Under the current environmental baseline, the federal navigation channel and Blair Waterway do not provide quality critical habitat for PS Chinook salmon. The presence of the federally authorized navigation channel, ensures that recovery of this habitat is not reasonably certain to occur. The proposed action would result in some temporary loss of habitat quality, but these effects are all expected to be temporary. These temporary effects are not nearly substantial enough to meaningfully impact the conservation value of critical habitat at the designation scale. Moreover, the proposed action would result in a slight increase in quality and quantity of habitat at Saltchuk, but is unlikely to provide a measurable increase in abundance or productivity at the population scale.

2.7 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon, PS steelhead, or PS/GB bocaccio or yelloweye rockfish or adversely modify designated critical habitat for PS Chinook salmon.

2.8 Incidental Take Statement

Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Harass" is further defined by interim guidance as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.8.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

- Incidental take in the form of injury or death due to entrainment or strike during clamshell dredging;
- Incidental take in the form of noise during dredging and installation of shoreline armoring;
- Incidental take in the form of permanent habitat alterations, from sediment deposition at Saltchuk;
- Incidental take in the form of harm from diminished water quality (turbidity, suspended contaminants, etc.); and
- Incidental take in the form of contaminated forage and diminished prey availability.

The distribution and abundance of fish that occur within an action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional and may operate across far broader temporal and spatial scales than are affected by the proposed action. Thus, the distribution and abundance of fish within the action area cannot be attributed entirely to habitat conditions, nor can NMFS precisely predict the number of fish that are reasonably certain to be injured or killed if their habitat is modified or degraded by the proposed action.

Therefore, we cannot predict with meaningful accuracy the number of PS Chinook salmon, PS steelhead, or PS/GB rockfish that are reasonably certain to be injured or killed by exposure to any of these stressors. Additionally, NMFS knows of no device or practicable technique that would yield reliable counts of individuals that experience these impacts. In such circumstances, NMFS uses the casual link established between the activity and the likely extent and duration of changes in habitat conditions to describe the extent of take as a numerical level of habitat disturbance. The most appropriate surrogates for take are action-related parameters that are directly related to the magnitude of the expected take.

For this proposed action, the potential for occurrences of 1) injury or death from entrainment or strike, elevated noise, and alteration of habitat and 2) harm from being exposed to elevated turbidity and reductions in forage for juvenile salmonids, is directly related to the amount of dredged material and the timing of the dredge operation.

Injury or death from entrainment or strike by dredge equipment – Since the potential for PS Chinook salmon (juvenile), PS steelhead (juvenile), PS/Georgia Basin DPSs of yelloweye rockfish and bocaccio (larvae and juvenile) to be entrained is most directly determined by the amount of sediment dredged and the timing of the operation, the extent of take identified for the proposed action is related to the amount of dredged material within a timeframe that anticipates the lowest presence of vulnerable life stages of listed fish. Therefore, the extent of take is a maximum of 3.0 million cy of sediment dredged within Blair Waterway to occur between the August 16 – February 15 work windows for four years. Exceeding this indicator for extent of take would trigger the reinitiation provisions of this Opinion.

Injury or death from elevated noise – PS Chinook salmon (juvenile), PS steelhead (juvenile), PS/Georgia Basin DPSs of yelloweye rockfish and bocaccio (larvae and juvenile) will be exposed to construction-related noise resulting from dredging equipment and construction vessels. Disruption of normal feeding and migration, and injury and death can occur from this exposure. The most appropriate and measurable surrogate for take associated with elevated noise is time spent dredging and operating construction vehicles in the August 16 and February 15, annual work windows for four years. Exceeding this indicator for extent of take would trigger the reinitiation provisions of this Opinion.

Harm from altered habitat – Juvenile PS Chinook salmon and PS/GB bocaccio will be exposed to altered habitat conditions at Saltchuk from the deposit of sediment from the Blair Waterway. During the deposition of 1.8 million cy of beneficial use sediment, juvenile Chinook salmon and juvenile and larval bocaccio will be exposed the placement of sediment over existing subtidal habitat. Since the potential for ESA listed fish to be displaced or smothered is most directly determined by the amount of sediment deposited at the Saltchuk site and the timing of the operation, the extent of take identified for the proposed action is related to the amount of deposited material within a timeframe that anticipates the lowest presence of vulnerable life stages of listed fish. Therefore, the extent of take is a maximum of 1.85 million cy of sediment deposited at Saltchuk to occur between the August 16 – February 15 work windows for four years. Exceeding this indicator for extent of take would trigger the reinitiation provisions of thisOpinion.

Harm from degraded water quality – PS Chinook salmon (juvenile), PS steelhead (juvenile), PS/Georgia Basin DPSs of yelloweye rockfish and bocaccio (larvae and juvenile) would be exposed to degraded water quality. Habitat modified temporarily by suspended solid and contaminants would injure fish by impairing normal patterns of behavior including rearing and migrating in the action area and causing potential health effects. Because injury to individuals can occur when exposed to high levels of suspended sediment, or as a result of avoiding areas affected with high levels of sediment, the extent of take is measured as the anticipated area where suspended sediment would be present. The levels of suspended contaminants are expected to be proportional to the amount of injury that the proposed action is likely to cause through physiological stress from elevated suspended sediments and contaminants throughout the duration of the projects' in water activities. Therefore, the maximum extent of take is defined by the relative increase in turbidity to baseline conditions within the annual work windows for four years. Specifically, turbidity levels shall not exceed 5 NTUs more than background levels when background turbidity is 50 NTUs or less, or there shall not be more than a 10 percent increase turbidity when the background turbidity is more than 50 NTUs. These increases would be limited to a 300 foot area of mixing within the 3-mile radius described in the action area. Exceeding this indicator for extent of take would trigger the reinitiation provisions of this Opinion.

Harm from diminished prey availability – Individual PS Chinook salmon (juvenile), PS steelhead (juvenile), PS/Georgia Basin DPSs of yelloweye rockfish and bocaccio (larvae and juvenile) would be affected by a temporary reduction in prey availability during construction activities. Reductions in fitness among juveniles are likely when prey availability is decreased, and competition increases for prey resources. Therefore, the extent of take is a maximum of 3.0 million cy of sediment dredged within Blair Waterway to occur between the August 16 – February 15 annual work window for four years. Exceeding this indicator for extent of take would trigger the reinitiation provisions of this Opinion.

Exceedance of any of the exposure limits described above would constitute an exceedance of authorized take that may trigger the need to reinitiate consultation. In addition, because the analysis included in this Opinion evaluates project effects for 50 years, the amount or extent of take described above is determined based on that length of time. We cannot reasonably predict the amount or extent of take that would occur after 50 years given the uncertainty of how baseline conditions may change as a result of extraneous factors such as climate change or population growth.

Although these take surrogates could be construed as partially coextensive with the proposed action, they still function as effective reinitiation triggers.

2.8.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1. The Corps shall minimize incidental take of listed species resulting from entrainment and strike.

2. The Corps shall minimize incidental take of listed species resulting from elevated noise.

3. The Corps shall minimize incidental take of listed species resulting from suspended sediment and re-suspended contaminants during dredging, shoreline stabilization, and material placement.

4. The Corps shall develop a monitoring and reporting plan to ensure that the RPM's are implemented as required and take exemption for the proposed action is not exceeded, and that the terms and conditions are effective in minimizing incidental take.

5. The Corps shall develop a plan to enhance restoration efforts implemented at the Saltchuk site and improve nearshore habitat conditions for listed species. Additionally, the Corps and non-federal sponsor shall engage NMFS in finalization of construction and beneficial material use designs to ensure take of listed species is minimized.

2.8.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the federal action agency and/or non-federal sponsor must comply with the following terms and conditions. The Corps has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement RPM 1 (minimize entrainment and strike during dredging):
    a. The Corps shall ensure that dredging equipment is lowered to the bottom slowly to allow ESA listed fish the opportunity to escape.
    b. The Corps shall develop a Dredging Monitoring Plan for NMFS review which monitors and analyzes the first dredge clamshell dredged materials in each new area of activity or in the same area of activity after 6 hours of inactivity for any fish. The Dredging Monitoring Plan shall be available for NMFS review a minimum of 60 days prior to dredging activities. The Dredging Monitoring Plan shall include:
        i. Methods of observation, such as videography or physical observers;
        ii. Identification and size of any fish categorized as either entrained or impacted and alive or dead;
        iii. The date and approximate time of the dredge entrainment;
        iv. An annual report of findings shall be provided to NMFS within 2 months after the work window closes.

2. The following terms and conditions implement RPM 2 (elevated noise):
    a. Adhere to in-water work window August 16 – February 15 for the four years of construction.
    b. The Corps shall develop an Underwater Noise Monitoring Plan to monitor underwater noise levels while dredging at the mouth of the Blair Waterway .

The plan shall be available for NMFS review a minimum of 60 days prior to construction. The Underwater Noise Monitoring Plan shall include:

   i. Methods of observation, such as hydrophones
   ii. A list of activities monitored, including underwater clamshell operation, vessel operations, and sediment deposits at Saltchuk;
   iii. An annual report of findings shall be provided to NMFS within 4 months after the work window closes.

3. The following terms and conditions implement RPM 3 (minimize turbidity and suspended sediments during dredge operation):
   a. Comply with Washington State water quality standards by conducting water quality monitoring during dredging activities. Per state permit, turbidity levels shall not exceed 5 nephelometric turbidity units (NTUs) more than background turbidity when the background turbidity is 50 NTUs or less, or there shall not be more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTUs as measured from a distance of 300 feet.
      i. If turbidity levels in the Blair Waterway exceed the standards as described in the Water Quality certification for this project, adhere to exceedance protocol in the Water Quality Monitoring Plan (WQMP), including notification and coordination with Ecology if additional BMPs are necessary to address turbidity.
      ii. If turbidity levels during material placement at Saltchuk exceed the standards as described in the Water Quality certification for this project, adhere to exceedance protocol in the WQMP, including notification and coordination with Ecology if additional BMPs are necessary to address turbidity. This may include use of a floating silt curtain as appropriate.
   b. Dredge in a manner that minimizes spillage of excess sediments from the bucket and minimizes the potential entrainment of fish. This includes, but is not limited to:
      i. Avoiding the practice of washing unsuitable material off the barge and back into the water. This can be accomplished by the use of hay bale and/or filter fabric.
   c. Ensure dredging contractor utilizes a current, accurate Global Positioning System (GPS) dredge positioning to control the horizontal and vertical extent of the dredge to ensure dredging does not occur outside the limits of the dredge prism.
   d. Ensure that an emergency cleanup plan is in place in the event the barge, truck, or railcar has an incident where unsuitable material is spilled. This plan will be on-board the vehicle at all times.

4. The following terms and conditions implement RPM 4 (monitoring and reporting):
   a. The Corps shall develop an Underwater Observation Monitoring Plan associated with dredging in Blair Waterway and material placement at Saltchuk.

b. The Corps shall provide NMFS with an Underwater Observation Monitoring Plan for review a minimum of 60 days prior to the initiation of construction activities. The Underwater Observation Monitoring Plan shall include:
    i. Methods and schedule to monitor ESA-listed fish presence immediately preceding dredging activities within the Blair Waterway;
    ii. Methods to monitor the abundance and diversity of ESA-listed fish utilizing Saltchuk prior to initiation of construction activities during the first year;
    iii. Methods and schedule to monitor the abundance and diversity of fish utilizing Saltchuk immediately preceding the deposition of sediments at Saltchuk during the construction period if "ramping" (e.g., thin-layer placement or excavator-assisted placement) is not used;

c. Submit annual monitoring reports within 4 months after the work window closes in each of the four years of construction, summarizing the following for the previous calendar year:
    i. Hours of dredging completed per day;
    ii. The number of days of dredging per month and for the entire year;
    iii. The total daily and cumulative sediment removal totals;
    iv. Total sediment disposed at each location (Open water site, Saltchuk, upland);
    v. Turbidity levels from monitoring and whether state turbidity compliance was met;
    vi. Results from dredging monitoring
    vii. Results from noise monitoring;
    viii. Results from underwater observation associated with dredging in Blair Waterway and material placement at Saltchuk.
    ix. Monitoring reports shall be submitted to: projectreports.wcr@noaa.gov, include **WCRO-2020-00645** in the subject line.

d. The USACE shall monitor and report the abundance and diversity of ESA-listed fish utilizing Saltchuk in years 3, 5, and 10 following complete construction.

e. The USACE shall monitor and report natural recruitment of eelgrass and SAV at Saltchuk in years 3, 5, and 10 following complete construction to determine if the beneficial use of dredged material is as beneficial as presumed in this Opinion.

5. The following terms and conditions implement RPM 5 (Restoration planning and design finalization):
    a. Develop a Restoration Plan to enhance actions taken at the Saltchuk Restoration Site that includes measures to improve nearshore habitat PBFs for PS Chinook salmon and PS/GB bocaccio. The Restoration Plan shall:
        i. Collaboratively engage with NMFS, state, federal, and tribal agencies in finalizing project designs;
        ii. Provide NMFS with finalized project designs within a minimum of 60 days prior to commencing construction.

Submit Reports. All reports shall contain the WCRO Tracking number and be sent by electronic copy to NOAA's reporting system email address at: projectreports.wcr@noaa.gov.

2.9 Conservation Recommendations

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02). The following two conservation recommendations are discretionary measures that NMFS believes are consistent with this obligation and therefore should be carried out by the Corps.

Recommended conservation measures include:

1. Monitor water quality for PCBs, PBDEs, and PAHs at the mouth of the Blair Waterway prior to and during construction to expand understanding of long-term exposure risks to ESA-listed salmonids and SRKW critical habitat and increase recovery potential for ESA-listed salmonids and rockfish by reducing the exposure of toxins.

2.10 Reinitiation of Consultation

This concludes formal consultation for the Corps.

As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the federal agency or by the Service where discretionary federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.11 "Not Likely to Adversely Affect" Determinations

Southern Resident Killer Whales

The Corps determined that the proposed action was not likely to adversely affect SRKW or adversely modify their critical habitat. NMFS concurs with the Corps' determination.

Between the three pods that comprise this DPS, identified as J, K, and L, some members of the DPS may be present in the Puget Sound at any time of the year based on observational data recorded since 1976. More generally, data shows that all three pods are in Puget Sound June through September, which means that all are likely present in Puget Sound during the designated work window. The whales' seasonal movements are only somewhat predictable and exhibit large inter-annual variability in arrival time and days spent in inland waters. In recent years, late arrivals and fewer days spent in inland waters has been common.

While SRKW are sighted in Commencement Bay, they are not known to enter the Port of Tacoma or nearby areas and typically avoid the high-traffic area around Tacoma Harbor. Vessel speed is the greatest predictor of noise levels received by killer whales. Dredges and associated work vessels will be either stationary or traveling slowly for the purpose of surveying the bottom surface, maneuvering the dredge and barge, or transiting the barge to disposal sites. Slow vessel speeds should minimize emitted sound. Based on the short distance of sound attenuation from the dredges and associated work vessels and that very few killer whales would be present, effects of underwater noise from dredging will be short duration, low intensity, minimal, and therefore insignificant. The number and spread of vessels are not expected to result in blocking movements of the whales in their travel corridors. Therefore, it is unlikely that any small transitory disturbance from vessels that might occur would have more than a very minor effect on passage in designated critical habitat. Lastly, given that the proposed action is expected to result in a 27% reduction in vessel activity throughout Puget Sound, and we did not find any information to indicate the larger vessels would result in an increase in ship strikes on SRKW or other marine mammals in the action area, effects from these activities on passage in SRKWs or their critical habitat is likely to be wholly beneficial.

Concentrations of PCBs and other bioavailable contaminants in biota may increase during dredging. The rate of resuspension is estimated at 3% of material with an increased bioavailability for approximately two to three years (AECOM 2012; Patmont et al. 2018). This minor fraction would have a negligible effect to killer whale prey and an undetectable contribution to the whales themselves. Analysis on continued use of the DMMP disposal sites concluded that effects of transport and disposal of dredged material containing biomagnifying substances to killer whales are discountable. A summary of the rationale provided is that the DMMP uses rigorous testing procedures to quantify effects and disposal sites are showing generally similar or lower concentrations of contaminants compared to nearby locations.

The impairment of prey (PS Chinook salmon) from the temporary construction effects of the proposed action is extremely small, due to the application of the work window to avoid peak presence of this species at the juvenile life stage and the other reasons discussed above. Given the total quantity of prey available to SRKWs throughout their range, this short-term reduction in prey that results from the temporary construction effects is extremely small. Because the annual reduction is so small, there is also a low probability that any of the Chinook salmon killed from implementation of the proposed action would be intercepted by the killer whales across their vast range in the absence of the proposed action. Therefore, the NMFS anticipates that any short-term reduction of Chinook salmon during construction would have little effect on Southern Resident killer whales. While water quality will be briefly reduced by turbid conditions and brief chemical contamination with the removal of the creosote pilings, these diminishments will ameliorate shortly after work ceases, and the features will re-establish their baseline level of function. NMFS did not identify enduring effects on SRKW from the proposed action. SRKW prey species, Chinook salmon, will be adversely affected by the proposed action as described above, but the numbers of individual fish affected, and the degree of these effects are unlikely to alter population level abundance of juvenile fish in a manner that will diminish prey availability of returning adult Chinook salmon. All effects on SRKW PBFs are insignificant.

Humpback Whale
The Corps made no determination of effects to humpback whales as a result of the proposed action.

Humpback whales are occasionally sighted in south Puget Sound, but they have never been documented in the Blair Waterway. Humpback whales if present in the vicinity of the project, would not be expected to venture into Commencement Bay. Humpback whales will not be exposed to the short-term water quality effects because they are unlikely to reach the areas where individuals would be found. The chance of a humpback whale being exposed to any effect caused by the dredging or construction in Commencement Bay is discountable. Any impact resulting from reduced vessel traffic would be wholly beneficial to humpback whales. Based on this analysis, NMFS determined that the proposed action is discountable, and not likely to adversely affect listed humpback whales.

Green Sturgeon
The Corps determined that the proposed action was not likely to adversely affect green sturgeon or adversely modify their critical habitat. NMFS concurs with the Corps' determination.

Effects of the action on green sturgeon are unlikely; if green sturgeon are present in the action area of Puget Sound, they rely on deep bottom areas for feeding and rearing, indicating that the effects of the action are unlikely. The only known spawning areas for green sturgeon are in the Rogue, Klamath, Trinity, Sacramento, and Eel rivers in southern Oregon and Northern California. Therefore, their presence in the project area is considered unlikely and therefore any effects of the action is insignificant.

Eulachon
The Corps determined that the proposed action was not likely to adversely affect eulachon. NMFS concurs with the Corps' determination.

Eulachon are endemic to the eastern Pacific Ocean and range from northern California to southwest Alaska and into the southeastern Bering Sea. The southern DPS of Pacific Eulachon includes populations spawning in rivers south of the Nass River in British Columbia to the Mad River in California. Eulachon primarily spawn in the Columbia River system in Washington State. Eulachon runs are typically found in systems with snow pack or glacier-fed freshets, or extensive spring freshets (Hay and McCarter 2000). Eulachon leave saltwater to spawn in their natal streams in late winter through early summer and typically spawn in the lower reaches of larger rivers fed by snowmelt, glacial runoff, or extensive spring freshets (Gustafson 2010). Spawning begins as early as December and January in the Columbia River system, peaks in February, and can continue through May. Larval outmigration occurs 30 to 40 days after spawning. After hatching, larvae are carried downstream and are widely dispersed by estuarine and ocean currents. Eulachon movements in the ocean are poorly understood. Eulachon are far less common in south Puget Sound drainages and are not considered to be established in the Puget Sound rivers (NMFS 2010). Eulachon may rarely enter the Puget Sound in large schools, but this has seldom been documented; the last such documented large school of Eulachon in the Puget Sound was in 1983 (NMFS 2010). Based on the low likelihood of Eulachon existing in Commencement Bay and Puget Sound we find the effects of the action on species to be unlikely, and therefore insignificant.

3 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)]

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific Coast groundfish (Pacific Fishery Management Council [PFMC] 2005), coastal pelagic species (CPS) (PFMC 1998), and Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The entire action area fully overlaps with identified EFH for Pacific Coast salmon, Pacific Coast groundfish, and coastal pelagic species. Designated EFH for groundfish and coastal pelagic species encompasses all waters along the coasts of Washington, Oregon, and California that are seaward from the mean high water line, including upriver extent of saltwater intrusion in river mouths to the boundary of the U.S economic zone, approximately 230 (370.4 km) offshore (PFMC 1998 a,b). Designated EFH for salmonids species within marine water extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone offshore of Washington, Oregon, and California, north of Point Conception to the Canadian border (PFMC 1999). Groundfish, coastal pelagic, and salmonid fish species that could have designated EFH in the action area are listed in tables 12, 13, and 14.

Additionally, Puget Sound is a Habitat Area of Particular Concern (HAPC), based on importance of the ecological function provided by the habitat. The environmental effects of the proposed project may adversely affect EFH for Pacific groundfish, coastal pelagic species, and Pacific coast salmon in the HAPC for these species.

Table 12. EFH Pacific coast groundfish species likely occupying the action area.

Common Name	Scientific Name	Common Name	Scientific Name
Arrowtooth flounder	*Atheresthes stomias*	Pacific Ocean perch	*Sebastes alutus*
Big skate	*Raja binoculata*	Pacific sanddab	*Ctlharichthys sordidus*
Black rockfish	*Sebastes melanops*	Petrale sole	*Eopsetta jordani*
Bocaccio	*Sebastes Paucispinis*	Quillback rockfish	*Sebastes maliger*
Brown rockfish	*Sebastes auriculatus*	Ratfish	*Hydrolagus colliei*
Butter sole	*Isopsetta isolepis*	Redbanded rockfish	*Sebastes proriger*
Cabezon	*Scorpaenichthys marmoratus*	Rex sole	*Glyptocephalus zachirus*
California Skate	*Raja inomata*	Rock sole	*Lepidopsetta bilineata*
Canary rockfish	*Sebastes pinniger*	Rosethorn rockfish	*Sebastes helvomaculatus*
China rockfish	*Sebastes nebulosus*	Rosy rockfish	*Sebastes rosaceus*
Copper rockfish	*Sebastes caurinus*	Rougheye rockfish	*Sebastes aleutianus*
Curlfin sole	*Pleuronichthys decurrens*	Sablefish	*Anoplopoma fimbria*
Darkblotch rockfish	*Sebastes crameri*	Sand sole	*Psettichthys melanistictus*
Dover sole	*Microstomus pacificus*	Sharpchin rockfish	*Sebastes zacentrus*
English sole	*Parophrys vetulus*	Shorts pine thornyhead	*Sebastolobus alascanus*
Flathead sole	*Hippoglossoides elassodon*	Spiny dogfish	*Squalus acanthias*
Greenstriped rockfish	*Sebastes elongatus*	Splitnose rockfish	*Sebastes diploproa*
Hake	*Merluccuys productus*	Starry flounder	*Platichthys stellatus*
Kelp greenling	*Hexagrammos decagrammus*	Tiger rockfish	*Sebastes nigrocinctus*
Lingcod	*Ophiodon elongatus*	Vermilion rockfish	*Sebastes miniatus*
Longnose skate	*Raja rhina*	Yelloweye rockfish	*Sebastes ruberrimus*
Pacific cod	*Gadus macrocephalus*	Yellowtail rockfish	*Sebastes llavidus*

Table 13. EFH coastal pelagic species likely occupying the action area.

Common Name	Scientific Name
Market Squid	*Latigo opalescens*
Norther Anchovy	*Engraulis mordax*
Jack Mackerel	*Trachurus symmetricus*
Pacific Mackerel	*Scomber japonicas*
Pacific Sardine	*Sardinops sagax*

Table 14. EFH Pacific salmon species occupying the action area.

Common Name	Scientific Name
Chinook Salmon	*Oncorhynchus tshawytscha*
Coho Salmon	*Oncorhynchus kisutch*
Pink Salmon	*Oncorhynchus gorbuscha*

3.2 Adverse Effects on Essential Fish Habitat

The proposed action will temporarily diminish water quality, disturb benthic habitat and bottom sediments, and re-suspend contaminated sediments contemporaneously with pulses of turbidity.

While the action increases the overall depth of the Blair Waterway by 6 feet it does not change the functional characteristics of the habitat conditions within the waterway. The disturbance is expected to short lived and benefit species at the Saltchuk disposal site over the long-term.

3.3 Essential Fish Habitat Conservation Recommendations

NMFS determined that the following conservation recommendations are necessary to avoid, minimize, mitigate, or otherwise offset the impact of the proposed action on EFH:

1. Require vessel operators to operate at the lowest safe maneuvering speeds and power settings when maneuvering in waters close to the shoreline;
2. Allow no overflow from the barge or hopper;
3. When using a mechanical dredge increase cycle time and reduce bucket deployment;
4. Always use equipment that generates the least amount of sedimentation, siltation, and turbidity;
5. When using a clamshell bucket, dredge in complete passes;
6. Sample and monitor noise levels in real-time during dredging activities. If noise levels surpass accepted thresholds for aquatic organisms implement alternative methodology to reduce noise;
7. Incentivize development of peer-reviewed studies that identify how noise generated from dredging impacts aquatic organisms and EFH; and
8. Restore eelgrass and nearshore habitat along the Northwest shoreline and throughout Commencement Bay nearshore areas.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in Section 3.2, above, for Pacific coast salmon, Pacific coast groundfish, and coastal pelagic species.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Corps must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the federal agency have agreed to use alternative time frames for the federal agency response. The response must include a description of the measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this Opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this Opinion are the Corps. Individual copies of this Opinion were provided to the Corps. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this Opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, if applicable, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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DEPARTMENT OF THE ARMY
U.S ARMY CORPS OF ENGINEERS, SEATTLE DISTRICT
4735 EAST MARGINAL WAY SOUTH BLDG 1202
SEATTLE, WA 98134-2388

March 15, 2022

Planning, Environmental and Cultural Resources Branch

Kim W. Kratz
Assistant Regional Administrator
Oregon Washington Coastal Office
National Marine Fisheries Service
1201 Northeast Lloyd Boulevard, Suite 1100
Portland, Oregon 97232

Dear Mr. Kratz:

This letter responds to the February 16, 2022, Essential Fish Habitat (EFH) Conservation Recommendations accompanying the National Marine Fisheries Service (NMFS) Biological Opinion (BiOp) on the effects of the U.S. Army Corps of Engineers' (Corps) Proposed Tacoma Harbor Navigation Improvement Project in the Blair Waterway of Tacoma Harbor, Pierce County, Washington (HUC 171100190204; WCRO-2020-00645). That document was in response to the Corps' Biological Assessment, same subject, submitted in March 2020 pursuant to Section 7 of the Endangered Species Act, as amended.

The Corps is providing a detailed response to NMFS' EFH conservation recommendations within 30 days of their receipt, as provided in 50 CFR 600.920(k)(1). The conservation recommendations from NMFS are stated below, followed by an explanatory response to each. Section 3 of the BiOp contains eight EFH conservation recommendations. In response to your request to identify the number of conservation recommendations accepted, the Corps accepts recommendations one through five (a-e) in full, number six (f) in part, and numbers seven and eight (g-h) in full as allowed under existing Corps programs and authorities. Our detailed responses indicate the acceptance status of each recommendation.

EFH Conservation Recommendations:

a. Require vessel operators to operate at the lowest safe maneuvering speeds and power settings when maneuvering in waters close to the shoreline.
b. Allow no overflow from the barge or hopper.
c. When using a mechanical dredge increase cycle time and reduce bucket deployment.

d. Always use equipment that generates the least amount of sedimentation, siltation, and turbidity.
e. When using a clamshell bucket, dredge in complete passes.

EFH Recommendations (a) - (e) Response: Accepted. These recommendations are generally standard practices within the Corps' dredging protocols and described in the specifications of dredging contracts. The Corps will include these recommendations in the applicable dredging contract(s).

f. Sample and monitor noise levels in real-time during dredging activities. If noise levels surpass accepted thresholds for aquatic organisms implement alternative methodology to reduce noise.

EFH Recommendation (f) Response: Accepted as follows. Underwater noise will be monitored as described in Term and Condition 2 of the BiOp. Alternative methodologies to reduce noise during mechanical (clamshell) dredging are not feasible; however, mechanical dredging generates less noise than hydraulic dredging. Available measures to minimize noise will already be implemented, such as using a clamshell bucket and recommendations listed above under a and c.

g. Incentivize development of peer-reviewed studies that identify how noise generated from dredging impacts aquatic organisms and EFH.

EFH Recommendation (g) Response: Accepted. Studies of dredging effects, including those from noise, are performed by the Corps' Engineer Research and Development Center (ERDC) under the Dredging Operations and Environmental Research Program (DOER; https://doer.el.erdc.dren.mil). DOER supports the Corps' Operation and Maintenance Navigation Program. Research is designed to balance operational and environmental initiatives and to meet complex economic, engineering, and environmental challenges of dredging and disposal in support of the navigation mission. Research will continue under these and other applicable Corps programs and authorities. Results are disseminated to Corps technical staff through webinars, newsletters, and the online ERDC library, which is also available to the public at the link above. A portion of DOER and ERDC research result in peer-reviewed journal publications (https://erdc-library.erdc.dren.mil/jspui/). Navigation programs receive research information from technical staff, engineering regulations, and the annual Corps national dredging meeting, as appropriate.

h. Restore eelgrass and nearshore habitat along the Northwest shoreline and throughout Commencement Bay nearshore areas.

EFH Recommendation (h) Response: Accepted. This project does not have an ecosystem restoration component, but the Corps has included beneficial use of dredged material at Saltchuk in the Recommended Plan that, once constructed, would be expected to improve nearshore habitat conditions along the northwest shoreline of Commencement Bay. Planting eelgrass is not part of dredged material placement at Saltchuk. However, the project will raise substrate to elevations suitable for potential eelgrass colonization (+5 to -10 feet mean lower low water). In addition, this may encourage others to further pursue habitat restoration actions in and near Saltchuk. The Port of Tacoma (Port), for instance, has expressed plans to perform habitat restoration adjacent to Saltchuk. Port actions are still being developed, but initial designs include tidal marsh benches, removal of shoreline structures, and riparian habitat improvements.

Thank you for your attention to this matter. If you have any questions or need additional information, please contact Ms. Katie Whitlock at 206-764-3576 or Kaitlin.E.Whitlock@usace.army.mil.

Sincerely,

Laura A. Boerner, LG, LHG
Chief, Planning, Environmental & Cultural
Resources Branch

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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SUPERFUND &
EMERGENCY
MANAGEMENT DIVISION

August 14, 2020

Laura A. Boerner, LG, LHG
Chief, Planning, Environmental, and Cultural Resources Branch
Corps of Engineers, Seattle District
P.O. Box 3755
Seattle, Washington 98124-3755

Re: EPA Comments on USACE Draft Tacoma Harbor Feasibility Report/Environmental Assessment

Dear Ms. Boerner:

We have received you letter dated May 28th and concur that your letter clearly articulates our April 29th conversation regarding contaminant concentrations and management of sediments in the Blair Waterway. Based on the relatively low contaminant concentrations, we agree that USACE could easily manage these sediments with the standard Best Management Practices currently identified in the draft Feasibility Report and used during typical navigation dredging projects with unsuitable material.

As a point of clarification, the February 14 letter was sent to you from the NEPA review group at EPA, which is separate from the Superfund and Emergency Management Group (SEMD). My office cannot speak to the monitoring at the open water disposal site as it is beyond our purview. We have shared your letter with them so that they are aware of your response. EPA will continue to coordinate with you on this project through that office. Please make sure that you send your other responses to that group rather than to SEMD.

If you have any further questions or concerns regarding this project, please contact Justine Barton, Water Division, at (206) 553-6051 or by email at barton.justine@epa.gov.

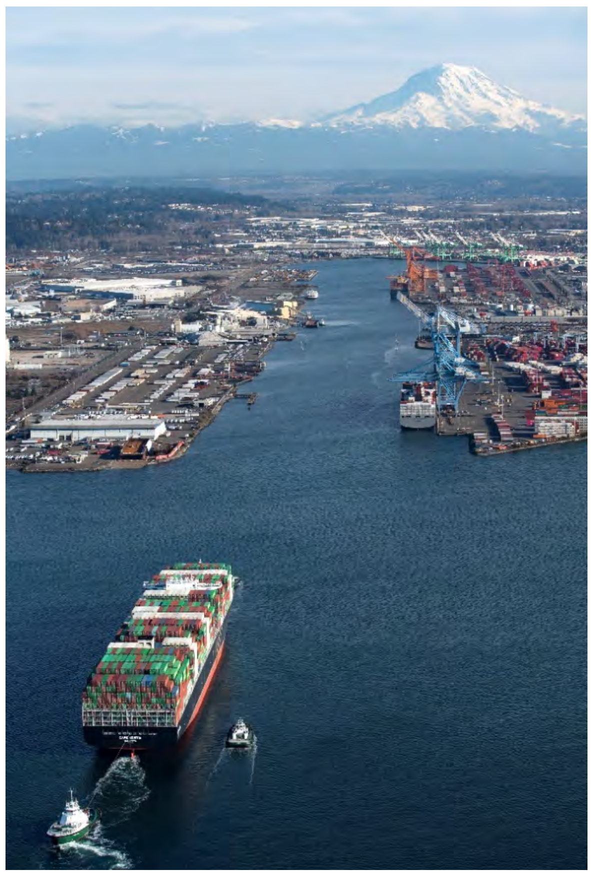
Sincerely,

Kristine Koch
Project Manager
SEMD Cleanup Section 3

cc: Justine Barton, EPA-WD via email
Kristen Kerns, USACE via email

TACOMA HARBOR, WA
NAVIGATION IMPROVEMENT PROJECT
PIERCE COUNTY, WASHINGTON

BIOLOGICAL ASSESSMENT



JANUARY 2020

US Army Corps of Engineers®
Seattle District

Port of Tacoma

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1 Introduction

This Biological Assessment (BA) addresses the effects of the U.S. Army Corps of Engineers (Corps) proposal for navigation channel improvements in the Blair Waterway at Tacoma Harbor, Washington on species protected under the Endangered Species Act (ESA) of 1973. The federally authorized Tacoma Harbor navigation project, consisting of the Hylebos Waterway, Blair Waterway, two training walls at the mouth of the Puyallup River, and the Thea Foss Waterway, is located in Puget Sound's Commencement Bay at Tacoma, Washington. The Corps identified alternatives at Blair and Sitcum waterways during initial plan formulation; however, the Port of Tacoma subsequently requested to remove Sitcum Waterway from the study scope (Chapter 3 of the draft Feasibility Report/Environmental Assessment [FR/EA]; USACE 2019). The Blair Waterway provides approximately 2.75 miles of deep draft navigation accessible from Commencement Bay, Puget Sound, and the Pacific Ocean. For the proposed action, the Blair Waterway will be dredged with a clamshell dredge, dredged materials will be barged, and in-water disposal of suitable materials will occur at the Dredge Material Management Program (DMMP) open-water site in Commencement Bay. Material would be placed Saltchuk aquatic site, an approximately 64 acre site located northeast of the Blair waterway, if it is suitable for beneficial use of dredged material and based on ongoing habitat model evaluation, funding, and approval. Dredged material that does not meet DMMP standards for open-water disposal, or the standards set for Saltchuk beneficial reuse, will be taken to an appropriate upland disposal site.

Consultations with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS; jointly the Services) on disposal of dredged material at the DMMP open-water disposal sites in Puget Sound were conducted separately (USACE 2015a). Therefore, this BA evaluates only the dredging of the Blair Waterway, a range of slope stabilization measures, and any potential effects of material placement at Saltchuk and transporting material to a transloading facility for upland disposal. Species considered in this BA are only those ESA-listed species with potential to occur within a 3-mile radius of the project area in the Blair Waterway (Section 2, Figure 3).

This BA will serve as the consultation document addressing the deepening activities during Section 7 consultation with the Services per the requirements of the ESA. It evaluates potential effects of the project on Essential Fish Habitat (EFH) under Public Law 104-297 (the Sustainable Fisheries Act of 1996), which amended the Magnuson-Stevens Act. Effects to marine mammals protected under the Marine Mammal Protection Act (MMPA) of 1972 (16 U.S.C. §§ 1361-1407) appear in Section 7.

1.1 Authority

This study is authorized by Section 209, Rivers and Harbors Act of 1962, Public Law 87-874, stating:

> "The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to wind or tidal effects, to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its territorial possessions, which include the following named localities:…Puget Sound, Washington, and adjacent waters, including tributaries, in the interest of flood control, navigation, and other water uses and related land resources."

Section 209, Rivers and Harbors Act of 1962, Public Law 87-874 allows for the evaluation of alternatives for navigation improvement and consideration of ecosystem restoration in the form of beneficial use of dredge material at Tacoma Harbor including the non-Federal Sitcum waterway.

1.2 Purpose and Need for Federal Action

The purpose of the proposed Federal action is to achieve transportation cost savings (increased economic efficiencies) at Tacoma Harbor. Depths of the Blair Waterway result in container ships often experiencing tidal restrictions due to inadequate channel depth. These tidal restrictions are operational inefficiencies and economic inefficiencies that translate into costs for the national economy.

1.3 Consultation History

The Tacoma Harbor Federal Navigation Channel includes the Hylebos Waterway, Blair Waterway, two training walls at the mouth of the Puyallup River, and the Thea Foss Waterway. During maintenance dredging of the existing Federal channel, dredged material determined suitable for aquatic disposal would be transported to the DMMP-managed multi-user Commencement Bay open-water disposal site, and material that is unsuitable for in-water disposal would be transported to an upland facility. The following documents represent the known history of ESA consultations relevant to the action area of the proposed action described in this document. The proposed navigation improvement action does not include any additional waterways or training structures at the mouth of the Puyallup River.

Multiuser DMMP sites

- NMFS Consultation No. WCR-2015-2975. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion, Section (a)(2) "Not Likely to Adversely Affect" Determination, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation, and Fish and Wildlife Coordination Act Recommendations: Multiuser DMMP sites in Puget Sound and Grays Harbor, December 2015
- USFWS Ref. 01EWFW00-2015-I-0724. Letter of Concurrence: Continued Use of Multiuser Dredged Material Disposal Sites in Puget Sound and Grays Harbor, July 2015
- USACE Biological Evaluation: Continued Use of Multiuser Dredged Material Disposal Sites in Puget Sound and Grays Harbor, May 2015
- NMFS Tracking No. 2010/06456. Letter of Concurrence: Endangered Species Act Section 7 Formal Consultation for the Continued Use of Puget Sound Dredged Disposal Analysis Program Dredged Material Disposal Sites, Puget Sound, Washington; November 2011
- USFWS Ref. 13410-2010-I-0542. Letter of Concurrence: Puget Sound Dredged Disposal Analysis Program, January 2011
- NMFS Tracking No. 2010/04249. Biological Opinion: Endangered Species Act Section 7 Formal Consultation for the Continued Use of Puget Sound Dredged Disposal Analysis Program Dredged Material Disposal Sites, Puget Sound, Washington; December 2010
- USACE Biological Evaluation: Continued Use of Puget Sound Dredged Disposal Analysis Program (PSDDA) Dredged Material Disposal Sites, August 2010

Blair Waterway Dredging Modification

- NMFS Tracking No. NWR-2011-2336. Blair Waterway, Minor Bank Stabilization Activities (NWS-2010-1340-WRD, Port of Tacoma)

- NMFS Tracking No. NWR-2008-6286. Maintenance Dredging at Washington United Terminal, Blair Waterway, Pierce County (NWS-2008-01128-WRD), Port of Tacoma
- NMFS Tracking No. NWR-2007-7908. Reinitiation - Blair Waterway Infrastructure Improvements (Dredging/Widening) (Port of Tacoma 200400818), Pierce County
- NMFS Tracking No. NWR-2007-5821. Reinitiation - Blair Waterway Infrastructure Improvements (Dredging/Widening) (Port of Tacoma 200400818), Pierce County
- NMFS Tracking No. NWR-2005-265. Blair Waterway Infrastructure Improvements (Dredging/Widening) (Port of Tacoma 200400818), Pierce County
- NMFS Tracking No. NWR-2004-751. Blair Waterway Infrastructure
- NMFS Tracking No. NWR-1999-1496. Blair Waterway Channel Deepening, Tacoma Harbor, WA

2 Description of the Project Area and Action Area

The project area is the Port of Tacoma near the city of Tacoma in the Blair Waterway (Figure 1 and Figure 2). The action area (i.e., the area affected directly or indirectly by the dredging project) is defined as the federally authorized navigation channel in the Blair Waterway and an approximately 3-mile radius surrounding the Blair Waterway (Figure 3). A 3-mile radius was chosen to fully capture effects within Commencement Bay and the lower Puyallup River. The lack of terrestrial species affected by the proposed project primarily limits the action area to the aquatic portions of the Blair Waterway, Saltchuk, and Commencement Bay; however, the action area also encompasses the intertidal portion of Saltchuk (Figure 3). The 3-mile radius encompasses the farthest extent of effects that could occur outside the project area, such as water quality impacts, noise and disturbance from vessel or equipment activity, potential entrainment, and transport of materials by boat to the transloading facility. The complete authorized Federal Navigation Channel within Tacoma consists of the Hylebos Waterway, Blair Waterway, two training walls at the mouth of the Puyallup River, and the Thea Foss Waterway. The proposed action will occur only in the Blair Waterway and potentially at Saltchuk. The current configuration of the Blair Waterway provides about 2.75 miles of deep draft navigation, including the turning basin, accessible from Commencement Bay, Puget Sound, and the Pacific Ocean. The entire length is currently dredged to -51 feet below mean lower low water (MLLW; hereafter expressed as -X MLLW, which indicates the number of feet below MLLW). The current federally authorized dimensions of the Federal Blair Waterway appear in Table 1. The current channel depth is -51 MLLW.

Table 1. Current Federally Authorized Widths by Channel Station on Blair Waterway.

Stations along the channel	Authorized widths (feet)
STA 0 to STA 12	520
STA 12 to STA 44	520 narrowing to 343
STA 44 to STA 52	520
STA 52 to STA 79	520 narrowing to 330
STA 79 to STA 100	330
STA 100 to STA 116	330 widening to 1,682
STA 116 to STA 140	1,682

Figure 1. Location of Tacoma Harbor within Washington State.

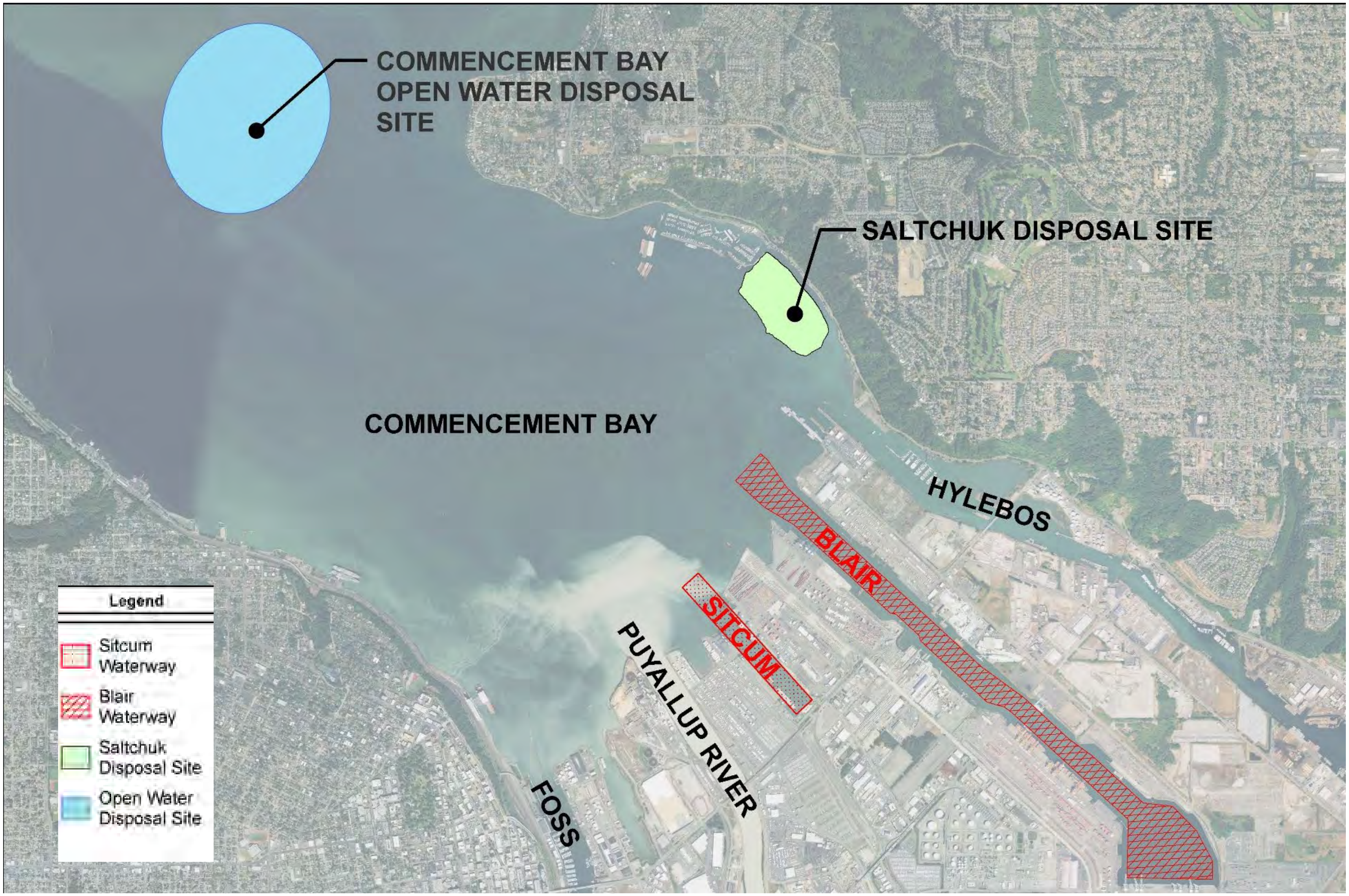

Figure 2. Tacoma Harbor Project Area, which includes Blair Waterway, Saltchuk disposal site, and Commencement Bay open-water disposal site. Navigation improvements to Sitcum Waterway are not being investigated.

Figure 3. Project area and action area with a 3-mile radius surrounding the project site (Blair Waterway).

3 Proposed Action

The Corps and Port of Tacoma determined the deepest channel that is economically justified is -57 MLLW (USACE 2019). This plan is the Tentatively Selected Plan (TSP), which is the plan that the Corps has identified to carry forward for public review during the feasibility study. The Corps will refine the TSP, if needed, based on public review and additional feasibility-level analysis to identify a recommended plan for approval and congressional authorization for construction. A detailed account of the TSP selection appears in USACE 2019. A summary of the proposal appears below:

- Deepen the existing Blair Waterway from an authorized depth of -51 MLLW to -57 MLLW
- Selective channel widening from 450 feet to 865 feet (Table 2)
- Ongoing evaluation of beneficial use at the Saltchuk site, based on preliminary analysis using the pending nearshore habitat valuation model (Appendix A)

Table 2. Federally Authorized and Proposed Widths by Channel Station (STA) at Blair Waterway.

Stations along the channel	Authorized widths (feet)	Proposed width (feet)
STA -5 to STA 0		865
STA 0 to STA 12	520	800
STA 12 to STA 44	520, 343	520
STA 44 to STA 52	520	520
STA 52 to STA 79	520,330	520
STA 79 to STA 100	330	450
STA 100 to STA 116	330, 1,682	525
STA 116 to STA 140	1,682	1,935

The feasibility level sediment sampling indicates that out of the estimated total 2,783,000 cubic yards (CY) of dredge material from this area, approximately 2.4 million CY should be suitable for open-water disposal sites, and 392,000 CY would be unsuitable requiring upland disposal. The estimated time to dredge is approximately 3 years. The in-water work window for material disposal at the Commencement Bay open-water disposal site (Figure 4) is from August 16 through February 15 based on avoiding impacts to the vulnerable life stages of sensitive fish species, including migration, spawning, and rearing. In-water work for other locations of Commencement Bay, including dredging, is July 16 through February 15 (Washington Administrative Code [WAC] 220-660-330; Corps 2017b). For this project, it is assumed that there would be one Operation and Maintenance (O&M) dredge event every 25 years, with a volume of approximately 100,000 CY.

Additional evaluation of beneficial use is included in the TSP because the incremental cost of beneficial use of dredged material at Saltchuk (Appendix A) is reasonable in relation to the environmental benefits achieved (Section 3.6.1.2 of the draft FR/EA; USACE 2019). Full placement at Saltchuk would involve the placement of about 1.8 million CY of suitable dredged material, reducing the quantity of material going to the DMMP Commencement Bay open-water disposal site by an equal amount. The Corps is continuing evaluation of environmentally beneficial use of dredged material at the Saltchuk site. At this stage of design proposals and scenario analysis, the Corps and non-Federal sponsor are evaluating only a conceptual-level design to determine whether any proposal for beneficial use would have environmental benefits, be a cost-effective scenario for dredged material disposal, and be technically feasible. Analysis must demonstrate the value of the environmental resources restored by the placement method, describe and quantify the environmental outputs, and show Federal and State resource agencies support for the environmentally beneficial disposal method.

Three primary areas of wood waste deposits cover approximately 13% (8 acres) of the 64-acre site. The wood waste present at Saltchuk is not known to be chemically treated, and thus not a suspected source of Hazardous, Toxic, and Radiological Waste (HTRW). This aspect of the proposed action would require additional investigation for how to meet the Sediment Management Standards as set forth by Washington Department of Ecology (Ecology) and how best to achieve environmental benefits while avoiding additional impacts that can sometimes occur from burying wood waste. This action is part of the TSP; therefore, the Corps and non-Federal sponsor will coordinate with Ecology and all other relevant natural resources agencies and tribes throughout the next stages of design.

The quantities of sediment that will need to be dredged to achieve this improvement are up to approximately 2,804,000 CY from the Blair Waterway. These quantities assume the proposed depth of -57 MLLW, and that the contractor removes the 2-foot allowable overdepth while dredging the channels. O&M needs of the Saltchuk site are assumed to be minimal and will be evaluated prior to the final FR/EA and would be the responsibility of the non-Federal sponsor, and are not included in this Federal proposed action.

The method for dredging is mechanical (using a clamshell bucket dredge), which will use a digging bucket to remove the material suitable for open-water placement, while an environmental bucket will be used for material unsuitable for open-water placement. Dredged material will be placed on a barge adjacent to the dredge.

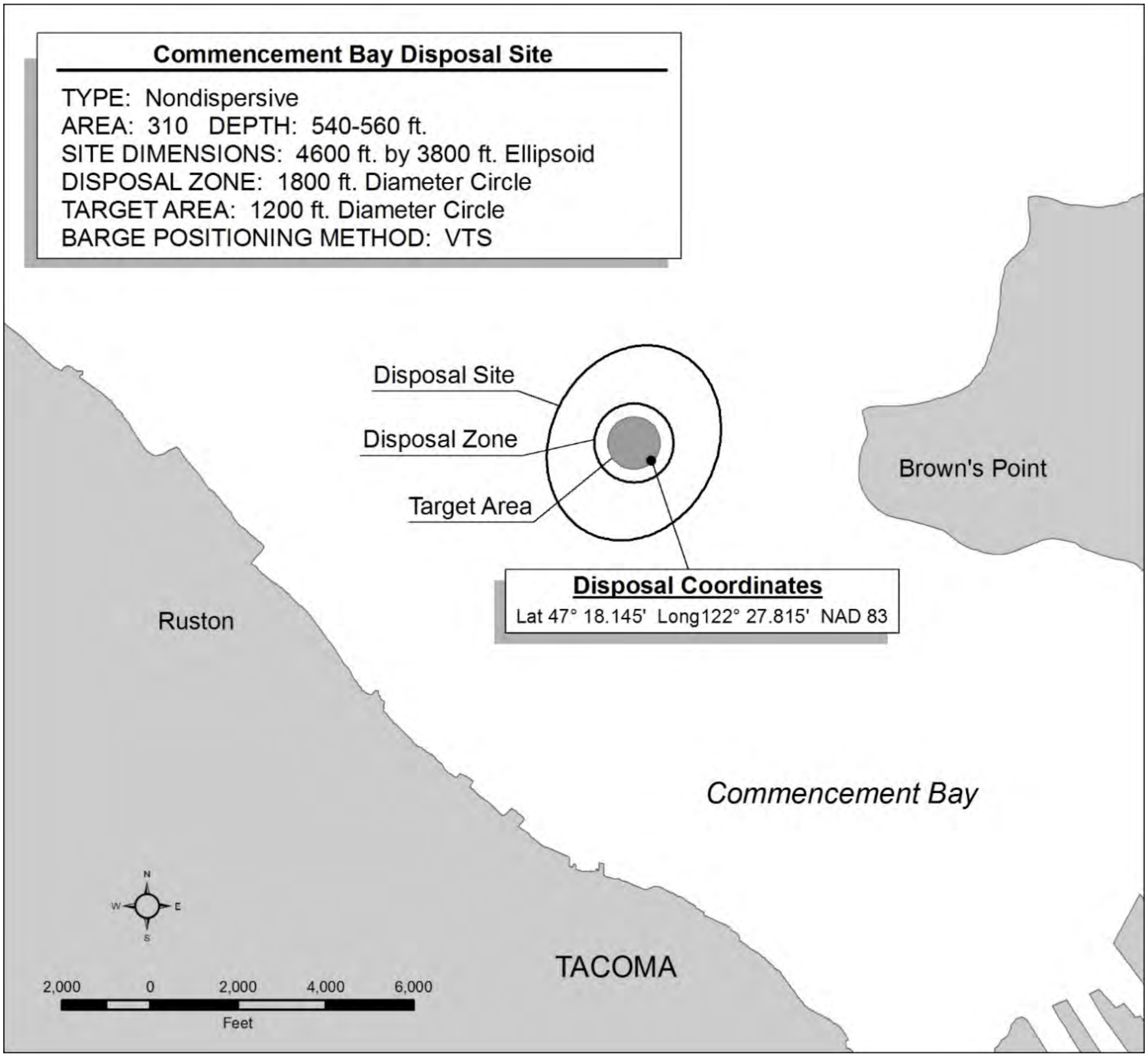

Figure 4. Commencement Bay Multi-user Dredged Material Disposal site.

The recommended sideslope for the Federal channel is a ratio of 2 horizontal on 1 vertical (2H:1V). This design is informed by an analysis of the Blair Waterway bathymetry survey from 2018, which indicates that the sideslopes from previous deepening projects have tended to stabilize at 2H:1V, or shallower. In other words, when the channel sideslope is at a ratio of 2H:1V or shallower, the Corps believes that engineered slope stabilization measures such as sheetpile or secant pile walls are not necessary to maintain the slope and prevent sloughing. Previous geotechnical work by others for berth expansions supports this assessment. In addition, Blair Waterway was last dredged approximately 20 years ago, which has provided ample time to see potential sloughing effects after dredging and stable slopes to develop. With this observed sideslope behavior, the Corps believes approximately 2H:1V slopes associated with the preferred alternative will not require engineered slope stabilization (e.g., sheetpile or secant pile walls) in most of the project. As needed, the Corps will consider sideslope stabilization measures at select areas in the Pre-construction Engineering and Design (PED) phase along the following stationing:

- Area 1: STA 44+00.00 to STA 48+00.00
- Area 2: STA 74+50.00 to STA 82+00.00
- Area 3: STA 94+50.00 to STA 97+50.00
- Area 4: STA 118+00.00 to STA 125+50.00

Figure 7 shows the potential locations where sideslope stabilization may be necessary for the navigation channel along the Blair Waterway. Sideslope stability requirements will be further analyzed and addressed in PED phase when ship simulation confirms the final channel alignment and width. Stabilization measures may include, but are not limited to, secant wall, sheet pile wall, and/or 1.5:1 slopes with rock toe stabilization. The actual stabilization method employed for each area will depend on whether or not the top of the slope in each area extends into the upland facilities and, if it does not, the available clearance (i.e., distance) between the top of the slope to upland facilities. Upland is land elevated above shore land, in an area above where water flows. Upland facilities include parking lots, buildings, utilities, or other infrastructure.

Several assumptions about sideslope stability measures are made in the draft FR/EA, to address the level of uncertainty given the range of slope stability measures in this planning document. To account for variations in cost among the range of slope stability measures, the draft FR/EA assumes that the project will include the most expensive stabilization measure of vertical slopes (i.e., secant wall) at Areas 1-4. To ensure that we have analyzed the most extensive potential impacts to the environment, we evaluated a range of slope stability measures that would have the greatest amount of physical impact (i.e., greatest area of fill material) and the greatest construction impacts (e.g., noise). Given the uncertainty of slope stabilization needs and design, this BA will examine a range of slope stabilization measures with feasibility-level preliminary design, and current information regarding each Area. The Corps will provide updated design information to the Services in PED, and the Corps will determine whether a request for reconsultation is warranted at that time, after assessing if there is new information that was not appropriately addressed in this consultation regarding the effect of the actual specific slope stabilization measures employed at these four locations.

Area 1 (STA 44+00.00 to STA 48+00.00) is about a third of the way into the channel on the southwestern side (Figure 7). Slopes extend to the edge of the adjacent uplands facilities, which consist of an asphalt-paved parking lot. There may be enough clearance so that additional stabilization measures are not necessary at this location, and the natural 2H:1V slope may be structurally appropriate for the final design. Alternatively, Area 1 may have to use a 1.5H:1V slope-rock toe combination. Additional analysis once the design is further refined in PED will be necessary to determine the actual appropriate engineering solution at this location. For purposes of this BA, it is assumed that additional stabilization measures in the form of 1.5 H:1V slope-rock toe combination will be required at this location.

Area 2 (STA 74+50.00 to STA 82+00.00) is about midway into the channel on the north side (Figure 7). Area 2 is Puyallup Tribe of Indians (Tribal) property, so Real Estate considerations may limit the work that can be performed here (Section 5.4 of the draft FR/EA; USACE 2019). A 2H:1V slope reaches well into the uplands in Area 2, likely prompting the need for stabilization measures. It is also unlikely that a 1.5H:1V slope-rock toe combination can be implemented in Area 2. HTRW material remains in place in the uplands at this location, also referred to as the Lincoln Avenue Ditch and Former Lincoln Avenue Ditch. This material is outside the proposed navigation channel alignment, adjacent to the east side of Blair Waterway (Area 2 on Figure 3-4 in the Draft FR/EA; USACE 2019), and has institutional controls in place to limit disturbance of the site in the upland (upland is land elevated above shore land, in an area above where water flows). Based on conceptual design information, the Corps assumes there is enough distance between the proposed navigation channel and existing institutional controls in the uplands that extend approximately 30 feet from the top of the bank to allow for an engineering solution that completely avoids the remaining contamination in this upland area. There is a strong probability that more substantial stabilization measures such as sheet piling or a secant wall may be necessary to protect the institutional controls in place. For purposes of this BA, it is assumed that additional stabilization measures in the form of sheep piling or a secant wall will be required at this location.

Area 3 (STA 94+50.00 to STA 97+50.00) is on the north side of the channel and is Puyallup Tribal property (Figure 7). As with Area 2, a 2H:1V slope extends into the uplands and a 1.5H:1V slope-rock toe solution may not completely prevent extension to the uplands. Depending on Real Estate considerations and further analysis, a 2H:1V cutback may be completed. If such a cutback cannot be done, a more substantial stabilization such as sheet piling would be anticipated for Area 3. For purposes of this BA, it is assumed that additional stabilization measures in the form of sheep piling will be required at this location.

Area 4 (STA 118+00.00 to STA 125+50.00) is on the north side of the channel within the entrance to the turning basin (Figure 7). It is similar to Area 1, where a 2H:1V slope barely extends into the uplands. This area does not include any uplands facilities or major infrastructure, the land here is owned by the Port, and it is used for storage. Depending on compatibility with upland use by the Port, Area 4 could have a 1.5H:1V slope-rock toe combination measure or a 2H:1V slope with no stabilization. For purposes of this BA, it is assumed that additional stabilization measures in the form of a 1.5H:1V slope-rock toe combination measure will be required at this location.

Local Service Facilities (LSFs) include terminals and transfer facilities, docks, berthing areas, and local access channels. The LSFs assumed for this project include berthing area deepening at Husky Terminal, Washington United Terminal (WUT), and Pierce County Terminal (PCT) for any depths below -54 MLLW. LSFs are 100 percent non-Federal costs. Port of Tacoma provided estimated lengths of slope strengthening required for each container facility (Figure 5). As shown, 1,140 feet, 2,010 feet, and 2,090 feet of slope strengthening are required for all berth deepening below -54 MLLW at Husky, WUT, and PCT, respectively. These improvements include reinforcement of the slope as well as construction of a new toe wall. State, local, or private actions that may affect shoreline or aquatic habitat in the action area will be required to obtain Federal permits, and as such will undergo separate Section 7 consultation and review.

Figure 5. Anticipated Slope Strengthening by Facility for Depth Below -54 MLLW.

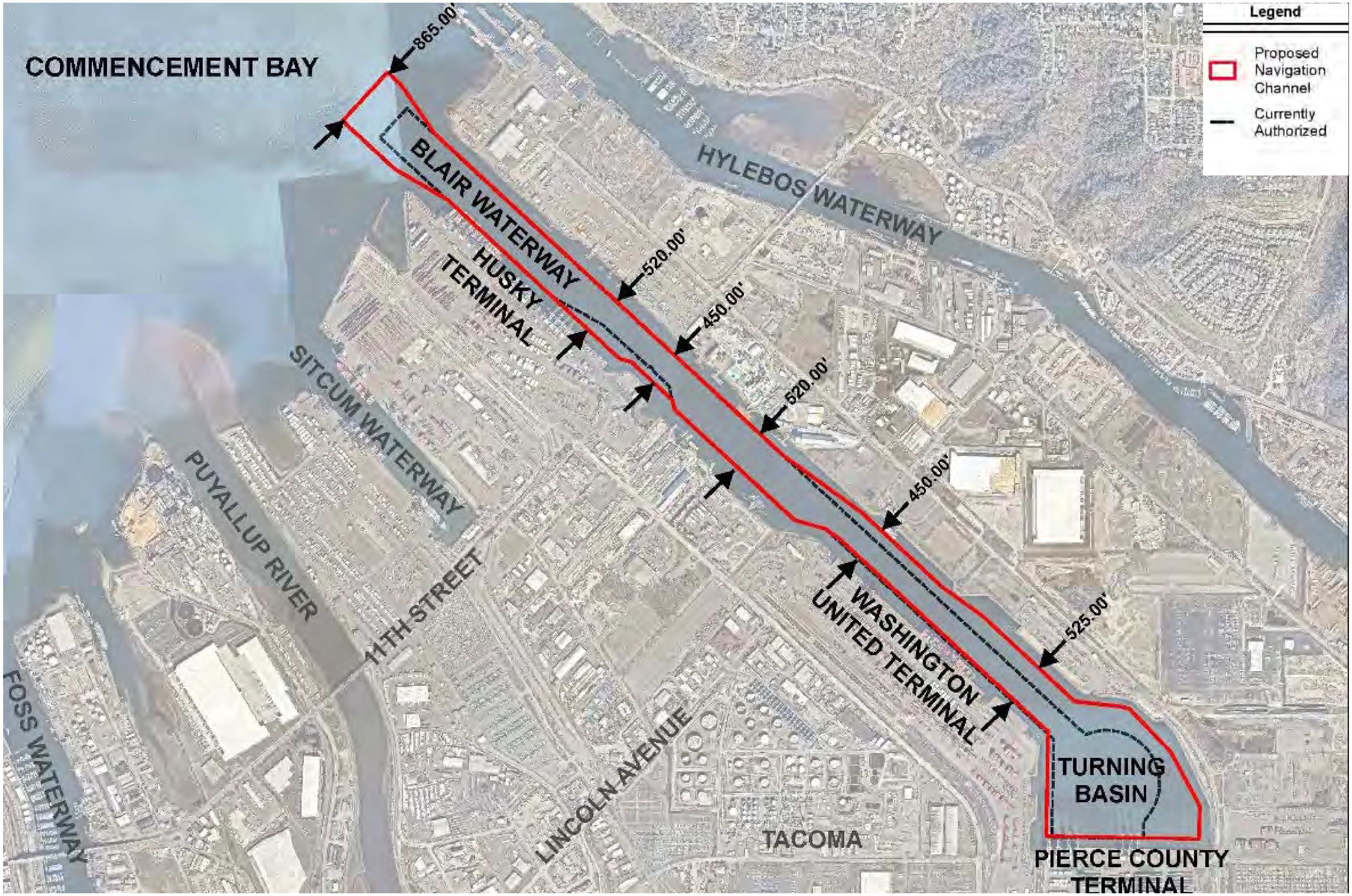

Figure 6. Tentatively Selected Plan (TSP) for the Tacoma Harbor Navigation Improvement Project, where the Blair Waterway would be dredged to -57 MLLW.

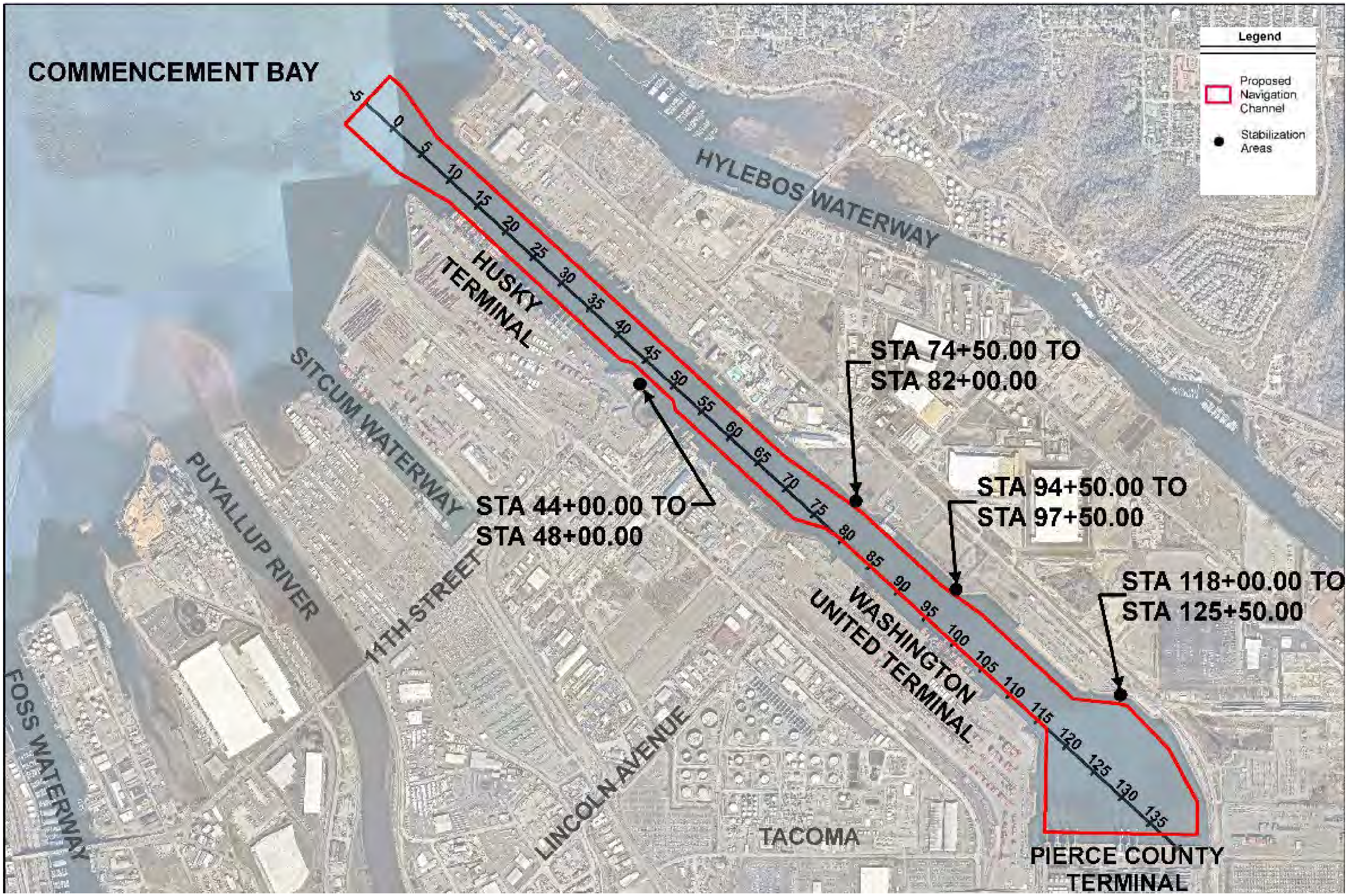

Figure 7. Potential Side Slope Stabilization Areas for the Tentatively Selected Plan (TSP).

To execute construction, several pieces of in-water equipment will be operating for up to 24 hours per day. Only one dredge will be operating at a time and will be running nearly continuously during the in-water work windows except for breaks for crew change or machinery maintenance. Vessels associated with the proposed transport and disposal activities are primarily tugboats with barges. One to two tugboats for towing barges is expected to be employed for the duration of this project transiting between the waterway and the Commencement Bay open-water disposal site. A survey vessel will slowly transit the area to measure dredging progress. The draft Water Quality Monitoring Plan (WQMP; Appendix B) calls for monitoring twice per day; a WQMP will be developed and provided to for approval by Ecology during PED phase. The duration of work will most likely be throughout the six- to seven-month work window (July 16 through February 15) in three consecutive years to accomplish the channel deepening. The in-water work window for material placement at the Commencement Bay open-water disposal site is from August 16 through February 15. In-water work in Commencement Bay, including dredging, is authorized to occur July 16 through February 15 (WAC 220-660-330; Corps 2017b). Therefore, Saltchuk construction may occur during this work window. The Corps would coordinate with Washington Department of Fish and Wildlife (WDFW) and affected tribes to confirm the appropriate in-water work windows.

Corps policy recommends dredged material placement in the least costly manner consistent with sound engineering practice and pursuant to all Federal environmental standards including the environmental standards established by Section 404 of the Clean Water Act of 1972 or Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972, as amended. These criteria determine the "base plan" for dredged material placement. The TSP as described above includes a base plan for disposal of dredged material that meets open-water disposal criteria to occur at the Commencement Bay open-water disposal site and for material unsuitable for aquatic disposal to be disposed of at an upland facility. The quantity estimated as suitable for open-water disposal is approximately 2.4 million CY.

The Saltchuk site is not the least cost placement site and is not the base plan. However, based on preliminary analysis and results, the TSP includes additional evaluation of beneficial use of dredged material at Saltchuk. Full placement at Saltchuk for beneficial use of dredged material would be about 1.8 million CY of dredged material, reducing the quantity of material going to the Commencement Bay open-water disposal site by an equal amount. Material would be placed via bottom-dump barge for the first bench (up to -20 MLLW). For placement of dredged material shallower than -20 MLLW, additional equipment such as flat deck barges and a barge-mounted excavator would be required to place and shape the material. If beneficial use of dredged material is not carried forward, then about 2.4 million CY would go to the Commencement Bay open-water disposal site. The remaining 392,000 CY in the Blair Waterway that may not meet open-water disposal criteria will be disposed upland at an appropriate facility.

This consultation document is intended to cover the complete action as described above, which is anticipated to take about three years to complete. Maintenance dredging of the navigation channel is expected to be necessary approximately once every 25 years and existing environmental documentation would be supplemented at such time that maintenance is needed.

4 Affected Resources and Environmental Baseline Condition

4.1 Baseline Conditions

The environmental baseline reflects the past and present impacts of all Federal, State or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02 [2019]). The ongoing consequences to the environment of the presence and operation of the facilities and structures under the current configuration constitute a portion of the pre-existing status quo. These continuing effects comprise part of the environmental baseline, to which the effects of the proposed action of waterway deepening and widening the Federal channel, as well as dredge material placement, would be added. The consequences of the proposed Federal action thus consist of the temporal impacts of construction, altered operational use of the Port, as well as the incremental long-term effects of alterations in configuration of the deepened waterway and modified nearshore from the beneficial use of the dredged material, in comparison to the environmental baseline.

Development of Commencement Bay as a port likely began with the Northern Pacific Railroad that crossed salt marsh from the City of Puyallup to Tacoma at Thea Foss Waterway in 1874 (USACE 1993). There was limited development before 1877 and the earliest photos and maps indicate that the main habitat types of Commencement Bay were 2,085 acres of intertidal mudflats and about 3,894 acres of salt/brackish marsh. Only about 180 acres of mudflat and 50 acres of salt/brackish marsh remained by 1999, although restoration projects have brought back about 235 acres of habitat (EarthCorps 2015).

Lingering effects of more than a century of human development combined with numerous ongoing activities in the industrial waterways have contributed to the currently degraded environmental baseline conditions in Commencement Bay, including the Blair Waterway. The most notable HTRW site within the study boundary is the Commencement Bay Nearshore Tideflats Superfund Site, placed on the National Priorities List (NPL) in 1981. The Record of Decision for the site was issued in September 1989. Blair Waterway was originally included as a component of the Superfund Site. The Operable Units (OUs) associated with Blair Waterway include the Commencement Bay/Nearshore Tideflats Sediments OU (OU1) and the Commencement Bay/Nearshore Tideflats Source OU (OU5; Map appears in Appendix H of the draft FR/EA; USACE 2019). The U.S. Environmental Protection Agency (EPA) issued a partial deletion in 1996 pertaining to the portions of the two separate OUs addressing sediments contained in and properties draining to the Blair Waterway (EPA 2014). As such, the environmental baseline assumes that no further Federal action is required to address remediation of sediments or associated sources to Blair Waterway. Additional HTRW site descriptions appear in Section 4.11 of the draft FR/EA (USACE 2019). There are no HTRW sites overlapping Saltchuk.

4.1.1 Terrestrial Habitat

The shorelines of Commencement Bay have been highly altered using riprap, and other materials to provide bank protection. The Port of Tacoma waterways were developed for industrial and commercial operations and the upland areas are heavily industrialized. Blair Waterway comprises seven percent of the total of armored shoreline that covers 71 percent of the length of the Commencement Bay shoreline. Commencement Bay contains dense industrial, commercial, and residential development and is a major shipping route for containerized and bulk cargo, which is consequently subject to high volumes of marine traffic. Air quality has been a local concern in the neighborhoods surrounding Tacoma's industrial area including the project area. The Port of Tacoma has been implementing emissions reduction programs and achieving a net reduction. Sediments, including those along the shorelines in the project area have been determined to be contaminated and require clean-up actions, which are already completed at some sites while work continues at others.

4.1.2 Aquatic Habitat

Aquatic portions of the project area are composed of intertidal and subtidal habitats. Intertidal habitat along the shorelines of the project area is limited by shoreline armoring and overwater structures. Commencement Bay has been highly modified by industrial development with large areas of fill, dredging, stabilization, and infrastructure (Simenstad 2000). Overwater structures in the form of piers for ship loading are prevalent along the shorelines of the project area. Based on shoreline surveys and aerial photo interpretation of the area, approximately five miles, or 20 percent of the Commencement Bay shoreline, is covered by wide over-water structures (Kerwin 1999). The Blair Waterway is altered from its natural state using riprap that provides low to medium quality feeding and refuge habitat for juvenile salmon. This shading affects the community of the subtidal organisms that serve as fish food or habitat structure in the form of eelgrass and kelp (Nightingale and Simenstad 2001). Piers and other overwater structures can inhibit juvenile salmon migration as physical barriers, shading that causes avoidance, and increased susceptibility to predation (Simenstad et al. 1982). The project area within the Blair Waterway contains no kelp or eelgrass patches, but there is some eelgrass near the mouth of the Hylebos Waterway.

Portions of Commencement Bay are on Ecology's 303(d) list of threatened and impaired waters, listed as "polluted" for specific parameters. Inner Commencement Bay is listed for Bis(2-Ethylhexyl)phthalate and polychlorinated biphenyls (PCBs). Within the inner bay, Thea Foss Waterway is listed for PCBs, and Hylebos Waterway is listed for dieldrin, PCBs, chlorinated pesticides, dichlorodiphenyltrichloroethane (DDT), and high molecular weight Polycyclic Aromatic Hydrocarbons The Blair Waterway is not on the 303(d) list, but it is listed under "waters of concern" for benzene, tetrachloroethylene, and trichloroethylene. Outer Commencement Bay, which includes Saltchuk, is listed for bacteria, DO, PCBs, and Bis(2-Ethylhexyl)phthalate.

Baseline conditions include regular disruptions on a daily basis when large shipping vessels transit the channel and displace fish and wildlife due to underwater noise and physical presence. Tacoma Harbor already receives calls from the 14,000 twenty-foot equivalent unit (TEU) capacity *Thalassa Axia*, which began calling in November 2018. The *Thalassa Axia* is the largest ship calling at Tacoma Harbor as of December 2019. This also includes regular maintenance projects and other planned infrastructure upgrades by the Port (Sections 1.4, 3.5, and 4.11 of the draft FR/EA; USACE 2019). Dredging and in-water work can cause fish to avoid areas due to noise of machinery or dredges and associated vessels. To minimize impacts to salmonids, dredging schedules and in-water work observe in-water work windows.

The in-water work window, established by State and Federal agencies, minimizes potential impacts to important fish, wildlife, and habitat resources. The in-water work window for material disposal at the Commencement Bay open-water disposal site is August 16 through February 15 to avoid impacts to vulnerable life stages of sensitive fish species, such as migration, spawning, and rearing. The Washington Administrative Code (WAC) and Corps' Regulatory Program authorize all other in-water work in Commencement Bay, including dredging, to occur July 16 through February 15 (WAC 220-660-330; USACE 2019).

The depth of sea floor in most of Commencement Bay (30-100 meters; 98-330 feet) and the depth of Blair Waterway (-51 MLLW) is not habitat that salmonids select for feeding or refuge. Some estuarine and marine fish and sub-tidal marine invertebrates inhabit and feed at deeper subtidal elevations within the action area. Additionally, the invertebrates inhabiting the substrate of the Blair Waterway, such as polychaete and nematode worms, do not contribute significantly to the salmonid food chain (Hiss and Boomer 1986). The Blair Waterway has side slopes of 2H:1V in most locations.

Wapato Creek drains to the head of the Blair Waterway. Salmonid habitat is limited due to extremely low summer and fall flows, poor water quality and heavy siltation due to residential and commercial development, agricultural and storm runoff, and heavy industry discharge. Intermittent surveys from the 1970s to the 1990s found an extremely limited number of coho and fall chum salmon use and spawn in the lower reaches of Wapato Creek and its tributary, Simon's Creek (E. Marks, PTI, pers. comm. 2019). In addition, although winter steelhead may utilize Wapato Creek, data is limited (SalmonScape 2019). There is no documentation of use of Wapato Creek by Chinook salmon or steelhead for twenty years, and NMFS does not believe Wapato Creek provides suitable habitat under existing conditions (J. Fisher, NMFS, pers. comm. 2013). Surveys of Wapato Creek have been inconsistent and low priority due to low salmon production and utilization, and limited accessibility (E. Marks, PTI, pers. comm. 2019).

The Corps sampled and tested sediments within the proposed dredge footprint in 2019 per the Washington DMMP to assess the materials' suitability for open-water disposal. The advisory memo (Appendix C) shows the majority of native sediments dredged for the navigation improvement project will be eligible for open-water disposal or beneficial use at Saltchuk. (The feasibility level sediment sampling indicates that, of the estimated total 2,783,000 CY of dredge material from this area, approximately 2.4 million CY should be suitable for open-water disposal sites, and 392,000 CY would be unsuitable requiring upland disposal).

4.1.3 Saltchuk

Existing habitat of the Saltchuk site is degraded due to previous log raft storage at the site. Lower shore zone habitat (LSZ; from +5 to -10 MLLW) is composed of a substrate that transitions to sand and silt substrate near MLLW. Lower shore zone and deeper habitat includes wood waste. One large area of wood waste was observed from shore during a low tide event, which starts at approximately +0 MLLW (GeoEngineers 2014a, as cited in GeoEngineers 2015). Based on previous wood waste studies, this wood waste concentration extends to a depth of approximately -30 MLLW. It is assumed that 10% of the wood waste (0.83 acres total) is located in the LSZ.

Wood waste has accumulated over approximately 100 years due to log storage at the Saltchuk site. Log storage is visible on a 1931 aerial photograph as well as all subsequent aerial photographs (GeoEngineers

2015) but is no longer used for log storage. Three primary locations within the log storage area were observed to contain wood waste during the 1999 dive survey. Of the entire 64 acre Saltchuk site, approximately 13% (8 acres) is currently covered by wood waste. Ecology (2013) describes three main issues that excess wood waste can have on the benthic environment: 1) the physical presence of wood waste, which prevents biota from thriving and recruiting in and on native, healthy substrate; 2) decreased dissolved oxygen due to microbial decomposition, which can create an unhealthy or toxic environment for biota, and; 3) decomposition by-products such as sulfides, ammonia, and phenols, which can cause or contribute to toxicity.

Macroalgae in the LSZ is largely composed of sea lettuce (Ulva ssp.) and was observed at approximately the MLLW line. No eelgrass was observed within the project area; however, one patch of eelgrass was identified to the southeast of the project area near Hylebos Waterway at depths of approximately -6 feet to -10 MLLW during the underwater video survey conducted August 2014 (GeoEngineers 2015).

The site contains approximately 53 acres of deep subtidal zone habitat (beyond -10 MLLW). This habitat at the site has been incompletely assessed during a SCUBA dive survey in 1999 (Leon 2014, as cited in GeoEngineers 2015) and through a limited underwater video recorded August 4, 2014 (GeoEngineers 2014b, as cited in GeoEngineers 2015). The majority of the deep subtidal habitat at the site consists of brown and black silt with wood waste over gray clay (Anchor 2008, as cited in GeoEngineers 2015).

Macroalgae is present in areas of the deep subtidal habitat and generally consists of brown or red algae (Anchor 2008, as cited in GeoEngineers 2015). Invertebrates were observed during the dive survey including; polychaetes (unidentified species; only burrows observed), anemone (*Metridium senile*), sea stars (*Evasterias trochelii* and *Piaster ochraceus*), red rock crab (*Cancer productus*), ghost shrimp (*Neotrypaea californiensis*), nudibranch (*Dirona albolineata*) and egg masses, and rosy octopus (*Octopus rubescens*;) (Leon 2014, as cited in GeoEngineers 2015). At least 63 creosote-treated timber piles approximately 12 inches in diameter are present in the shallow subtidal zone (GeoEngineers 2015).

4.1.4 Fish

Marine and estuarine fishes in Commencement Bay include three-spine stickleback, shiner perch, Pacific staghorn sculpin, Pacific tomcod, ratfish, copper rockfish, and snake prickleback and forage fish (Dames and Moore 1981). Flatfish such as sole species (English, rock, flathead, C-O, and sand sole), starry flounder, and speckled sanddab are very common throughout Commencement Bay in flat, sandy substrate. The most common species in the waterways are English sole, flathead sole, Pacific staghorn sculpin, Dover sole, ratfish, Pacific tomcod, and starry flounder (Dames and Moore 1981).

Forage fish present include Pacific herring, surf smelt, and sand lance (Dames and Moore 1981). Pacific herring do not spawn in Commencement Bay. The closest pre-spawner holding area is outside of Commencement Bay at the south end of Vashon and Maury islands, and they are likely present within the Bay (Dames and Moore 1981; WDFW 2018). Forage fish are primarily pelagic and would be swimming through the area looking for food; sand lance burrow into sandy substrate and remain from dusk to dawn. Forage fish larvae are ubiquitous in Puget Sound and are a common component of the nearshore plankton. There are limited spawning areas within Commencement Bay, but surf smelt spawning was observed in 2006 on either side of the Puyallup River and near Thea Foss waterway, while sand lance have spawned near the Puyallup River and the southwestern side of Commencement Bay (WDFW 2018).

Spawning is much more extensive along Browns Point and outside the bay. Larvae and juveniles prey on epibenthic invertebrates and crustaceans and are themselves important prey items for larger juvenile salmon and bull trout.

The Puyallup/White River watershed enters Puget Sound at Commencement Bay. Nine stocks of anadromous salmonids have been documented in the Puyallup River: winter steelhead, bull trout, coastal cutthroat trout, and spring/fall Chinook, fall chum, coho, sockeye, and odd-year pink salmon (Dames and Moore 1981; NWIFC 2019). These multiple migratory runs of native and hatchery-reared salmonid stocks occur in multiple seasons during the year in Commencement Bay. Rearing and foraging by juvenile salmonids occurs along the limited shoreline areas that are shallow or retain natural structural diversity. Returning adult salmon congregate at the mouth of the Puyallup River prior to upstream migration. Juvenile salmonids may use the nearshore reaches in addition to Commencement Bay to transition into marine waters. Juvenile salmonids generally enter Commencement Bay January through August, with peak outmigration in May (Marks et al. 2018).

4.1.5 Wildlife

The project area is primarily the aquatic habitat of Saltchuk and the Blair Waterway, a heavily used navigation channel, which are both in close proximity to industrial port infrastructure and activities. The marine mammals most likely to be present in Commencement Bay include harbor seals, Steller sea lion, harbor porpoise, California sea lions, gray whales, and rarely humpback whales, Bigg's (transient) killer whales, and Southern Resident Killer Whales (SRKW; Dames and Moore 1981). A variety of marine birds typical of developed areas in Western Washington occur within the project area, including osprey (*Pandion haliaetus*), glaucous-winged gull (*Larus glaucescens*), pigeon guillemonts, Caspian tern (*Hydroprogne caspia*), double-crested cormorant (*Phalacrocorax auritus*), and great blue heron (*Ardea herodias*). Birds and marine mammals in the project area are assumed to be habituated to the industrial port activities.

4.1.6 Benthic Invertebrates

Several factors determine the benthic invertebrate community, which includes small animals such as crustaceans, shellfish, worms, and insects that dwell in the sediment of estuarine and marine habitats. Factors that influence this community are primarily the substrate, period of inundation, and salinity as well as energy in the form of currents and wave action. The area where work is proposed, also known as the affected environment, is at the bottom of the channel and the areas that may require slope stabilization of the Blair Waterway. Saltchuk is also a component of the affected environment. The habitat classification is estuarine intertidal (Dethier 2014). Due to extensive dredging to create this navigable channel and the development of Commencement Bay, the estuarine habitat of the Blair Waterway is much deeper (-51 MLLW) than an average estuary.

The benthic invertebrate community in Blair Waterway has a high proportion of pollution-tolerant species (Partridge et al. 2010). Since 1999, the Blair Waterway benthic community has been described as adversely affected by natural or human stressors compared to the greater Puget Sound due to extremely low arthropod abundance, low species diversity, and high numbers of mostly stress-tolerant polychaetes (marine worms; Partridge et al. 2010). Benthic samples collected in 1999, 2008, and 2014 all had mollusks and arthropods, but bivalves (clams) and polychaetes were most abundant (Weakland et al. 2016).

4.2 Endangered Species Act Listed Species Present in the Action Area

Based on available information on the distribution of listed, proposed, and candidate species known to occur in the project area, and all consequences caused by the proposed action to ESA-listed species, the Corps has identified eight species or distinct population segments (DPS) that potentially occur in the action area of the Commencement Bay reach of Puget Sound or the Blair Waterway. These appear in Table 3 with their listing status and critical habitat status.

Table 3. ESA-listed species potentially occurring in the project area and their critical habitat designation.

Species	Listing Status	Critical Habitat
Bull trout (Coastal/Puget Sound DPS) (*Salvelinus confluentus*)	Threatened Nov. 1, 1999	Designated Oct. 18, 2010
Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened Mar. 24, 1999	Designated Sept. 2, 2005
Puget Sound steelhead (*O. mykiss*)	Threatened May 11, 2007	Designated Feb. 24, 2016
Bocaccio (*Sebastes paucispinis*)	Endangered Apr. 28, 2010	Designated; disposal site only Nov. 13, 2014
Yelloweye rockfish (*Sebastes ruberrimus*)	Threatened Apr. 28, 2010	Designated; disposal site only Nov. 13, 2014
Pacific Eulachon (Southern DPS) (*Thaleichthys pacificus*)	Threatened Mar. 18, 2010	Designated Oct. 20, 2011
Marbled murrelet (*Brachyramphus marmoratus*)	Threatened Sep. 28, 1992	Designated Oct. 4, 2011
Southern Resident killer whale (*Orcinus orca*)	Endangered Nov. 18, 2005	Designated Nov. 29, 2006

Other ESA-listed species may occur within uplands and marine areas of Commencement Bay and Puget Sound, but are not expected to occur in the project area. Upland species include streaked horned lark (threatened, *Eremophila alpestris strigata*), yellow-billed cuckoo (threatened, *Coccyzus americanus),* marsh sandwort (endangered, *Arenaria paludicola*), water howellia (*Howellia aquatilis*), and marine species include humpback whale (endangered, *Megaptera novaeangliae*), and leatherback sea turtle (endangered, *Dermochelys coriacea*). The Corps found no records of sightings of leatherback sea turtles in Puget Sound, and there are no breeding beaches in Washington.

The project area does not contain habitat that would attract streaked horned lark or yellow-billed cuckoo for breeding or feeding. Commencement Bay does not have coastal dune areas or airport runways where streaked horned lark nest, and the species is considered absent from former breeding sites on the Washington Coast north of Grays Harbor (Stinson 2016). Yellow-billed cuckoo records through 1941 suggest the Tacoma area was a historic nesting area, but the most recent sighting near Tacoma was before 1934 and the nearest nesting populations are in northern California and southern Idaho (Wiles and Kalasz 2017). The range of the marsh sandwort and the water howellia overlaps with landward portion of the action area but the urban and industrial landscape does not include suitable habitat for these species. There have been no recent sightings and both species are considered absent from the project area.

Humpback whales have been sighted in Central Puget Sound, and their overall numbers in the Salish Sea have increased in the last decade (Calambokidis et al. 2018); however, however healthy animals would not utilize areas near the waterway, nor would they be found near the shallow waters of the Saltchuk site. Therefore, humpback whales would not encounter effects of dredging based on the localized and short-term nature of effects.

The Corps has determined there will be no effect to these four species due primarily to the extremely low likelihood of their occurrence and/or the effects of the project would not extend to the species or harm their prey items or habitat in any measurable way.

4.3 Designated Critical Habitat in the Action Area

Of the ESA-listed species, only the salmonids and SRKW have designated critical habitat within the action area of the proposed project, including Saltchuk, considered in this document. Material dredged in this action that is determined suitable for aquatic disposal will be placed at the DMMP-managed Commencement Bay open-water disposal site. Use of the DMMP-managed disposal site has undergone consultation (see Consultation History in Section 2 of this document) and is therefore not considered in this document.

4.3.1 Bull Trout Critical Habitat

Critical habitat for Coastal/Puget Sound bull trout was designated by USFWS in September 2005 (70 FR 56211; USFWS 2005) and revised in October 2010 (75 FR 63898; USFWS 2010). In marine nearshore areas like the action area, the inshore extent of critical habitat is mean higher high water (MHHW), including tidally influenced freshwater heads of estuaries. Adjacent shoreline riparian areas, bluffs, and uplands are not critical habitat. The offshore extent of critical habitat for marine nearshore areas is to the depth of 30 meters (98 feet) relative to MLLW, which is the average depth of the photic zone. This proposed project falls within the geographical boundaries of Critical Habitat Unit 2 – Puget Sound (Marine).

4.3.2 Chinook Salmon Critical Habitat

Critical habitat for 12 species of salmonids including Puget Sound Chinook salmon was designated by NMFS in September 2005 (70 FR 52630; NMFS 2005a). In marine, estuarine, and nearshore areas like the action area, the line of extreme high water defines the inshore extent of critical habitat. The offshore extent of critical habitat for marine nearshore areas is to the depth of 30 meters (98 feet) relative to MLLW, an area that generally coincides with the maximum depth of the photic zone in Puget Sound. The action area lies within the nearshore marine areas critical habitat zone.

4.3.3 Steelhead Critical Habitat

Critical Habitat for Puget Sound steelhead was designated by NMFS in February 2016 (81 FR 9252; NMFS 2016a). In marine, estuarine, and nearshore areas like the action area, the line of extreme high water defines the inshore extent of critical habitat. The offshore extent of critical habitat for marine nearshore areas is to the depth of 30 meters (98 feet) relative to MLLW, an area that generally coincides with the maximum depth of the photic zone in Puget Sound. The action area lies within the nearshore marine areas critical habitat zone. Much of the Puyallup basin is mapped critical habitat for the species including the lower Puyallup and Commencement Bay with certain areas excluded for Tribal, WFP, and HFP lands. These areas include the portion of lower Puyallup River and Tacoma Harbor that falls within the Puyallup Tribe of Indians Reservation.

4.3.4 Southern Resident Killer Whale Critical Habitat

Critical habitat for SRKW was designated by NMFS in November 2006 (71 FR 69054; NMFS 2006). Puget Sound is one of the three specific areas are included in the designation. Based on the natural history of the killer whales and their habitat needs, the physical or biological features of designated critical habitat include water quality to support growth and development; prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and passage conditions to allow for migration, resting, and foraging. Designated critical habitat does not include waters shallower than 20 feet based on extreme high tide. SRKW critical habitat proposed along the outer coast of Washington in 2019 (84 FR 49214) would not be affected by the proposed action.

5 Evaluation of Project Effects on ESA-listed Species and Designated Critical Habitat

Evaluation of possible impacts of the proposed action is based on predicting changes from the baseline condition. This analysis focuses on the effects of the proposed action, as described in Section 3, on ESA-listed species and critical habitat. The dredging activities are proposed to occur for three years from August 16 through February 15, with in-water disposal of suitable material at the Commencement Bay DMMP site l, and from July 16 through February 15 for material placement at Saltchuk.

5.1 General Effects of the Proposed Action

5.1.1 Sediment

Shoaling (the accumulation of sediment within the channel) is estimated to remain steady at about 1,200 CY a year on average based on historic shoaling patterns. Additional information on the shoaling calculation is available in Appendix B of USACE 2019. It is estimated that about 30,000 CY of O&M dredging will be required every 25 years. Therefore, deepening the channels is not anticipated to change the amount of sedimentation in the Blair Waterway. This will not cause an increase in maintenance dredging quantities compared to the baseline conditions.

Sediments placed at Saltchuk would be a similar type and coarseness as some already present in the nearshore sites. Other areas with wood waste or fine material would be covered by native material. Overall sediment quality is expected to improve with beneficial use of dredged material at Saltchuk due to placement of native material and capping of wood waste.

Given the highly industrialized nature of Commencement Bay and Blair Waterway, there are numerous State and Federal cleanup sites immediately adjacent to Blair Waterway. There are 43 Model Toxics Control Act (MTCA) sites surrounding Blair Waterway, along with six Resource Conservation and Recovery Act (RCRA) sites, four Comprehensive Environmental Response, Compensation, and Liability Act sites, and four NPL sites. Fifteen of these sites have known contaminated groundwater and are located immediately next to Blair Waterway. An additional five sites are located one block further away from Blair. It is not known if these sites are leeching contaminated groundwater into Blair Waterway, but it is possible depending on the extent and direction of the plume of contaminated groundwater and the geologic material.Two of the NPL sites listed, Commencement Bay Nearshore Tideflats and Glenn Springs Holdings, are among the contaminated groundwater sites immediately next to, but not overlapping, Blair Waterway. Slope stability design for navigation purposes will receive additional consideration in the PED phase to ensure an engineering solution to address slope stability in the area also complete avoidance of disturbing HTRW material. Design of the side slope will also have to consider potential groundwater impacts, particularly related to any changes in the flow regime.

Because some of the dredged sediments are unsuitable for aquatic disposal, it is important to consider whether re-suspension of this material and its contaminants would cause biological effects to ESA-listed species. It is important to note that unsuitable material does not contain contaminants at levels that requires actionable cleanup under MTCA; instead, the material is unsuitable for aquatic placement. Assuming the standard 3% rate of re-suspension (AECOM 2012), approximately 13,000 CY of unsuitable material would be re-suspended during construction. This estimate is conservative and accounts for dredging to -58 MLLW, which is the maximum depth analyzed in the draft FR/EA (USACE 2019) and the total volume of dredged material includes 2 feet of overdepth during dredging. Different amounts of the mouth (85%), middle (40%), head (100%), and native material (all material approximately below -53 MLLW; 95%) are likely to be appropriate for beneficial use (DMMP 2019). While exact quantities are not available, the level of risk of harm to fish, wildlife, and invertebrates is estimated as low, given that the unsuitable material is a minor fraction of the sediments to be dredged.

Environmental dredging best management practices (BMPs) can mitigate sediment resuspension effects to a degree. Coarser sediments are likely to redeposit close to the dredge location; finer particles are likely to travel further downstream before resettling. The low current velocity in the Blair Waterway would limit the distance fine particles would travel from the dredge site. Resuspension occurs with much greater severity when subsurface debris is encountered. This is due to the dredging bucket not being able to close fully (because it is obstructed by debris) before removing sediments to the surface. The Corps assumes that all appropriate and feasible BMPs to reduce unsuitable material resuspension will be implemented depending on the nature of the sediment. However, some resuspension of unsuitable material during dredging is unavoidable, even with implementation of BMPs.

5.1.2 Water Quality

Some dredged material may contain sediment with biological and chemical oxygen demand that could temporarily lower local ambient dissolved oxygen (DO) levels during dredging. The upper portion of sediment is classified as loam to silt loam while native sediments are sand to loamy sand. Infaunal and benthic organisms inhabit the upper sediment, thus the likelihood of finding much anaerobic sediment in this stratum of sediment is small. Deeper sediment within the dredge prism is more likely to have anoxic conditions. Sediment with a biological oxygen demand will likely be a minor fraction, if any, of the material dredged (USACE 2015b); therefore, the Corps anticipates little or no reduction in ambient DO during dredging. No aspects of the project could change the temperature regime.

Clamshell dredging and material placement at nearshore locations such as Saltchuk typically results in short-term increases in turbidity in a linear plume downcurrent from the dredging activity. The small patch of eelgrass near the mouth of the Hylebos Waterway will be a consideration during material placement at Saltchuk. Water quality protection measures for the protection of eelgrass (e.g., turbidity curtains) would be refined when more detailed current information is available during the PED phase. Turbidity monitoring will occur during dredging to adhere to State water quality requirements as provided by the project's Water Quality Certification. The duration of work will most likely be the entire six- to seven-month work window in three consecutive years to accomplish the channel deepening. This work window is protective of sensitive species.

5.1.3 Fish, Wildlife, and Invertebrates

Dredging for deepening is expected to temporarily displace the bottom-dwelling resident fishes such as flounder, sole, and sculpins. Dredging activity affects only a small area at any given time of the total construction project and the benthic fishes are expected to return the area as the dredge moves to each sequential portion of the channel. The dredge equipment operates in a very small footprint compared to the 214.5 acres of the Blair Waterway channel; therefore, the mobile and migratory fish have a broad area for avoidance of the dredge equipment.

Most forage fish do not occur in the benthic areas of navigation channels and thus are not affected by maintenance dredging. Those that might be transiting navigation channels are not associated with one location, are highly mobile, and can avoid dredging operations, especially clamshell dredges due to the extremely low risk of entrainment. Although sand lance burrow into sandy substrates, it is assumed they would not select an area undergoing active dredging, and if dredging commenced where sand lance were present, they are at low risk of entrainment by clamshell dredges. The effect to the school of fish will be discountable. Likewise, the turbidity plume from the loam, silt loam, or loamy sand as the clamshell bucket rises through the water column may cause a school of forage fish to leave the area, however, no mortality is anticipated, as there is ample aquatic habitat for escape. While forage fish are a prey item for marbled murrelets, the slight displacement of the prey item out of the Blair Waterway is not expected to have any effect to prey availability or abundance.

Effects of dredging on the anadromous salmonids are short-term; these include noise and visual disturbance from the dredging activities and increased turbidity during dredging that may cause an avoidance response of adults during upstream spawning migration. Avoidance of the dredging or turbidity is expected to cause a slight detour around the dredging, particularly within the most constricted portions of the channel (e.g. 200- to 250-meter-wide). However, active dredging is unlikely to delay or substantially divert adult migrating salmonids because the adults can easily swim around a dredge operation without effects to their migration; in addition, they do not have to pass through the Blair Waterway to reach the Puyallup River. The Blair Waterway is an isolated channel that does not have an active outflow of water that would otherwise attract salmon to swim into the channel. Any turbidity plume associated with dredging the channel will be localized and of short duration as the sand settles quickly through the water column and would not be expected to extend more than several hundred feet downcurrent from the dredge. Juvenile salmonids typically move downstream in spring, generally follow the shoreline towards Saltchuk and across the entrance to the Blair Waterway, and are substantially protected by the in-water work windows; therefore, they are unlikely to be affected by dredge and disposal operations. Juvenile Chinook salmon may rear in nearshore areas into the early part of the in-water work window but are unlikely to remain in areas around the waterways due to the lack of useable shallow water habitats.

Any sediments determined to be unsuitable for aquatic disposal will be hauled off site to an appropriate upland disposal site. While this removes unsuitable sediment from the aquatic environment, some amount of resuspension will occur during the dredging process, estimated at approximately 3% or 13,000 CY for the proposed action. Bioaccumulative toxins appear in fish tissues collected throughout the Puget Sound region, and especially in urban areas (Puget Sound Action Team 2007). Concentrations of PCBs and other bioavailable contaminants in biota may have a minor increase during dredging. The increase in contamination concentrations in biota is a temporary effect, which will persist for a number of years following cessation of dredging. The resulting removal of sediment will be a net long-term benefit to the aquatic environment in the Blair Waterway, especially for bottom-dwelling fish that often test positive for contaminants in Puget Sound.

Placement of dredged material at the Saltchuk site would cause mortality of invertebrates present where the bulk of material lands. Larger organisms such as crabs would generally be able to flee the area. Sediments would be a similar type and coarseness as some already present in the nearshore sites. Other areas with wood waste or fine material would be covered by native material. Covering the wood waste with native material may initially harm habitat during early consolidation because any infauna and epifauna would be exposed to the pore water forced upwards from the wood waste below. Depending on the nature of the disposal material, and the wood waste being covered, this may be a transient, short-lived effect. The depth of the total habitat area available would be reduced to provide shallow water habitat for juvenile salmonids. In a relatively short period, organisms would reestablish in the placement area due to recruitment from adjacent non-disturbed areas. Based on these factors, effects to benthic invertebrate populations and their habitat due to dredging and material placement would be minor and insignificant.

Several pieces of equipment will be operating and producing underwater noise for up to 24 hours per day during the in-water work windows, for up to three years. Tugboats have a dominant frequency range of 100-500Hz with a peak output at 170dB_{RMS}, which is above the threshold for Level B harassment of fish (150 dB_{RMS}) and marine mammals (120 dB_{RMS}). Level B harassment has the potential for continuous noise to disturb but not injure for the species of concern in close proximity to the tug, and is expected to attenuate to background quickly with distance from the vessel (approximately 500 meters [1,640 feet]; Clarke et al. 2003). Fish behavior studies have shown that fish will avoid the area of noise and resume normal behaviors just beyond range of harassment noise levels, indicating discountable levels of effect would be occurring near dredging operations (Hastings and Popper 2005). In addition, noise measurements taken during dredging in the Snohomish River recorded a peak output of 168 dB re 1µP at 30 meters (98 feet) when a scow was moved into position by a tug (Pentec 2010). In a similar study, noise measurements during dredging at a frequency range of 100-500 Hz were 140-145 dB re 1µP at 100 meters (328 feet; less than the Level B harassment for fish; SAIC 2011 and RPS). Because the threshold for Level B harassment is measured in dB_{RMS}, which is the root mean square over some determined period and an "average," it is assumed the continuous noise of tug movements would generate a lower dB_{RMS} than the peak sound levels reported in the Snohomish River and be below thresholds or at ambient levels less than 500 meters (1,640 feet) from the tug. Audible frequencies ranges for marine mammals varies among species—pinnipeds begin at 500 Hz (Schusterman et al. 1972), mysticete whales at 10 Hz (Gordon and Moscrop 1996), odontocete whales at 100 Hz (Gordon and Moscrop 1996), and SRKW at 500 Hz (Hall and

Johnson 1971). The dredging location within the Blair Waterway, large size of Commencement Bay, and NMFS (2020) guidelines for viewing marine mammals by watercraft (50 yards from seals and sea lions; 100 yards from large whales; 200 yards from killer whales) are expected to be protective of marine mammals. When in motion, sound produced by the tugboats will be transient and expected to be below background levels a short distance (<500 meters [1,640 feet]) from the moving vessel with no lasting effects to fish, diving birds, or marine mammals.

Dredging causes direct mortality to benthic invertebrates that are incapable of avoiding the disturbance. The surface area that will be dredged is 214.5 acres in the Blair Waterway. The dredging will take up to three years to complete; therefore, the areas in which the benthic organisms are eliminated will not be the total surface area in a single dredging event. This will allow organisms to migrate from undisturbed areas into the deepened segments. Recovery begins with the early colonizers and takes less than a year for the short-lived organisms that have rapid growth and re-population strategies; this is followed by the longer-lived species that generally grow larger but have a slower recovery time of two to three years (Newell et al. 1998).

Slope strengthening in Blair Waterway may be necessary. The exact type of slope strengthening would be refined in PED, but it can be reasonably expected that the installation of slope strengthening would create a temporary disturbance (e.g., sheet pile driving or riprap placement) but BMPs such as vibratory pile driving, bubble curtains, or using the minimum amount of slope strengthening possible would minimize short-term and localized impacts. The Blair Waterway was artificially created and generally has a 2H:1V side slope and piers with varying degrees of slope strengthening (e.g., bulkheads, piles, and riprap) along the length of the channel. This habitat is not high quality aquatic habitat for juvenile salmonids or benthic invertebrates, so presence of engineered slope strengthening along about 8% (762 linear meters total) of the approximately 8,707 linear meters of overall Blair Waterway shoreline in areas of similar, existing development would not substantially degrade the habitat quality of this highly industrial and stabilized waterway.

Construction of slope stability measures in Areas 1-4 would create noise disturbances during construction, depending on the stabilization measure. Grading the slope to the appropriate channel depth would have in-water noise effects as described above for dredging. Construction of a 1.5H:1V slope with a rock toe would have in-water noise effects as described above for dredging. Barges would be used to transport and stage the riprap; the riprap would be placed in a controlled manner (i.e., gradually lowered into place), with the use of a skip box or clamshell bucket at the appropriate elevation above the sediment surface to minimize sediment disturbance.

Construction of slope strengthening with sheet piles or secant walls would temporarily create underwater noise in the Blair Waterway that would extend into Commencement Bay. For this project, vibratory pile driving is the preferred method for installation of sheet piles or secant piles as impact pile driving tends to produce the highest, most damaging noise levels. The vibratory hammer produces sound energy that is spread out over time and is generally 10 to 20 dB lower than impact pile driving therefore, vibratory pile driving is often an avoidance and minimization measure in pile driving projects, depending on the type of construction project and substrate conditions (Caltrans 2015). A similar project in the Blair Waterway found that noise levels were unlikely to exceed 160 dB_{RMS} during vibratory installation of 12-

24-inch concrete piles (BergerABAM 2012). The distance at which 160 dB_{RMS} was expected to attenuate to 120 dB_{RMS} was approximately 2.8 miles (BergerABAM 2012), which is approximately the distance between Area 1 and the mouth of Commencement Bay. The Blair Waterway and shape of Commencement Bay are expected to contain a substantial portion of noise generated. See Appendix E for an example of estimated noise propagation during sheet pile installation as shown in Berger ABAM 2012. A more refined noise analysis for slope stabilization using noise-generating construction methods such as vibratory or impact hammer installation would be provided in PED based on final designs of slope stabilization measures, materials, and installation details.

Economic forecasting has identified a substantial long-term benefit for fish, wildlife, and invertebrates: by the year 2035, navigation improvement is expected to reduce the number of vessel calls from 590 per year to 428 per year compared to the existing condition (USACE 2019). This approximately 27% reduction in vessel calls would reduce disturbance to not only fish in the waterway but also throughout Commencement Bay and the shipping channel in Puget Sound. The economic analysis assumes the same commodity throughput for deepening as the current depth. However, with channel deepening, vessels can load to their full summer loadline draft in order to carry more cargo in each transit. Larger ships results in fewer required transits for the same commodity throughput and a reduction in transportation costs. Table 4 summarizes vessel characteristics by class. Table 5 compares the current channel depth (-51 MLLW) calls to the estimated calls for each depth through -58 MLLW. The analysis assumes that with a channel depth of -57 MLLW, Tacoma Harbor will require 150 and 162 fewer calls in 2030 and 2035, respectively. The number of calls for Post-Panamax Generation 4 (PPX4) and Post-Panamax Generation 3 (PPX3; e.g., 14,000 nominal TEU capacity ship *Thalassa Axia*) vessels would remain the same for all channel depths from -51 (current channel depth) to -57 MLLW (proposed channel depth) in 2030 and 2035, but the number of vessel calls by smaller vessels are projected to reduce as the depth of the channel increases.

For maintenance dredging of the proposed -57 MLLW wider and deeper Federal channel, based on historic shoaling patterns, it is estimated the Blair Waterway will require approximately 30,000 CY of O&M dredging every 25 years to maintain the authorized depth of -57 MLLW.

Table 4. Fleet Subdivisions on Draft (distance from the bottom of vessel to the waterline), Beam (widest point), and LOA (length overall).

Vessel Fleet Subdivision (Containerships)	Dimension	From (feet)	To (feet)
Sub Panamax (SPX) (MSI[1] size brackets: 0.1-1.3, 1.3-2.9 k TEU)	**Beam**	0	98
	Draft	8.2	38.1
	LOA	222	813.3
	DWT	13,000	40,000
Panamax (PX) (MSI size brackets: 1.3-2.9, 2.9-3.9, 3.9-5.2, 5.2-7.6 k TEU)	**Beam**	98	106
	Draft	30.8	44.8
	LOA	572	970
	DWT	49,000	69,000
Post-Panamax (PPX1) (MSI size brackets: 2.9-3.9, 3.9-5.2, 5.2-7.6, 7.6-12 k TEU)	**Beam**	106	138
	Draft	35.4	47.6
	LOA	661	1,045
	DWT	66,000	86,000
Super Post-Panamax (PPX2) (MSI size brackets: 5.2-7.6, 7.6-12 k TEU)	**Beam**	138	144
	Draft	39.4	49.2
	LOA	911	1,205
	DWT	97,000	110,000
Ultra Post-Panamax (PPX3) (MSI size brackets: 5.2-7.6, 7.6-12, 12 k + TEU)	**Beam**	144	168
	Draft	40	53
	LOA	Up to 1,220	
	DWT	104,000	166,000
New Post-Panamax (PPX4) (MSI size brackets: 12 k + TEU)	**Beam**	168	200
	Draft	45	54
	LOA	1,150 and greater	
	DWT	150,000	205,000

[1] MSI = Maritime Strategies Inc.

Table 5. Vessel calls by year, class, and channel depth.

Vessel Class	-51 MLLW	-52 MLLW	-53 MLLW	-54 MLLW	-55 MLLW	-56 MLLW	-57 MLLW	-58 MLLW
2030								
SPX	0	0	0	0	0	0	0	0
PX	0	0	0	0	0	0	0	0
PPX1	49	25	4	0	0	0	0	0
PPX2	155	155	155	132	107	80	54	54
PPX3	229	229	229	229	229	229	229	229
PPX4	116	116	116	116	116	116	116	116
Total	**549**	**525**	**502**	**477**	**452**	**425**	**399**	**399**
2035								
PX	0	0	0	0	0	0	0	0
PPX1	81	55	29	5	0	0	0	0
PPX2	132	132	132	130	107	79	50	50
PPX3	189	189	189	189	189	189	189	189
PPX4	189	189	189	189	189	189	189	189
Total	**590**	**565**	**539**	**513**	**485**	**457**	**428**	**428**

5.2 Effects on Listed Species and Critical Habitat

5.2.1 Puget Sound Chinook salmon

Use of the Action Area

Two distinct populations of Chinook are present in the Puyallup River Basin: White River spring Chinook and Puyallup River fall Chinook. White River spring Chinook are the only spring Chinook stock in the south/central Puget Sound region (Marks et al. 2018). Adult spring Chinook salmon migrate through Commencement Bay to the Puyallup River as early as March or April, while adult fall Chinook salmon generally enter the Puyallup River June through early November on their way to spawning habitat far upstream from the action area (Marks et al. 2018). Adults will hold in moderate to deeper depths utilizing colder water in the action area. Adults may remain near the mouth of their natal river for days to weeks before entering the river.

Juvenile Chinook salmon typically use shallow water habitat and distributary channels for rearing habitat. These components were mostly eliminated by the industrial development and use of the estuary. Juvenile salmonid trapping by the Puyallup Tribal Fisheries Department observed juvenile Chinook salmon emigrating from the lower Puyallup River (River Mile 10.6) as early as January and as late as August, although the peak outmigration is typically late May (Marks et al. 2018). Historic beach seine sampling (1980-1995) in the Blair Waterway generally captured juvenile Chinook salmon after mid-February and before mid-August, with a peak around the end of May (Pacific International Engineering 1999).

Within the Blair Waterway, beach seine data consistently show juvenile Chinook salmon use of the Fairliner site (in the Blair Waterway) and near the mouth of the waterway (E. Marks, PTI, pers. comm. 2019). Beach seine sets in February and March 2004 at sites around Commencement Bay captured 2-7 juvenile Chinook salmon per set in the Fairliner Site and near the mouth of the waterway; meanwhile in 2005, 16 juvenile Chinook salmon were captured in one set at the Fairliner Site at the end of January and 1-23 fish were captured in February (E. Marks, PTI, pers. comm. 2019). In the Commencement Bay nearshore, 30-37 juvenile Chinook were sampled on two occasions in June 2013 for a contaminant study (O'Neill et al. 2015). No juvenile Chinook salmon were captured at Slip 5 or near the mouth of the Blair Waterway in 2016 sampling, but beach seine sets captured 0-4 and 0-2 juvenile Chinook salmon per set at the Fairliner Site in February and March 2016, respectively (E. Marks, PTI, pers. comm. 2019). Sampling at Squally Beach near Saltchuk in 2016 saw the most juvenile Chinook in a June 14th beach seine set (10 fish) and the fewest in a June 9th set (1 fish), while the other sampling dates in April and May had 2-4 fish each (E. Marks, PTI, pers. comm. 2019). These observations suggest that the timing of outmigrating and rearing juvenile Chinook in the Blair Waterway and Commencement Bay nearshore could have minimal overlap with construction or maintenance dredging at the end of the in-work window.

Effects of the Proposed Action

Dredging will occur throughout the in-water work window of July 16 (material placement) or August 16 (open-water disposal) through February 15 for up to three years to achieve target depths; maintenance dredging would follow this about once every 25 years. This timing overlaps with adult Chinook holding and upstream migration through the action area. This timing does not substantially overlap with the timing of when juvenile Chinook migrate downstream from the Puyallup River habitats outward toward Commencement Bay; juveniles outmigrate from the Puyallup River as early as January, but the peak in May is after the in-water work window has closed later in February (Marks et al. 2018).

The location of dredging will be restricted to only the proposed designated Federal navigation channel to depths of -51 MLLW to -57 MLLW with associated widening, plus two feet overdepth dredging. None of the dredging will occur in the intertidal zone or under the pier decking. The dredging location may overlap with areas of moderate to deeper, colder water where adult Chinook may be holding or migrating; however, these large and highly mobile fish are expected to be able to avoid the clamshell dredge and risk of entrainment is extremely low. Displacement of adults may occur on a minor scale as the dredge operates in a small area compared to the entire width of the navigation channel and aquatic habitat available. Dredging is not expected to cause any physical harm. Juvenile Chinook salmon typically migrate along channel margins in shallower water and their habitat use is not expected to overlap with the location of the dredging machinery. The shallowest material placement at Saltchuk extends to -5 MLLW, so very early outmigrating juvenile Chinook salmon may encounter material placement; however, this is a small proportion of Commencement Bay and the in-water work window is protective of the majority of juvenile Chinook salmon.

Underwater Noise

Underwater noise must be considered for projects that operate machinery in aquatic habitat. Noise levels that are considered harassment of salmonids are 150 decibels, root mean square (dB_{RMS}) for continuous exposure and 187 dB_{RMS} for pulsed (Blaxter and Hoss 1981, Knudsen et al. 1992). Dredging in the Snohomish River with a clamshell dredge generated peak noise levels as high as 170 dB re µP (SAIC and

RPS Evans Hamilton 2011). Another study in Cook Inlet recorded a peak noise level of 124 dB re µP when the clamshell hit a course substrate bottom (Dickerson et al. 2001). The Snohomish River study reported peak sound in dB re µP. Note that the thresholds listed above are in dB_{RMS}, which is the root mean square over some determined period. NMFS gives clear guidance for calculating dB_{RMS} for impact and vibratory pile driving, but there is no guidance for the type of sound generated by a clamshell dredge. Noise generated by clamshell dredges is characterized as continuous, since the elevated sound pressure occurs over several seconds (not milliseconds, as is the case with pulsed noise). It is assumed that since dB_{RMS} is an "average" that clamshell dredging would generate a lower dB_{RMS} than the peak sound levels reported in the Snohomish study. The Cook Inlet study also found that softer substrates are more effective at absorbing sound and peak sound measurements in softer substrates did not exceed thresholds for continuous sound. In addition, the dB_{RMS} reported in the Cook Inlet are just barely above harassment thresholds, and the substrate in the Blair Waterway is softer (sand and fine mixture) than that of both of studies and is therefore likely to better attenuate noise for overall lower sound levels.

Several pieces of equipment will be operating and producing underwater noise for up to 24 hours per day during the in-water work window for up to three years. It is assumed only one dredge will be operating at a time and will be running nearly continuously. One to two tugboats for towing barges will be transiting between the waterway and the Elliott Bay open-water disposal site. A survey vessel will slowly transit the area to measure dredging progress. Tugboats have a dominant frequency range of 100-500Hz with a peak output at 170dB_{RMS}, which is above the threshold for Level B harassment for salmonids in close proximity to the tug but is expected to attenuate quickly with distance from the vessel. When in motion, sound produced by the tugboats will be transient and expected to be below background levels a short distance from the moving vessel with no lasting effects, and therefore insignificant. Since the aquatic habitat in the waterway is 200 to 250 meters wide (650 to 820 feet wide), even when the dredge is in the center of the channel, there will be an area available for avoidance of harassment noise levels.

Noise generated by some slope stabilization measures (e.g., vibratory sheet pile driving or secant wall installation) would exceed the 150 dB_{RMS} threshold for harassment of salmonids. Based on previous vibratory pile installation (BergerABAM 2012), noise is not expected to exceed 160 dB_{RMS} and would attenuate to 120 dB_{RMS} at approximately 2.8 miles. In addition, previous pile installation work (Appendix E) has only elevated sound levels in Commencement Bay within a small area where Chinook salmon are unlikely to be present or noise is likely to be discountable.

Turbidity

Water quality parameters such as temperature, dissolved oxygen, and turbidity are correlated with discharge from the Puyallup River, large vessel traffic (e.g., 14,000 TEU ships and larger), and the greater Puget Sound water conditions (Puyallup River Watershed Council 2014). Turbidity is created when large ships enter the Blair Waterway due to the proximity of the propellers to the bottom of the waterway. Sediment can be disturbed and suspended, temporarily creating a plume of turbidity. This occurs when large ships (14,000 TEU and larger) enter the channel at the current -51 MLLW channel depth. The vessel classes calling at Tacoma Harbor would remain the same among depths (-51 MLLW to -57 MLLW), but a deeper channel would reduce the distance from the keel of the ship to the substrate and likely reduce sediment disturbance in the Blair Waterway. In addition, glacial meltwater and high loads of fluvial material generate turbidity in the Puyallup River and into Commencement Bay during times of peak flow, typically during spring and summer melt and fall-winter rains (Puyallup River Watershed Council 2014). These events overlap with some juvenile Chinook salmon presence in the Puyallup River. There are limited data on DO and temperature within the Blair Waterway, but DO measurements in December 1980 were about 6.4 to 7.7 mg/L in the Blair Waterway (Dames and Moore 1981). Outer Commencement Bay is recognized as impaired for DO because samples taken from 1993-2008 were below 6 mg/L (Ecology 2018). Although inner Commencement Bay is not included in this listing for DO impairment, the entire Commencement Bay is part of the Puget Sound Nutrient Source Reduction Project to address human sources of nutrients that may lower DO (Ecology 2019). Temperatures in October 1980 in the Blair Waterway were about 15 °C at the surface to 12 °C at the bottom, while temperatures in December were about 10 °C throughout the water column (Dames and Moore 1981). The proposed dredging is not likely to have an effect on temperature and dissolved oxygen, but can produce localized, short-term turbidity directly downcurrent from the dredging operation as the clamshell bucket lifts through the water column and at the placement site at Saltchuk.

The effects of turbidity on anadromous fish can be classified as behavioral, sublethal, or lethal, depending on the amount of material that becomes re-suspended generally measured as the level of turbidity (Newcombe and MacDonald 1991, Kjelland et al. 2015). Behavioral effects are described as any effect that results in a change of activity usually associated with an organism in an undisturbed environment. These effects include effects to avoidance responses, territoriality, feeding, and homing behavior (Sigler et al. 1984, cited in LaSalle 1988). Sublethal effects relate to tissue injury or alteration of the physiology of an organism. Sublethal effects are chronic in nature and while not leading to immediate death, may result in mortality over time. These may include effects such as gill trauma, or impacts to osmoregulation, blood chemistry, and reproduction and growth. Lethal effects kill individual fish and can cause overall population reductions, or damage the capacity of the system to support future populations.

Suspended sediment levels high enough to cause lethal effects generally are not attained in the natural estuarine environment or during dredging operations (Cordone and Kelley 1961, cited in Gregory 1988; LaSalle 1988) and are not expected to be present during the proposed dredging project. It is apparent that salmonids have the ability to cope with some level of turbidity at certain life stages (Gregory and Northcote 1993). Evidence of this is illustrated by the presence of juvenile salmonids in turbid estuaries prior to leaving for the ocean and in local streams characterized by high natural levels of glacial silt, and therefore high turbidity and low visibility (Gregory and Northcote 1993). However, salmonid populations not normally exposed to high levels of natural turbidity or exposed to anthropogenic sediment sources may be deleteriously affected by levels of turbidity considered to be relatively low (18–70 Nephelometric Turbidity Units [NTUs]; Gregory 1994). Based on the range of turbidity levels throughout the year from the Puyallup River of 1 milligram per liter (mg/L) to over 1500 mg/L during storm events, this would indicate that juvenile Chinook salmon in this river system are adapted to tolerating at least moderate levels of suspended solids during their outmigration.

Other factors to consider regarding turbidity caused by dredging are the coarseness of the material being dredged and the current speed in the waterbody. According to sediment sampling in 2019, the sediment in the top two feet of substrate is 24-90% sand (median 72%), and fine material content was 3.8-76%

(median 27.5%; DMMP 2019, Appendix C). Native material below the top two feet of substrate have a higher percentage of sand and lower percentage of fines than non-native material (DMMP 2019). The average speed of water currents is 0.05 meters per second (m/s; 0.16 feet per second) at the mouth to 0.01 m/s (0.03 feet per second) at the head of the waterway during all tidal phases. The typical quantity of re-suspension is 3% of dredged material (AECOM 2012). Given the grain size and current speeds, this material is expected to fall back to the sea floor in close proximity to the dredging location and Saltchuk without a substantial turbidity plume.

The severity of response of all listed salmonids is anticipated to be no greater than an avoidance of the immediate area of the narrow band of turbidity plume. The orientation of the plume will depend on a combination of dredge or barge location and tidal direction. The area of turbidity that is greater than background levels is expected to occur in only a minor portion of the waterway is being dredged or during material placement at Saltchuk. The Blair Waterway is currently 200-250 meters wide (650 to 820 feet wide) at its narrowest point and Saltchuk is along the open shoreline of Commencement Bay. Fish are expected to have ample area in the aquatic habitat to find refuge without harm from turbidity caused by dredging.

The Corps plans to submit of materials to Ecology for their certification under Section 401 of the Clean Water Act that the project meets State water quality standards. The preliminary estimate is for a 150-foot area of mixing, and the Corps will determine whether there will be a need for a 300-foot area of mixing based on modeling data for grain size, current velocity, and other factors in PED. The Corps anticipates that 150-300 feet will be sufficient distance for turbidity to dissipate to have no or very few exceedances of water quality criteria as measured in NTUs. For consistency with State water quality standards, the expectation is no more than 5 NTUs above background when ambient turbidity is less than 50 NTUs; and no more than 10 NTUs above background when ambient is above 50 NTUs at a distance of 150 feet down current of the dredge. The dredging contractor will conduct water quality monitoring during dredging, and will be required to implement BMPs to insure that potential effects of turbidity are minimized. Dredging requirements will include corrective measures that will be invoked if water quality parameters exceed established standards during dredging operations. These corrective measures emphasize the following: 1) modifying the dredging activity or equipment; 2) reducing the dredging rate; or 3) stopping dredging operations. These corrective measures apply until dredging operation demonstrates compliance with water quality standards. These requirements are expected to minimize water quality impacts during dredging to localized, short-term events. In the event that an extended area of mixing is requested, the request will apply only in areas where sediment has been determined suitable for open-water disposal or placement at Saltchuk.

Due to the low likelihood for a broad or lengthy turbidity plume and the lack of substantial overlap between timing and location of proposed dredging with juvenile Chinook salmon migration and habitat usage, there is low likelihood for behavioral and sublethal effects, and extremely low likelihood for lethal effects. Adult Chinook salmon migrating upstream past or moving in the waterway are large and highly mobile fish that are expected to be able to avoid deleterious effects of the small amount of turbidity associated with the dredging operation.

Effects to Critical Habitat

This section evaluates the potential for effects to the PBFs (physical and biological features) determined to be essential to the conservation of Puget Sound Chinook salmon.

PBF #1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.

> Dredging and the resulting channel improvements will not affect Chinook salmon spawning and larval rearing sites. These sites are in the mainstem Puyallup and White rivers and their tributaries. The dredge area is in Commencement Bay and the facility for transloading to upland disposal has not been identified but is assumed to be located in Commencement Bay. Therefore, the project will have no effect on this PBF.

PBF #2. Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

> Dredging will occur in deep water portions of the Blair Waterway in the middle of the channels away from the shore, and the waterway is estuarine, not freshwater, thus the dredge operations will not adversely affect freshwater rearing conditions. The facility for transloading to upland disposal has not been identified but is assumed to be located in Commencement Bay at an existing developed site that would not contain habitat conditions suitable to support growth and development of juvenile salmon. Therefore, the project will have no effect on this PBF.

PBF #3. Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channel, and undercut banks supporting juvenile and adult mobility and survival.

> Dredging and transloading for upland disposal will not adversely affect freshwater migration corridors because the project area is estuarine habitat, downstream of freshwater habitat. Therefore, the project will have no effect on this PBF.

PBF #4. Estuarine areas free of obstruction with water quality, water quantity, and salinity, conditions supporting juvenile and adult physiological transitions between fresh-and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

> The existing baseline does not support most of the required conditions in the Federal navigation channel. Since dredging will occur only in the center of the channels at depths of -51 to -57 MLLW, it is expected to have no effect on forage food organisms for salmon (e.g. insects and epibenthic organism in shallower, nearshore areas). Material placement at Saltchuk would cause mortality of invertebrates present where the bulk of material lands. Larger organisms such as crabs would generally be able to flee the area. In a relatively short period, organisms would reestablish in the placement area due to recruitment from adjacent non-disturbed areas. There will be no impact to

natural cover. The depth of the total habitat area available would be reduced to provide shallow water habitat for juvenile salmonids and to improve sediment quality at Saltchuk. This will not degrade any conditions or habitats that support juvenile and adult physiological transitions between fresh and saltwater. The effects of the project to this PBF are expected to be insignificant and discountable. Therefore, the project will not adversely affect this PBF.

PBF #5. Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

The existing baseline condition does not support the required conditions in the Federal navigation channel. The dredging site located in the Federal navigation channel and will not approach the intertidal zone of the nearshore area. No natural cover exists in the project area. Consequently, deepening the Blair Waterway and subsequent maintenance dredging will have no effect on nearshore marine areas. Placement of dredged material at Saltchuk will create shallow water habitat for juvenile salmonids. Changes to water quality would be localized and temporary during placement of beneficial use of dredged material at Saltchuk, and negative effects will be minimized with BMPs. The effects of constructing Saltchuk are expected to be insignificant and discountable. Therefore, the project will not adversely affect this PBF.

PBF #6. Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The dredging site is located within an industrial Port waterway. This area is adjacent to a migration corridor and baseline conditions do not support growth and maturation. Saltchuk is not located in an offshore marine area. Therefore, the project will have no effect on this PBF.

Effects Determination

There is limited concurrence of timing and location of dredging co-occurring with adult and juvenile Chinook salmon use of the Blair Waterway and Saltchuk. However, spring-run Chinook salmon are an important prey resource to SRKW and are the only spring Chinook salmon stock in the south/central Puget Sound region. Based on the importance of this species to SRKW and the low but not discountable probability that juvenile Chinook salmon may be present during temporary and localized effects of construction, this project may affect and is likely to adversely affect Puget Sound Chinook salmon. Based on the analysis of effects to each PBF of designated critical habitat, this project may affect, but is not likely to adversely affect critical habitat for Chinook salmon.

5.2.2 Puget Sound Steelhead

Use of the Action Area

Two distinct populations occur in the basin: Puyallup\Carbon winter steelhead and White River (Puyallup) winter steelhead (WDFW 2015). These populations typically start to enter the river in January and then hold throughout the river until moving to spawning grounds in March through June (NMFS 2005b). However, a few summer-run strays (unlisted), likely from the Green or Skykomish rivers, are caught annually during August and September in the lower Puyallup (Marks et. al 2014). Mainstem spawning occurs as low as RM 10 in the Puyallup River and RM 3 on the Carbon River (Pierce County 2013). Juvenile outmigration in the Puyallup River system generally occurs between April and July (Berger et al. 2011). Juveniles are not anticipated to be in the nearshore zone of the action area in large numbers because the majority of steelhead smolts migrate directly to the open ocean and do not rear extensively in the estuarine or coastal environments (Burgner et al. 1992). Adults are expected to occur in the deep, open-water areas around the Blair Waterway during the winter of their upstream spawning migration, and juveniles may occur in the shallow nearshore zone during typical outmigration periods in the spring and early summer. Adult fish would typically be oriented to the outflow of the Puyallup River. There is no information indicating that adults would enter and use waterways as a migratory route or holding area.

Effects of the Proposed Action

Channel dredging, disposal, and material placement at Saltchuk will occur throughout the in-water work window of July 16 or August 16 through February 15 for up to three years to achieve target depths. This timing overlaps with the early migration phase of adult steelhead to the Puyallup River. The in-water work window is closed for the duration of the juvenile outmigration period. Dredging activities would be adjacent to open-water areas where adult steelhead holding and migration may occur only when work is occurring near the opening to the waterway. Under that situation, these large and highly mobile fish are expected to be able to avoid the clamshell dredge and risk of entrainment is extremely low. Displacement of adults may occur on a minor scale as the dredge operates in a small area compared to the entire width of the navigation channel and aquatic habitat available. Dredging and material disposal at an upland facility or at Saltchuk is not expected to cause any physical harm.

Effects of dredging and material placement at Saltchuk would be expected to be the same for adult steelhead as those described for adult Chinook salmon regarding minor disturbances and behavioral effects from noise and turbidity.

Effects to Critical Habitat

The PBFs for steelhead critical habitat are identical to Chinook salmon critical habitat and all the effects identified for Chinook salmon are the same for steelhead; therefore, the analysis is not repeated here. The effects determination is the same.

Effects Determination

Based on limited coincidence of timing and location of dredging co-occurring with adult steelhead migration through Commencement Bay, this project may affect, but is not likely to adversely affect Puget Sound steelhead. Based on the analysis of effects to each PBF of designated critical habitat, this project may affect, but is not likely to adversely affect critical habitat for Puget Sound steelhead.

5.2.3 Coastal/ Puget Sound Bull Trout

Use of the Action Area

Five local bull trout populations are located within the Puyallup River Watershed Core Area; they consist of the (1) Carbon River; (2) Greenwater River; (3) Upper Puyallup and Mowich rivers; (4) Upper White River; and (5) West Fork White River (USFWS 2015). They exhibit resident, fluvial and anadromous life history forms. Spawning occurs in the late summer and early fall in the upper portion of the Carbon River and in the White River, above the limits of the action area (Marks et al. 2018).

During the fall and winter, migratory bull trout journey from spawning and rearing habitats in the upper watershed to foraging and overwintering habitats located lower in the river system. From spring through early summer, migrant bull trout commence their upstream journey to cooler spawning, rearing, and foraging refugium high in the watershed where spawning will occur primarily during the month of September (Marks et al. 2018). Migratory bull trout rear in upstream tributaries for 1 to 4 years before migrating downstream, usually in the spring, to a river, lake, or estuary/nearshore area (USFWS 2015).

Anadromous adult and sub-adult bull trout utilize marine waters for foraging and as a migratory corridor to reach other rivers. The period of marine occupancy is primarily March-July with most fish returning to freshwater no later than mid-July. In estuary and marine waters bull trout remain near the surface, seldom reaching depths greater than 30 feet. During fall and winter, only a very small number of bull trout (less than 1%) are expected to occupy marine areas, and only for short periods of time (Goetz 2016). Anadromous bull trout tagged with acoustic transmitters in the White River have been monitored entering and exiting Commencement Bay in late spring and early summer. During the same study, tagged bull trout were not observed entering any of the Commencement Bay waterways (USACE unpublished data).

Effects of the Proposed Action

Dredging will occur throughout the in-water work window of July 16 or August 16 through February 15 for up to three years to achieve target depths. This timing overlaps with the period of lowest bull trout abundance in estuary and marine winters, and the Blair Waterway and Saltchuk site are not considered quality estuarine or nearshore habitat. Therefore, it is assumed that very few fish would be affected by the dredging, transport for upland disposal, or material placement at Saltchuk.

The location of dredging will be restricted to only the proposed designated Federal navigation channel, as widened and to the depth of -57 MLLW. None of the dredging will occur in the intertidal zone or under the pier decking. The outer area of the dredging location may overlap with areas where bull trout may forage; however, these fish occupy shallower depths and are highly mobile, and therefore are expected to be able to avoid the clamshell dredge and material placement at Saltchuk, and risk of entrainment is extremely low. Additionally, they would be feeding on juvenile salmonids and forage fish, which are typically associated with the shallow areas along the shoreline rather than the deep water of the Blair Waterway. Material placement at Saltchuk will occur when fewer juvenile salmonids are foraging in Commencement Bay, so fewer bull trout are expected to be attracted to Saltchuk when there are fewer prey items available. Displacement of adults may occur on a minor scale as the dredge operates in a small area compared to the entire width of the navigation channel and aquatic habitat available. Dredging is not expected to cause any physical harm.

The effects of underwater noise and turbidity associated with the dredging project area and Saltchuk assumed the same for the adult and subadult bull trout as they are for adult Chinook salmon and steelhead as described in section 5.2.1. There may be minor behavioral effects as bull trout avoid noise and turbidity. The severity of effects is expected to be no greater than avoidance of noise and turbidity with sufficient aquatic habitat to avoid lethal or sublethal effects.

Effects to Critical Habitat

This section evaluates the potential for effects to the bull trout PBFs determined to be essential to the conservation of Coastal/Puget Sound bull trout.

PBF #1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

Dredging, transport of dredged material to a transloading facility for upland disposal, and material placement at Saltchuk will not have any effect to springs, seeps, groundwater sources, or subsurface water connectivity that contributes to water quality and quantity because there is nothing in the project that can effect these parameters. Therefore, the project will have no effects on this PBF.

PBF #2. Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

The Blair Waterway may function only minimally as a migratory corridor for bull trout; however, bull trout may enter the action area to feed on juvenile salmon and forage fish. Dredging and material placement at Saltchuk will result in temporary, localized increases in turbidity low in the water column, which could affect localized movements of bull trout (but will not block any kind of migratory corridor). If adult or subadult bull trout are present during dredging or material placement, they could easily avoid any areas of elevated turbidity, especially since the dredging operation is restricted to the central portion of the waterway allowing passage along either shoreline away from the dredge operation and Saltchuk is a minor portion of Commencement Bay. Therefore, the project will not have adverse effects on this PBF.

PBF #3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

Dredging will not affect terrestrial organisms because dredging will occur in the center of the waterway and will not affect shorelines or riparian vegetation. Dredging and material placement will affect benthic organisms in the dredge footprint and at Saltchuk. However, the aquatic macroinvertebrates (benthic only) at the depths of the waterway do not constitute significant prey for bull trout as they forage in shallower water. Saltchuk will improve sediment conditions for benthic organisms. Bull trout that might occur in the area are likely there to feed on salmon juveniles and forage fish. Regardless, because of the relatively small size of the dredge footprint and Saltchuk, the loss of benthic organisms from dredging will be insignificant compared to the total area of benthic forage areas available. Dredging could have a small but negligible indirect effect on bull trout through potential short-term effects to bull trout prey (juvenile salmonids and forage fish) and their habitat. However, bull trout prey is unlikely to be significantly affected by the proposed dredging operations. Therefore, the project will have discountable adverse effects on this PBF.

PBF #4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and un-embedded substrates, to provide a variety of depths, gradients, velocities, and structure.

Baseline conditions for this PBF in the Blair Waterway have none of the required characteristics to provide complex habitat. Dredging for the proposed navigation channel improvements and Saltchuk construction will not result in the degradation of shoreline complexity. Because the actions will take place in the center of the waterway and Saltchuk, side channels, pools, and undercut banks will not change. Further, navigation channel dredging and disposal at Saltchuk will not affect stream velocities or other hydraulic characteristics. Therefore, the project will have no measurable adverse effects on this PBF.

PBF #5. Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.

Dredging, material placement, and transport for upland disposal of sediment will not affect water temperatures. Therefore, the project will not have adverse effects on this PBF.

PBF #6. In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

The proposed action does not occur in spawning and rearing areas. Therefore, the project will not have adverse effects on this PBF.

PBF #7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.

The Blair Waterway and Saltchuk are not located in the Puyallup River. The dredging for the proposed navigation channel improvements and Saltchuk construction will have no effect on the hydrograph or river flows nor will it influence the tidal regime. Therefore, the project will not have adverse effects on this PBF.

PBF #8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

Dredging and Saltchuk construction will not affect the quantity of water available to bull trout. Short-term water quality degradation due to localized turbidity will not affect reproduction and will have negligible and discountable effects on growth and survival. Therefore, the project will not have adverse effects on this PBF.

PBF #9. Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

There is nothing in the project that will affect non-native predatory fish abundance or occurrence in Commencement Bay. Therefore, the project will not have adverse effects on this PBF.

Effects Determination

Based on limited coincidence of timing and location of dredging and Saltchuk construction co-occurring with adult and subadult bull trout use of the Blair Waterway and nearshore areas, this project may affect, but is not likely to adversely affect Coastal/Puget Sound bull trout. Based on the analysis of effects to each PBF of designated critical habitat, this project may affect, but is not likely to adversely affect critical habitat for bull trout.

5.2.4 Georgia Basin Rockfish: Bocaccio and Yelloweye

NMFS listed three species of rockfishes on July 27, 2010 (NMFS 2010a). Bocaccio was listed as endangered, while Canary and Yelloweye rockfish were listed as threatened. Puget Sound Canary rockfish and their critical habitat were delisted (NMFS 2016b).

Use of the Action Area

Three life stages are considered: larvae are not able to swim directionally, juveniles are larger and able to swim to preferred habitats, and adults are strongly associated with rocky substrates deeper than 160 feet (Love et al. 2002). According to Love et al. (2002), the larval stage of the ESA-listed rockfish species do not occur in the intertidal, nearshore, or shallow shelf habitats of Puget Sound; larval rockfish are present in surface waters in central and south Puget Sound apparently with two peaks of seasonal abundance that occur in early spring and late summer (Greene and Godersky 2012). Juveniles settle in nearshore rocky habitat or in kelp forests (Love et al. 1991), but this habitat type is not associated with the proposed dredging in the Blair Waterway primarily because the nearshore zone is at least 900 meters (2,950 feet) away from the channel and has a variety of armoring types that are not suitable rocky habitat. Adult rockfish are not expected to occur in navigation channels as the channels are in shallower, sandy-bottom habitat away from marine deep, rocky habitat and are not near typical spawning locations. Saltchuk is in nearshore habitat.

Adults of the two ESA-listed species of rockfish tend to inhabit water deeper than 160 feet with rocky substrate and only water with salinity greater than 28 parts per thousand (MBC Applied Environmental Sciences 1987, Yamanaka et al. 2006); the Blair Waterway and Saltchuk are less than 60 feet deep. Therefore, few if any adult rockfish are expected to inhabit the Blair Waterway or Saltchuk. Although juveniles inhabit shallower water than adults, they are also associated with rocky areas with kelp cover and sandy areas with eelgrass beds. None of these habitats are present in the action area with the exception of a small eelgrass patch near the mouth of the Hylebos Waterway. Juvenile yelloweye rockfish, unlike boccacio, are not typically found in intertidal areas and instead settle in waters deeper than 98 ft (NMFS 2013).

There is only a slight chance the larval stage of these species would be present at the project site because at this life stage they are pelagic drifters at the mercy of the currents. All three life stages of rockfish are very unlikely to be in the action area due the lack of deep water, suitable rocky substrate, and preferred aquatic vegetation (kelp and eelgrass).

Effects of the Proposed Action

For any rockfish that may be present in the project area during dredging operations or Saltchuk construction, the effects described for the salmonids would be similar for rockfish, namely displacement due to noise and turbidity. The sound pressure levels from dredging equipment, barges, and tugboats would not be above a lethal threshold but may cause fleeing and avoidance behaviors by rockfish. The minor turbidity plume anticipated to occur from dredging the sandy substrate may have sublethal effects such as gill irritation, and would cause rockfish to flee the area. Given the relatively narrow band of the turbidity plume compared to the 200- to 250-meter width of the navigation channel, any rockfish in the area would be capable of finding refuge in clearer water than in the small dredging footprint. Dredging in the navigation channels would have a discountable effect to rockfish due to the extremely low likelihood of their presence.

The Blair Waterway and Saltchuk are excluded from rockfish critical habitat.

Effects Determination

Based on the low likelihood for rockfish presence in the Blair Waterway and the minor and discountable effects of the proposed action, this project may affect, but is not likely to adversely affect Georgia Basin rockfish.

5.2.5 Southern Resident Killer Whale (SRKW)

Use of the Action Area

The SRKW spend considerable time in the Salish Sea from late spring to early autumn, with concentrated activity in the inland waters of the State of Washington around the San Juan Islands, and then move south into Puget Sound in early autumn. The Whale Museum has maintained a long-term dataset of reported sightings throughout the Salish Sea; the resulting set of maps organized by month indicates that the months with the highest number of sightings are January and December with 5 sightings over the greater than 60-year timeframe of recorded sightings compiled in the maps (Olson 2014). While the SRKW are sighted in Commencement Bay, they are not known to enter the navigation channels. Several factors affect survival and well-being of killer whales, but the main factors are physical disturbance of behavior patterns by boat noise or intrusive boating activities, reduction of food source (primarily adult resident Chinook salmon), and bioaccumulation of persistent bioaccumulative toxins.

Effects of the Proposed Action

As described in section 5.1.3 and 5.2.1, intrusive noise levels can have behavioral and physiological effects on animals. Effects to any killer whales that enter the project area may include abandoning hunting, diving or increasing swimming speed to flee the area, and interrupted communication between individuals or pods. Killer whales typically avoid the high-traffic area around Tacoma Harbor. Houghton et al. (2015) found that vessel speed is the greatest predictor of noise levels received by killer whales. Dredges and associated work vessels will be either stationary or traveling slowly for the purpose of surveying the bottom surface, maneuvering the dredge and barge, or transiting the barge to the disposal site. The slow rate of travel should minimize sound emitted from each vessel. Noise during slope stabilization construction would be temporary, and, likely limited, based on slope position and geography of Blair Waterway and Commencement Bay (Appendix E). Based on the short distance of sound attenuation from the dredges and associated work vessels and the very few if any killer whales likely to be present, effects of underwater noise from dredging and Saltchuk construction will be short duration, low intensity, and therefore discountable. The proposed action is estimated to result in about 27% fewer vessel trips to transport the forecasted cargo, which would mean reduced underwater noise throughout the central and northern half of Puget Sound on a daily basis, year-round.

Vessels associated with the proposed transport and disposal activities are primarily tugs and barges, which are slow moving, follow a predictable course, do not target whales, and should be easily detected by marine mammals. As a result, vessel strikes are extremely unlikely and any potential for effects from vessel strikes is therefore discountable. Vessel operations may cause temporary disturbance; however, such disturbance is likely to be short-term and localized, with no lasting effects, and therefore insignificant. When in motion, sound produced by the tug will be transient and expected to be below background levels a short distance from the moving vessel with no lasting effects, and therefore insignificant.

Effects to prey species from the proposed action are negligible and will not reduce populations; therefore, there are no effects to killer whales from this factor.

Concentrations of PCBs and other bioavailable contaminants in biota may increase during dredging. The rate of resuspension is estimated at 3% of material with an increased bioavailability for approximately two to three years (AECOM 2012; Patmont et al. 2018). This minor fraction would have a negligible effect to killer whale prey items and an undetectable contribution to the whales themselves. Analysis for the ESA consultation on continued use of the DMMP disposal sites concluded that effects of transport and disposal of dredged material containing biomagnifying substances to killer whales are discountable. A summary of the rationale provided is that the DMMP uses rigorous testing procedures to quantify effects and disposal sites are showing generally similar or lower concentrations of contaminants compared to nearby locations. The complete analysis appears in the USACE (2015a) Biological Assessment and the NMFS (2015) Biological Opinion, which are hereby incorporated by reference.

Effects to Critical Habitat

Critical habitat includes marine waters of Puget Sound. This section evaluates the potential for effects to the Southern Resident killer whale PBFs determined to be essential to the conservation of killer whales:

PBF #1. Water quality to support growth and development.

> Navigation channel dredging and Saltchuk construction will occur near areas where SRKW may swim; however, these activities will comply with water quality certification conditions established by Ecology. Any effects on water quality are temporary, typically lasting only minutes. Minor and temporary turbidity increases caused by resuspension of dredged material will not cause a significant decline in water quality such that growth and development of killer whales would be affected.

PBF #2. Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth.

> SRKW feed primarily on Chinook salmon and chum salmon. Adult Chinook and chum salmon can easily swim around dredges, dredged material transport barges, and tugs. Therefore, dredging and transport of dredged material will have no effect on this PBF. Dredging will occur in the Federal navigation channel away from the shorelines where juvenile Chinook and chum salmon are typically found. Material placement for Saltchuk in the nearshore may occur, and effects to juvenile Chinook and chum salmon are expected to be short-term and discountable due to BMPs that temporally separate most juveniles from material placement and minimize effects to water quality. While bioaccumulation of contaminants in tissues is a concern, the contribution of the dredging activities is negligible and discountable and has insignificant effects on the food web upon which the SRKW depend.

PBF #3. Passage conditions to allow for migration, resting, and foraging.

Dredges, tugs, and barges will not block passage of killer whales through the area, especially as encounters with killer whales are extremely rare. The killer whales are extremely unlikely to enter the Blair Waterway or the shallow Saltchuk site, and would not be migrating toward the Puyallup River. The proposed action may have negligible effects to SRKW and their critical habitat due to minor underwater noise from dredging, but these effects would not cause harm or have a longer duration than the dredging operations.

Effects Determination

Based on the low likelihood for Southern Resident killer whale presence in the Blair Waterway and Saltchuk, and the minor and discountable effects of the proposed action, this project may affect, but is not likely to adversely affect SRKW. Based on the analysis of effects to each PBF of designated critical habitat, this project may affect, but is not likely to adversely affect critical habitat for SRKW.

5.2.6 Eulachon

Use of the Action Area

Eulachon mostly spawn in major rivers such as the Columbia, and larger tributaries to the Columbia in late winter and early spring. Eulachon are far less common in south Puget Sound drainages and are not considered to be established in the Puget Sound Rivers (NMFS 2010b). However, they have been reported sporadically; for example, one was caught in a Nisqually River smolt trap in 2013 (S. Hodgson, Nisqually Indian Tribe, pers. comm. 2014). There were small numbers of adult eulachon captured in a juvenile salmon out-migrant screwtrap at river mile 10 in the Puyallup River (R. Ladley, PTI, pers. comm. 2013) and identification was confirmed by NMFS and the University of Washington (C. Olds and J. Fisher, NMFS, pers. comm. to R. Ladley, Puyallup Tribe of Indians, 2012; J. Orr, NMFS, and T. Pietsch, Univ. of Washington, pers. comm. 2013). One adult female eulachon with eggs was caught during beach seining at the Rhone-Poulenc restoration site in the Blair Waterway (A. Berger, PTI, pers. comm. 2019). Eulachon may rarely come into Puget Sound in large schools, but this has seldom been documented; the last such documented large school of eulachon in Puget Sound was in 1938 (NMFS 2010b). Although runs can be very sporadic, timing appears to be related somewhat to water temperature and high tides; depending on the river this can be January through March, or as early as November and as late as April (NMFS 2017). Spawning outside of the Columbia River is more likely when environmental conditions in the Columbia River are suboptimal, such as cold water conditions less than 4 °C that slow or stop migration, or due to sporadic straying (WDFW and ODFW 2001). Between late winter and early summer, adult and larval eulachon could migrate through Commencement Bay to move between their spawning areas and marine habitats.

Effects of the Proposed Action

Dredging will occur throughout the in-water work window of July 16 or August 16 through February 15 for up to three years to achieve target depths. This timing overlaps with about half of the most active time for eulachon life stages. The dredging location may overlap with areas where adult eulachon may be migrating; however, these highly mobile fish are expected to be able to avoid the clamshell dredge and risk of entrainment is extremely low. The risk of clamshell bucket strike, entrainment by clamshell dredge, and vessel collision is discountable due to the ability of eulachon to move away from the threat. Larval eulachon are not expected to be present during dredging or Saltchuk construction. Displacement of adults may occur on a minor scale as Saltchuk construction and dredging occurs in a small area compared to the entire width of the navigation channel and aquatic habitat available. Dredging is not expected to cause any physical harm. During placement of dredged material at Saltchuk, a limited number of adult or larval eulachon directly under or immediately next to the plume could be entrained and killed; however, this is not expected to have a measureable or significant effect due to the timing, scale of Saltchuk, and very small number of larval eulachon expected to be present.

Effects of dredging would be expected to be the same for eulachon as those described for adult salmonids regarding minor disturbances and behavioral effects from noise and turbidity. The action area does not contain eulachon critical habitat.

Effects Determination

Based on the low likelihood for eulachon presence in the Blair Waterway and at Saltchuk, and the minor and discountable effects of the proposed action, this project may affect, but is not likely to adversely affect eulachon.

5.2.7 Green sturgeon

Use of the Action Area

The green sturgeon (the Southern DPS is listed as threatened) is the most widely distributed member of the sturgeon family. They are found in waters from San Francisco Bay to Canada, but the only known spawning rivers are the Rogue, Klamath, Trinity, Sacramento and Eel rivers with peak spawning from May to June (Adams et al. 2007). Green sturgeon prefer relatively shallow marine depths (20-60 m; Huff et al. 2011). Many make a rapid, long-distance seasonal migration along the west coast between California and British Columbia in the fall to overwinter (Erickson and Hightower 2007; Lindley et al. 2008). Many green sturgeon then migrate south to spend summer among multiple bays, estuaries, or rivers, with large numbers observed congregating within these areas to feed on shallow mud flats (Moser and Lindley 2007; Dumbauld et al. 2008; Lindley et al. 2008). Sturgeon are benthic feeders that are most often found on or near the bottom while foraging or while moving within rivers and estuaries. They also tend to rest and feed in deep channels and pools during daylight hours. No spawning or critical habitat is located in Puget Sound, but a few green sturgeon are recovered in Puget Sound as incidental harvest (NMFS 2002), and have been tracked in Puget Sound at a very low abundance rate in winter and summer months (Lindley et al. 2011, so they may enter the Sound to forage. Their presence in the project area is considered unlikely.

Effects of the Proposed Action

Dredging will occur throughout the in-water work window of July 16 or August 16 through February 15 for up to three years to achieve target depths. Adult and sub-adult southern green sturgeon would be exposed to a small risk of entrainment during the proposed dredging and in-water dredged material placement (NMFS 2018). The most likely areas for the very few green sturgeon that may use Commencement Bay are likely in the deepest waters away from Saltchuk, or in areas of the lower Puyallup River, which reduces the risk of entrainment or harm from beneficial use of dredged material. In addition, there is little evidence of mechanical dredge (i.e., clamshell) entrainment, bucket strike, or direct collision of mobile organisms such as fish, sea turtles, and whales (NMFS 2018). Entrainment by clamshell bucket or material placement is not likely to cause detectable or significant effects to green sturgeon populations. In addition, alteration of benthic habitats may harm the prey base of green sturgeon (Section 5.1.3). However, these potential effects are considered discountable due to lack of substantial change to prey resources, limited affected area, and low likelihood of Commencement Bay representing a significant green sturgeon foraging area.

Effects of dredging would be expected to be the same for green sturgeon as those described for adult salmonids regarding minor disturbances and behavioral effects from noise and turbidity. Critical habitat within marine waters includes areas within the 60-fathom isobath from Monterey Bay to the U.S.-Canada border, and many coastal bays and estuaries are designated as critical habitat; however, Commencement Bay is not within critical habitat (NMFS 2010c).

Effects Determination

Based on the low likelihood for green sturgeon presence in the Blair Waterway and Saltchuk, and the minor and discountable effects of the proposed action, this project may affect, but is not likely to adversely affect green sturgeon.

5.2.8 Marbled Murrelet

Use of the Action Area

Marbled murrelets are permanent resident birds of Puget Sound, but the species is not abundant anywhere in Puget Sound. From 2001-2010 in Puget Sound and the Strait of Juan de Fuca, the murrelet population has decreased annually by 7.4% (95% CI = -11.2% to -3.5%) while the overall population decline for the Pacific Northwest, including coastal Washington, Oregon, and California, was by 3.7% (95% CI = -4.8 to -2.7%; Miller et al. 2012). They are occasionally sighted in Commencement Bay, most often off Browns Point (Seattle Audubon Society 2019). The primary prey items for marbled murrelets in Puget Sound include Pacific sand lance (*Ammodytes hexapterus*), Pacific herring (*Clupea harengus*), and krill (euphausiids; Burkett 1995). Murrelets could be found foraging on small fish such as sand lance in the marine waters adjacent to the action area, though they are likely to be very transient. Threats to murrelet populations include the loss of nesting habitat, reduced availability or quality of prey, increased densities of nest predators, and emigration, all of which could affect survival and fecundity (Miller et al. 2012). Marbled murrelet density is typically correlated to nesting sites in Strait of Juan de Fuca, The San Juan Islands, and northern outer coast, and during April to mid-September breeding murrelets make daily flights from marine foraging areas to tend inland nest sites (WDFW 2016). Marbled murrelets could be present year-round but because marbled murrelets generally stay close to shore and away from populated and industrial areas, they are unlikely to be present in the Blair Waterway.

Critical habitat for the marbled murrelet consists of forest areas suitable for nesting or roosting and is not found in the vicinity of the project. No marine areas are designated as critical habitat for marbled murrelets. Their presence is considered uncommon.

Effects of the Proposed Action

It is possible that murrelets flying over the area during construction would be disturbed by the noise, especially if slope stabilization methods are used (e.g., sheet piles or secant walls). However, they have the ability to avoid the area and are assumed to be habituated to this highly industrial area. The proposed action would not negatively impact foraging habitat in Commencement Bay, and Saltchuk construction may provide additional spawning areas for sand lance. Blair Waterway deepening and maintenance dredging, upland disposal of dredged material, and beneficial use of dredged material at Saltchuk are not expected to cause physical harm. Effects to forage fish are discussed in Section 5.1.3. Disturbance to marbled murrelet is not expected to measurably reduce foraging success or survival, and population-level effects are unlikely to occur.

Effects Determination

Based on the low likelihood for marbled murrelet presence in the Blair Waterway and at Saltchuk, and the minor and discountable effects of the proposed action, this project may affect, but is not likely to adversely affect marbled murrelet.

5.3 Cumulative Effects

Under the ESA, cumulative effects include the effects of future State, local, or private actions that are reasonably certain to occur in the action area (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7. Other State, local, or private actions that may affect shoreline or aquatic habitat in the action area will be required to obtain Federal permits, and as such will undergo separate Section 7 consultation and review.

Various factors have contributed to low quality habitat in Commencement Bay waterfront. Those factors include shoreline fill, armoring and subsequent loss of wetlands, persistent contaminants from past industrial practices, periodic dredging, vessel traffic, and other ongoing and future construction related activities that may result in elevated turbidity and noise that affect the wildlife itself and/or their prey resources. Given the degraded state of the waterfront, when combined with the proposed Federal Action to deepen and widen the Federal channel in the Blair waterway, and to place suitable material at Saltchuk, cumulative negative impacts to ESA-listed species would be insignificant.

Berth deepening or pier stabilization by the Port (LSFs; Section 3) that require additional dredging, riprap, sheet piles, secant walls, or other in-water work will still occur in Blair Waterway. Although it is not part of the Federal action it is included here as a cumulative effect because this work is reasonably certain to occur, and could be necessary to different degrees as slope stabilization. The LSFs and potential Federal slope strengthening (Section 3) are unlikely to occur at the same time, but would expose fish and wildlife to similar effects. Migratory salmonids may encounter re-suspended unsuitable material on their outward migration if they are in the project area during planned upgrade construction or the proposed Federal navigation improvement. These fish may then encounter underwater noise or turbidity disturbance during any of these same activities as they may occur during the homeward migration when the fish are adults. All effects are expected to be short-term and sub-lethal but could affect the overall level of success in growth and reproduction. Long-term effects from global climate change (increased water temperatures, lower DO, and lower pH) could also affect overall fitness. However, the combined effect is not anticipated to be a measurable cumulative effect on fish populations.

The benthic community at the depth range of the Blair Waterway is not an important prey source to the federally protected species or other commercially important species present. Therefore, the effects to benthic organisms from navigation channel dredging and material placement at Saltchuk, which would only endure for up to three years after dredging is complete, are not a significant impact to this ecosystem. Deepening may reduce disturbance to the benthic community that occurs when propellers of the largest ships (i.e., 14,000 TEU and larger) move close to the substrate, but the deeper depths that are not the preferred feeding depths of juvenile salmonids will persist. O&M dredging would likely occur on a 25-year cycle or less frequently as there is very little sediment input to the Blair Waterway. The benthic community would not be frequently disturbed. In addition, sea level change may reduce the need for O&M dredging, and would be much smaller than the area for deepening because the dredging would only target areas above the authorized depth; therefore, the benthic organisms would likely reach an equilibrium community condition between O&M dredging events. Because effects to benthic invertebrates would be minor and short-term, no cumulative effects would occur due to this proposed action.

5.4 Impact Avoidance and Minimization Measures

The Corps will employ Best Management Practices (BMPs) and conservation measures throughout the execution of the project to minimize negative effects to the environment. BMPs and conservation measures are determined on a project-specific basis according to the project area and type of ecosystem present in the action area. These include but are not limited to the following measures:

1. Comply with all applicable water quality standards and enforceable conditions issued in the water quality certification and adhere to monitoring protocols in the water quality monitoring plan (Appendix B).
2. Dredge only within the designated work window of August 16 through February 15 for material placement at the Commencement Bay open-water disposal site. In-water work for other locations of Commencement Bay, including dredging, is July 16 through February 15 (WAC 220-660-330; Corps 2017b).
3. The entire footprint of the area to be dredged will undergo sediment testing to determine suitability for aquatic disposal and all material determined unsuitable will be transported for upland disposal at an appropriate facility.
4. An environmental clamshell bucket will be used in all areas in which sediment has been determined unsuitable for aquatic disposal to minimize resuspension of contaminated sediment.
5. The sideslopes of the navigation channel will be graded to ensure no sloughing will occur. Bathymetric surveys during and after construction will show whether sloughing has occurred.
6. All equipment will be inspected daily to ensure that it is in proper working condition and has no leaks of fuel or hydraulic fluids. Each vessel will have a spill kit on board at all times.

In addition to the BMPs listed above, pursuant to Section 2(b) of the Fish and Wildlife Coordination Act (FWCA), NMFS had the opportunity to provide input during the planning process, and provided a Planning Aid Letter (PAL) that describes fish and wildlife resources in the project area, potential negative effects of the proposed project, and recommendations for mitigating the effects. The PAL appears in Appendix D. The potential negative effects identified include the following:

- Increased turbidity from dredging that can cause lethal, sublethal, and behavioral effects to fish
- Potential resuspension of contaminants from dredged sediments
- Habitat disturbance for Essential Fish Habitat species (groundfish such as English sole) that forage in deep water
- Container ships are identified as having a potential effect on feeding behavior of SRKW

Recommendations applicable to ESA-listed species included:

- Work with NMFS, USFWS, Pierce County, Washington State Department of Fish and Wildlife (WDFW), EPA, and the Puyallup Tribe to determine restoration actions to mitigate for project impacts
- Coordinate with NMFS throughout the development of the alternatives and design of the project to expedite the ESA section 7 consultation
- Develop a contingency plan for to minimize water quality effects should possible contaminants be discovered during sediment sampling prior to dredging
- Provide a full characterization of sediment quality that will be used in nearshore placement
- Include an analysis of vessel effects to marine mammals
- Maximize habitat restoration in the nearshore
- Perform monitoring of habitat restoration site

After initial coordination and receipt of the PAL, the Corps considered the four key items identified as potential negative effects and incorporated analyses of these points into the environmental effects analysis in Chapter 4 of the draft FR/EA (USACE 2019).

The Corps has coordinated closely with the natural resources agencies and Puyallup Tribe of Indians during the alternatives development phase. This coordination and consultation, including with the Muckleshoot Indian Tribe, will continue through design and implementation to avoid and minimize project impacts. Based on the determination that most project adverse effects would be short-term and temporary, and the only permanent adverse changes would have insignificant and discountable effects to environmental resources, the Corps has elected not to incorporate compensatory mitigation into the project design. In recognition of the identified potential negative effects listed in the PAL, the Corps will avoid and minimize effects by incorporating all applicable BMPs as described in the draft FR/EA sections 4.7 Water Quality, 4.11 Hazardous, Toxic, and Radiological Waste, and 4.18 Public Health and Safety (USACE 2019). The Corps will continue to coordinate with NMFS throughout the study as part of ESA Section 7 consultation. A full sediment characterization will be conducted for all dredged material in PED. Applicable BMPs would be implemented while dredging sediment unsuitable for open-water disposal to avoid and minimize effects of unsuitable sediment. Vessel effects to marine mammals appear in sections 4.14, 4.15, and 4.16 of the draft FR/EA (USACE 2019). Beneficial use of dredged material at Saltchuk would maximize habitat restoration in the nearshore within the scope of this project; additional evaluation of Saltchuk is recommended under the TSP. The Corps is considering the PAL recommendation to perform monitoring at Saltchuk to confirm that fish use is established at baseline or improved levels, and at what time frame, and will analyze its applicability during the feasibility level design phase.

5.5 Summary of Effects Determinations for ESA-Listed Species

Based on the preceding analysis of effects along with the impact avoidance and minimization measures, the Corps has concluded that the project may affect, but is not likely to adversely affect most ESA-listed species and their critical habitat in the action area of the proposed navigation improvement project at Tacoma Harbor. The project may affect, and is likely to adversely affect Puget Sound Chinook salmon and their critical habitat in the action area. These conclusions are outlined in Table 5.

Table 6. Effects determinations for ESA-listed species and their critical habitat.

Species	Species Effects Determination	Critical Habitat Effects Determination
Bull trout (Coastal/Puget Sound DPS) (*Salvelinus confluentus*)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Puget Sound Chinook salmon (Oncorhynchus tshawytscha)	May Affect, Likely to Adversely Affect	May Affect, Likely to Adversely Affect
Puget Sound steelhead (Oncorhynchus mykiss)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Bocaccio (Sebastes paucispinis)	May Affect, Not Likely to Adversely Affect	N/A
Yelloweye rockfish (Sebastes ruberrimus)	May Affect, Not Likely to Adversely Affect	N/A
Green Sturgeon (Acipenser medirostris)	May Affect, Not Likely to Adversely Affect	NA
Pacific Eulachon (Southern DPS) (Thaleichthys pacificus)	May Affect, Not Likely to Adversely Affect	N/A
Marbled murrelet (Brachyramphus marmoratus)	May Affect, Not Likely to Adversely Affect	N/A
Southern Resident killer whale (Orcinus orca)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect

6 Essential Fish Habitat Assessment

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267) requires Federal agencies to consult with NMFS on activities that may adversely affect Essential Fish Habitat (EFH). The Act defined EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” EFH is the habitat (waters and substrate) required to support a sustainable fishery and a managed species’ contribution to a healthy ecosystem. Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish. Substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities.

6.1 Federal Action for Consultation

The proposed project is described in detail in Chapter 3 of this document. The Corps is the Federal action agency and the Port of Tacoma is the non-Federal partner for the project. The proposed action is for navigation improvements in the form of deepening and widening the existing Federal navigation channel in the Blair Waterway at Tacoma Harbor. This will be accomplished by dredging with in-water disposal of suitable material at the DMMP Commencement Bay open-water disposal site, as well as the ongoing evaluation of beneficial use of suitable dredged material at Saltchuk, and transportation of material determined to be not suitable for in-water disposal to a transloading facility for upland disposal at an approved facility. Construction will take approximately three years. Chapter 2 of this document provides a description of the action area for the project effects under consideration in this EFH assessment.

The objective of this EFH assessment is to determine whether the proposed action(s) “may adversely affect” designated EFH for relevant commercially, federally-managed fisheries species within the proposed action area. It also describes conservation measures proposed to avoid, minimize, or otherwise offset potential adverse effects to designated EFH resulting from the proposed action.

6.2 Identification of Essential Fish Habitat

Essential fish habitat is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. “Waters” include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include aquatic areas historically used by fish where appropriate. “Substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities (NMFS 1999).

Estuaries of Washington, including Puget Sound and the Pacific Ocean off the mouth of these estuaries, are designated as EFH for various groundfish, coastal pelagic species, and several of the Pacific salmon. The action area previously described in this document (see Chapter 2) lies within the Washington State coastal estuarine EFH composite and has been designated as EFH for various life stages of 25 species of groundfish (PFMC 1998), 5 coastal pelagic species, and 3 species of Pacific salmon according to Federal Fisheries Management Plans developed by the Pacific Fishery Management Council. The proposed action occurs within EFH and will affect EFH of Pacific coast groundfish, coastal pelagic species, and Pacific salmon species (Table 7).

Table 7. Essential fish habitat species and their life history stages that may be found in the project area.

Common Name	Scientific Name	Adult	Juvenile	Larvae	Egg
Groundfish Species					
Soupfin Shark	Galeorhinus galeus	X	X		X
Spiny Dogfish	Squalus acanthias	X	X		X
California Skate	Raja inornata	X	X		X
Ratfish	Hydrolagus colliei	X	X		
Lingcod	Ophiodon elongatus	X	X	X	X
Cabezon	Scorpaenichthys marmoratus	X	X	X	X
Kelp Greenling	Hexagrammos decagrammus	X	X	X	X
Pacific Cod	Gadus macrocephalus	X	X	X	X
Pacific Whiting (Hake)	Merluccius productus	X	X	X	X
Sablefish	Anoplopoma fimbria		X		
Black Rockfish	Sebastes melanops	X	X		
Bocaccio	Sebastes paucispinis		X	X	
Brown Rockfish	Sebastes auriculatus	X	X		X
Canary Rockfish	*Sebastes pinniger*	X	X	X	
Copper Rockfish	Sebastes caurinus	X	X		X
Quillback Rockfish	Sebastes maliger	X	X	X	X
English Sole	Parophrys vetulus	X	X	X	X
Pacific Sanddab	Citharichthys sordidus		X	X	X
Rex Sole	Errex zachirus	X			
Starry Flounder	Platichthys stellatus	X	X	X	X
Coastal Pelagic Species					
Northern anchovy	Engraulis mordax	X	X	X	X
Pacific sardine	Sardinops sagax	X	X	X	X
Pacific (chub) mackerel	Scomber japonicas	X	X	X	X
Jack mackerel	Trachurus symmetricus	X	X	X	X
Market squid	Loligo opalescens	X	X	X	X
Pacific Salmon					
Chinook salmon	Oncorhynchus tshawytscha	X	X		
Coho salmon	Oncorhynchus kisutch	X	X		
Puget Sound pink salmon	Oncorhynchus gorbuscha	X	X		

6.3 Potential Adverse Effects to EFH of the Proposed Project

The effects to water quality would be as described in Section 5.1.2; temporary and localized increases in turbidity, most notably near the seafloor as sediment escapes from the clamshell dredge. Dredging will take the duration of the six- to seven-month work window over three years of construction. Following construction, no permanent effects to water quality from turbidity would endure.

As described in Section 5.1.1, resuspension of sediments unsuitable for aquatic disposal is a concern for the project area. Bioaccumulative toxins appear in fish tissues collected throughout the Puget Sound region, and especially in urban areas (Puget Sound Action Team 2007). Concentrations of PCBs and other bioavailable contaminants in biota, including edible species, will have a minor increase during dredging. The increase in contamination concentrations in biota is a temporary effect that will persist for a number of years following cessation of dredging. The resulting removal of sediments unsuitable for aquatic disposal sediment will be a net long-term benefit to the aquatic environment in the Blair Waterway, especially for bottom-dwelling fish that often test positive for contaminants in Puget Sound.

Effects to the groundfish species such as sole and flounder would be as described in Section 5.1.3; the primary impact would be temporary displacement and entrainment in the small area where the dredge is working, during potential construction of slope stabilization measures, and with placement of materials as Saltchuk. Fish are expected to return to the area as the dredge moves away and after material is placed.

It is expected that benthic invertebrates within the proposed dredge prism will be eliminated by navigation channel dredging or material placement at Saltchuk, removing a potential prey source for groundfish in small areas at a time. As described in Section 5.1.3, invertebrates are expected to rapidly recolonize the dredged area and Saltchuk, and there would not be a permanent effect to the prey base for fish. Effects to habitat, which are expected to be discountable in the Blair Waterway environment, appear in Section 5.1.3. Post-remediation cap monitoring is recommended to verify the Saltchuk cap integrity and long-term recolonization of the benthic community; however, this monitoring is subject to approval and funding availability.

Temporarily elevated underwater noise will be an effect to EFH for all species groups. This is described in Section 5.1.3. Fish are not anticipated to suffer physical harm from the dredging equipment; however, they may avoid the area immediately around the dredge and associated vessels.

The only permanent changes to the benthic habitat are that the Blair Waterway will change from the uniform depth of -51 MLLW to become an even depth of -57 MLLW across the full length and width of the navigation channels, and slope stabilization may be installed at four locations along the waterway. This change in depth and potential slope stabilization measures do not constitute a substantial impact to EFH that would warrant mitigation.

6.4 EFH Conservation Measures

All of the BMPs and conservation measures as described in Section 5.5 that will be employed to protect the ESA-listed species are assumed equally protective of the waters and substrate that support the species with designated EFH in the project area. The Corps will employ the conservation measure of conducting maintenance dredging as infrequently as possible and only as needed to maintain navigability of the proposed authorized channel width and depth at -57 MLLW. Hydraulic modeling shows this is anticipated to be required approximately every 25 years. In addition, material placement at Saltchuk will have temporary and localized effects to EFH as described in Section 5, but will ultimately benefit juvenile Chinook salmon by creating shallow water habitat that is scarce in Commencement Bay and improving the benthic environment. This will have ancillary benefits for EFH species and habitat of Commencement Bay.

6.5 Conclusion

The project actions described in this document have the potential to adversely affect the EFH of federally managed species, but these effects are expected to be localized, temporary, and minimal. The minor and discountable effects from the proposed action will be offset by the overall improvement to EFH by the resulting removal of unsuitable sediment and beneficial use of dredged material at Saltchuk. The Corps believes the combination of the impact avoidance measures provided will reduce effects on EFH to the point that the effects will be insignificant and discountable, and thus the proposed dredging operation and Saltchuk construction will not adversely affect EFH.

7 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 (16 U.S.C. §1361-1407) restricts harassment of marine mammals and requires interagency consultation in conjunction with the ESA consultation for Federal activities. All marine mammals are protected under the MMPA regardless of whether they are endangered, threatened, or depleted. Marine mammal species that have been observed in the action area include harbor seal (*Phoca vitulina*), harbor porpoise (*Phocoena phocoena*), gray whales (*Eschrichtius robustus*), killer whale (*Orcinus orca*), Bigg's (transient) killer whales, and California sea lion (*Zalophus californianus*). Other species that may occur in Puget Sound, but are unlikely to enter the action area include humpback whale (*Megaptera novaeangliae*), Steller sea lion (*Eumetopias jubatus*), Northern elephant seal (*Mirounga angustirostris*), Dall's porpoise (*Phocoenoides dalli*), and Minke whale (*Balaenoptera acutorostrata*).

The project area is primarily the aquatic habitat of the high-use navigation channel and nearshore area (Saltchuk) surrounded by the industrial port infrastructure and activities. The marine mammals most likely to be present include harbor seals, California sea lions, and rarely killer whales. The marine mammals that occur regularly in the project area are assumed to be habituated to the industrial port activities.

The topics of concern for marine mammals include resuspension of contaminated sediments due to dredging, underwater noise from dredging and associated vessels, vessel traffic associated with construction, and effects to prey species. Each of these topics appears in Section 5.2.5 for the analysis of effects to SRKW. The effects are presumed to be the same for the other marine mammals potentially present in the action area; therefore, the analysis is not repeated here. Further information regarding underwater noise is presented below for analysis of its effects to the broader suite of marine mammal species.

Marine mammals use vocalizations to identify themselves, their location, territory, or reproductive status and communicate with each other about presence of prey, another animal, or danger. Loudness, frequency, duration, and types of sounds vary widely among the species, and can be compared to the audiogram for the species if one has been developed. Audiograms are the graphic display of hearing sensitivity, which plot frequency against hearing threshold. Available data show that whales' auditory thresholds can extend as low as 10Hz for the mysticetes (i.e. the baleen whales such as humpback and gray whales) and as high as 500kHz for some odontocetes (i.e. the toothed whales such as porpoise and killer whales) (Gordon and Moscrop 1996). California sea lions are most sensitive to sounds between 1 kHz and 28 kHz with peak sensitivity around 16 kHz (Schusterman et al. 1972). Harbor seals have a slightly broader range with ability to hear up to about 50 kHz for sounds over 60 dB (1 μPa @ 1 m; Richardson et al. 1995). The Steller sea lion hearing range is 500 Hz to 32 kHz with less sensitivity at the low and high frequencies.

Killer whales rely on their highly developed acoustic sensory system for navigating, locating prey, and communicating with other individuals (Ford 1989). Noise pollution from marine vessel traffic is one of the main concerns with decline in the endangered Southern Resident killer whale population because of how it may affect their vocalizations and hearing. Excessive noise levels may mask echolocation and other signals the species use, as well as temporarily or permanently damage hearing sensitivity. Vessel traffic negatively affects foraging behavior of the SRKW, which can have biologically significant consequences and is likely a factor in their low population level (Lusseau et al. 2009).

For a determination on whether construction related noise would affect marine mammals, one must consider the frequency, location, intensity, and duration of the sound source as well as the audiogram of the recipient species. If an audiogram is available for a species, then using that audiogram helps to analyze the effects of noise on important biological resources; otherwise, the hearing frequency range may be the best available information. Effects analysis requires calculating the sound exposure level that the animal receives. Table 8 displays data collected on hearing capabilities of marine mammals.

Table 8. Hearing capabilities of marine mammals and sound threshold for continuous and pulsed noise that can cause behavioral disruption and injury.

Species	Audible Frequencies	Level B harassment (continuous)	Level B harassment (pulsed)	Level A injury
Pinnipeds in general[1]	500Hz – 50kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
California sea lions	1kHz – 28kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
Harbor seals	1kHz – 50kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
Steller sea lions	500Hz – 32kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
Mysticete whales[2]	10Hz – 8kHz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}
Minke whale[2]	10Hz – 500Hz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}
Odontocete whales[2]	100Hz – 500kHz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}
Killer Whale (orca)[3]	500Hz – 105kHz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}

[1] Schusterman et al. 1972

[2] Gordon and Moscrop 1996

[3] Hall and Johnson 1971, Bain et al. 1993, Szymanski et al. 1999

Potential effects to marine mammals would come from elevated sound (underwater), which could disrupt foraging behavior, diving patterns, and social interactions. The established threshold for harassment of seals and sea lions is 120 dB_{RMS} for continuous sound, 160 dB_{RMS} for pulsed sound, and 190 dBRMS for injury (both pulsed and continuous). As described in Section 5.1.3 and 5.2.1 regarding potential noise from slope stabilization and dredging, evidence from previous studies compared to the Tacoma Harbor action area has led to the conclusion that the proposed clamshell dredging and vibratory installation of slope stabilization in the Blair Waterway would have a discountable effect of causing animals to avoid the area, but would not rise to the level of causing a significant impact.

Marine mammals are active in Commencement Bay, and take advantage of barges and buoys as resting areas. According to the Washington Department of Fish and Wildlife's Atlas of Seal and Sea Lion Haulout

Sites in Washington (Jeffries et al. 2000), the nearest harbor seal and sea lion haulout sites are in northeast Commencement Bay on buoys, floats, and discontinued log booms. Commencement Bay is not considered a major pupping and nursing site, and although the number of haul outs and sightings of pups were increasing in 2009, the discontinuation of log booms removed a major haul out location in Commencement Bay. The seals and sea lions that do enter the area are likely accustomed to a higher level of underwater noise due to the heavy vessel traffic around Commencement Bay and especially the Blair Waterway. Large shipping vessels can generate noise levels well above harassment and injury thresholds depending on variables like vessel speed, oceanic conditions, water temperatures, and bathymetry (McKenna et al. 2013, Richardson et al. 1995).

The resulting removal of sediment that contains contaminants will be a net long-term benefit to the aquatic environment in the Blair Waterway. No long-term changes to marine mammal use of the project area are anticipated. The navigation improvement project has a potential to reduce total number of vessel calls at the Port of Tacoma, which would reduce ambient underwater sound in the project area and throughout the shipping channel in the northern portion of Puget Sound.

Slope strengthening such as sheet piles, secant walls, or other vertical slope strengthening solutions at four locations in Blair Waterway may be necessary (Section 3 of this BA and Section 3.5 of the draft FR/EA; USACE 2019) and would be determined in PED after additional information is collected by ship simulation. Likewise, the construction method has not been determined at this point of the feasibility phase, but typical construction methods for slope strengthening could create a temporary disturbance to fish and wildlife in the area. Impacts of potential construction methods would be temporary and spatially limited due to the confined nature of the Blair Waterway that would reduce, but not completely eliminate, the noise transmission into inner Commencement Bay. In addition, potential slope strengthening locations within the Blair Waterway are away from areas that fish and wildlife utilize more frequently. Measures to minimize disturbance such as bubble curtains, in-water work windows, and construction techniques such as vibratory installation or auguring may be implemented, but the identification and feasibility of these measures would not be known until the type of slope strengthening and construction method is confirmed and designs are available in PED. An Incidental Harassment Authorization (IHA) would be obtained from NOAA in PED when design information is available, as warranted. Engineered slope strengthening and construction methods would be coordinated with the Services for impacts to ESA-listed species and consultation reinitiated as warranted. Given the location, limited duration, and potential slope strengthening designs and measures available to minimize disturbance, slope strengthening is unlikely to cause a significant effect to fish and wildlife populations.

Based on the preceding analysis showing low likelihood for harm to animals and overall negligible effects of dredging and material placement at Saltchuk or an upland facility, the Corps has determined there is no requirement to seek an Incidental Harassment Authorization for the Tacoma Harbor Navigation Improvement project during the feasibility phase. An Incidental Harassment Authorization (IHA) for effects associated with slope strengthening would be obtained from NOAA in PED when final design information is available, as warranted.

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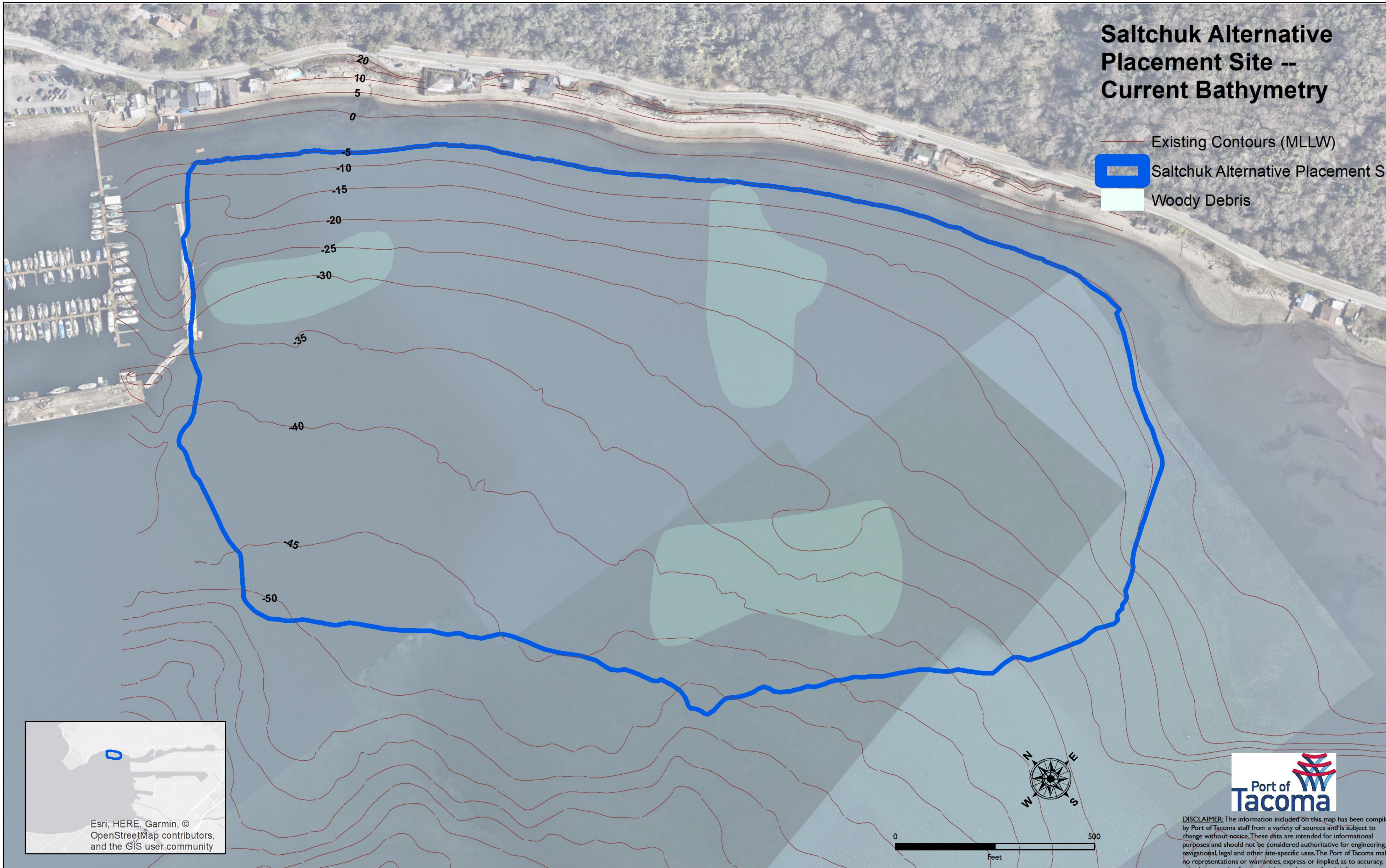
Saltchuk Alternative Placement Site -- Current Bathymetry
Existing Contours (MLLW)
Saltchuk Alternative Placement Site
Woody Debris
20
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
N
E
S
W
0
500
Feet
Port of Tacoma
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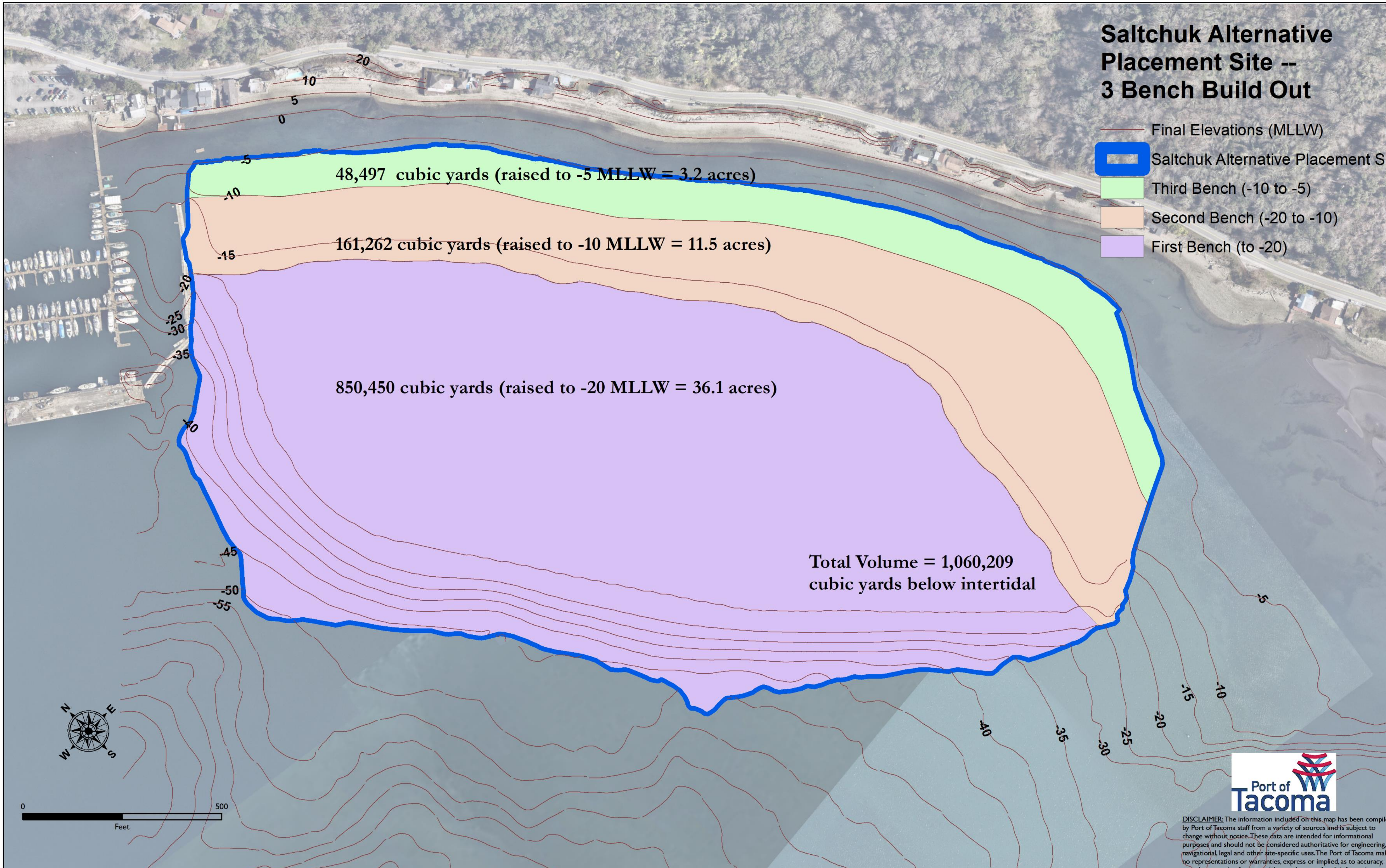

Saltchuk Alternative Placement Site -- 3 Bench Build Out
Final Elevations (MLLW)
Saltchuk Alternative Placement Site
Third Bench (-10 to -5)
Second Bench (-20 to -10)
First Bench (to -20)
48,497 cubic yards (raised to -5 MLLW = 3.2 acres)
161,262 cubic yards (raised to -10 MLLW = 11.5 acres)
850,450 cubic yards (raised to -20 MLLW = 36.1 acres)
Total Volume = 1,060,209 cubic yards below intertidal
20
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
N
E
W
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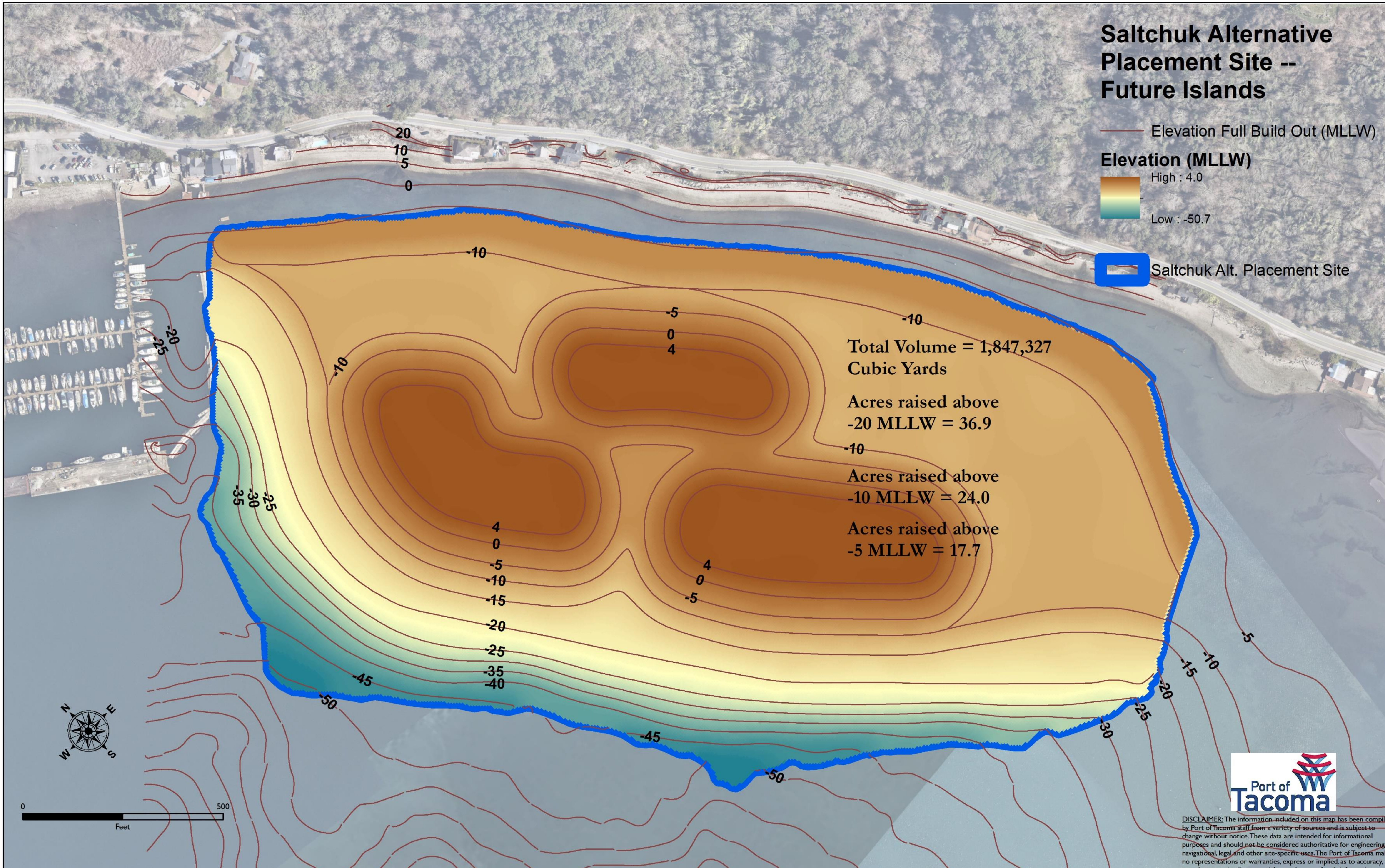

Saltchuk Alternative Placement Site -- Future Islands
Elevation Full Build Out (MLLW)
Elevation (MLLW)
High : 4.0
Low : -50.7
Saltchuk Alt. Placement Site
Total Volume = 1,847,327 Cubic Yards
Acres raised above -20 MLLW = 36.9
Acres raised above -10 MLLW = 24.0
Acres raised above -5 MLLW = 17.7
N
E
W
S
0
500
Feet
Port of Tacoma
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Final
September 2019

Tacoma Harbor Beneficial Use Habitat Evaluation Model Approval Request

Contents

Figures

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1 Background

The Tacoma Harbor, WA Deep Draft Navigation General Investigation Study (Tacoma Harbor GI) is evaluating the feasibility of deepening the Blair Waterway at the Port of Tacoma, Washington. The Base Plan is to dispose of material at the Commencement Bay open-water site, but there is an opportunity for beneficial use of dredged material at the Saltchuk site located along the northeastern shoreline of Commencement Bay (Figure 1).

The U.S. Army Corps of Engineers (Corps) is required to predict and quantify environmental benefits using models to justify federal investment in restoration projects.[1,2] For environmentally beneficial disposal methods with incremental federal costs that exceed the lesser of 25% of total Base Plan disposal costs or $300,000, the incremental costs must be justified by demonstrating that the monetary and non-monetary benefits (outputs) of the ecosystem restoration project justify its incremental costs above the Base Plan. It must be demonstrated that the environmental resources to be restored are valuable, the environmental outputs can be quantified and described, and federal and state resource agencies support the environmentally beneficial disposal method.

Beneficial use of dredged material has support from multiple agencies and the public. The Commencement Bay open-water disposal site is managed by the Dredged Material Management Program (a consortium of the Corps, Washington State Department of Ecology (Ecology), U.S. Environmental Protection Agency (EPA), and the Washington Department of Natural Resources), which encourages beneficial use of dredged material when available and feasible (SAIC 2009). In addition, Endangered Species Act (ESA) conservation measures for the Commencement Bay open-water site include evaluating dredged material for beneficial use such as in-water habitat restoration projects as an alternative to disposal (NMFS 2015). During the Tacoma Harbor GI scoping period, a comment received from the U.S. Environmental Protection Agency (EPA) encouraged the Corps to consider beneficial re-use of suitable sediment, especially in the nearshore zone. The Washington State Department of Ecology (Ecology) issued general guidance for wood waste cleanup in aquatic environments in 2013, which includes in situ capping as an option. Citizens for a Healthy Bay, a local environmental organization that represents and engages the public for the protection of Commencement Bay, tentatively supports beneficial use of dredged material depending on the sediment suitability

[1] Planning Guidance Notebook, ER 1105-2-100, Appendix E. April 22, 2000.

[2] Implementation Guidance for Section 204 of the Water Resources Development Act of 1992, as amended by Section 1038(2) of the Water Resources Reform and Development Act of 2014 and Section 1122(i)(2) of Water Resources Development Act 2016 - Regional Sediment Management. February 16, 2018.

determination. Finally, one scoping comment from an individual citizen referenced potential beneficial use of dredged material and it was in favor of this use.

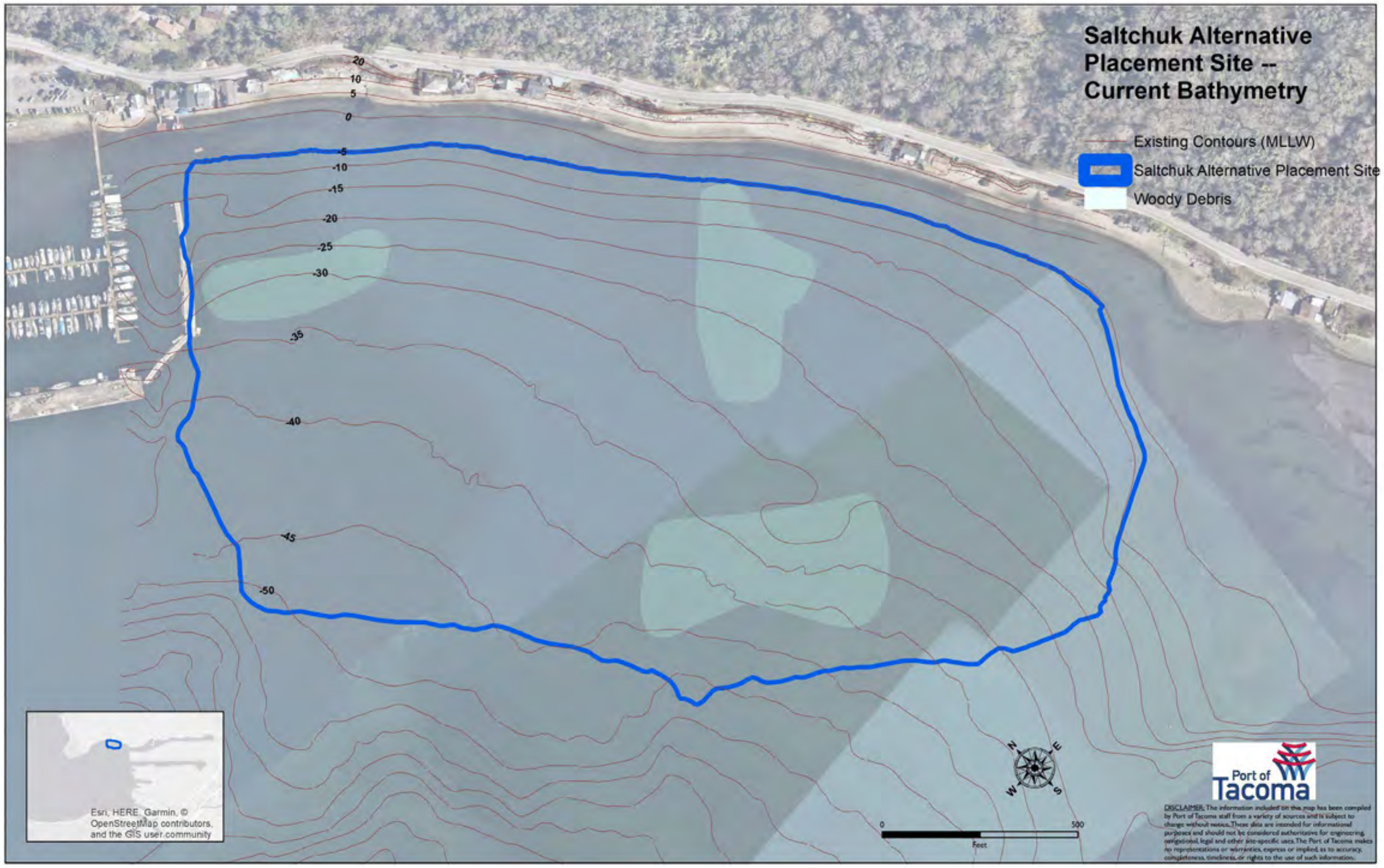

Figure 1. Saltchuk footprint within Commencement Bay with existing bathymetry and wood waste areas (Scenario A).

1.1 Problem Statement

A model is needed to assess quality of intertidal and subtidal marine habitat in Commencement Bay to evaluate the beneficial use of dredged material. Salmon habitat suitability index (HSI) models are based on freshwater life stages, which are not applicable to this project location in an estuary. The Seattle District considered using approved U.S. Fish and Wildlife Service HSI Models (i.e., “Blue Book” models) to assess habitat changes in the nearshore zone for species that have habitat requirements analogous to juvenile salmon. In particular, the juvenile English sole model (Toole et al. 1987) was considered based on correlation of juvenile English sole benefits to juvenile salmonids. However, after review of approved models, it was determined that these models did not use enough variables affected by beneficial use of dredged material or that they would not adequately capture the benefits to Chinook salmon (*Oncorhynchus tshawytscha*) brought about by placement of dredged material.

Many methods have been developed to assess impacts of proposed projects to anadromous fish species, especially salmonid species in the Pacific Northwest, with varying degrees of complexity (e.g., Lower Willamette River 2014, Skokomish River 2013, Willamette River 2012, and Skagit River 2011). These models tend to be fairly site specific and not appropriate for evaluation of beneficial use of dredged material at sites in the Commencement Bay nearshore zone.

1.1.1 Existing Conditions

The proposed beneficial use site is referred to as Saltchuk and is located along the northeastern shoreline of Commencement Bay. Over approximately 120 years, almost all the natural habitat in Commencement Bay was lost to human development; prior to 1877, the main habitat types of Commencement Bay were 2,085 acres of intertidal mudflats and about 3,894 acres of salt/brackish marsh (Corps 1993). By 2015 there were 106 acres of mudflat habitat and 72 acres of saltwater marsh (Kerwin 1999; EarthCorps 2015). Existing conditions at Saltchuk were documented prior to 2015 by Leon 2014 and GeoEngineers 2014b, as cited in GeoEngineers 2015. No restoration projects have been implemented at Saltchuk and it is assumed conditions have not changed significantly from the following description.

Lower Shore Zone (LSZ) habitat is composed of substrate that transitions to sand and silt substrate near mean lower low water (MLLW). LSZ habitat includes significant amounts of wood waste and one large area of wood waste starts at approximately MLLW. Based on previous wood waste studies, this wood waste concentration extends to a depth of approximately -30 MLLW. Macroalgae in the LSZ is largely composed of sea lettuce (Ulva spp.) at approximately the MLLW line. No eelgrass was observed within the project area; however, one patch of eelgrass was identified southeast of the project area at depths of approximately –6 feet to –10 MLLW during an underwater video survey conducted August 2014.

The site contains approximately 60.7 acres of deeper critical habitat zone (DZ) habitat (below -10 MLLW). The majority of the DZ habitat at the site consists of brown and black silt with wood waste over gray clay. Wood waste has accumulated over approximately 100 years due to log storage at the Saltchuk site. Log storage is visible on a 1931 aerial photograph as well as all subsequent aerial photographs. Three primary locations within the log storage area were observed to contain large quantities of wood waste during a 1999 dive survey.

Macroalgae is present in areas of the DZ and generally consists of brown or red algae. Invertebrates were observed during the dive survey including; polychaetes (unidentified species; only burrows observed), anemone (*Metridium senile*), sea stars (*Evasterias trochelii* and *Pisaster ochraceus*), red rock crab (*Cancer productus*), ghost shrimp (*Neotrypaea californiensis*), nudibranch (*Dirona albolineata*) and egg masses, and rosy octopus (*Octopus rubescens*; Leon 2014, as cited in GeoEngineers 2015). Ecology's Urban Bays monitoring program sampled the benthic community near Saltchuk at about -23 MLLW in 2014, and found 53% of the community was mollusks and 45% was annelids; only 0.59% was arthropoda and 0.82% was Echinodermata (Weakland et al. 2016). At least 63 creosote-treated timber piles approximately 12 inches in diameter are present from -5 MLLW to -15 MLLW. These piles are no longer associated with structures and would be removed by the Port of Tacoma.

1.1.2 Proposed Beneficial Use of Dredged Material

The objective of beneficial use of dredged material at Saltchuk is to restore nearshore intertidal and subtidal habitat substrate conditions for several fish and wildlife species, including ESA-listed species. The target species to benefit from the proposed project include juvenile and adult Chinook salmon, steelhead, and bull trout. Restoration actions are based on improving habitat conditions for these species and their prey species, such as forage fish and epibenthic and benthic invertebrates.

Dredged material would be placed by bottom dump barge or via excavator to enhance deep subtidal habitat and create and enhance shallow subtidal habitat. A range of scenarios appear in Table 1, including a minimum disposal scenario to build a bench to -20 ft MLLW (Scenario B), add benches to -10 ft MLLW (Scenario C) and -5 ft MLLW (Scenario D; Figure 2), and a full build-out (maximum disposal) to include island creation built on top of the benches (Scenario E; Figure 3).

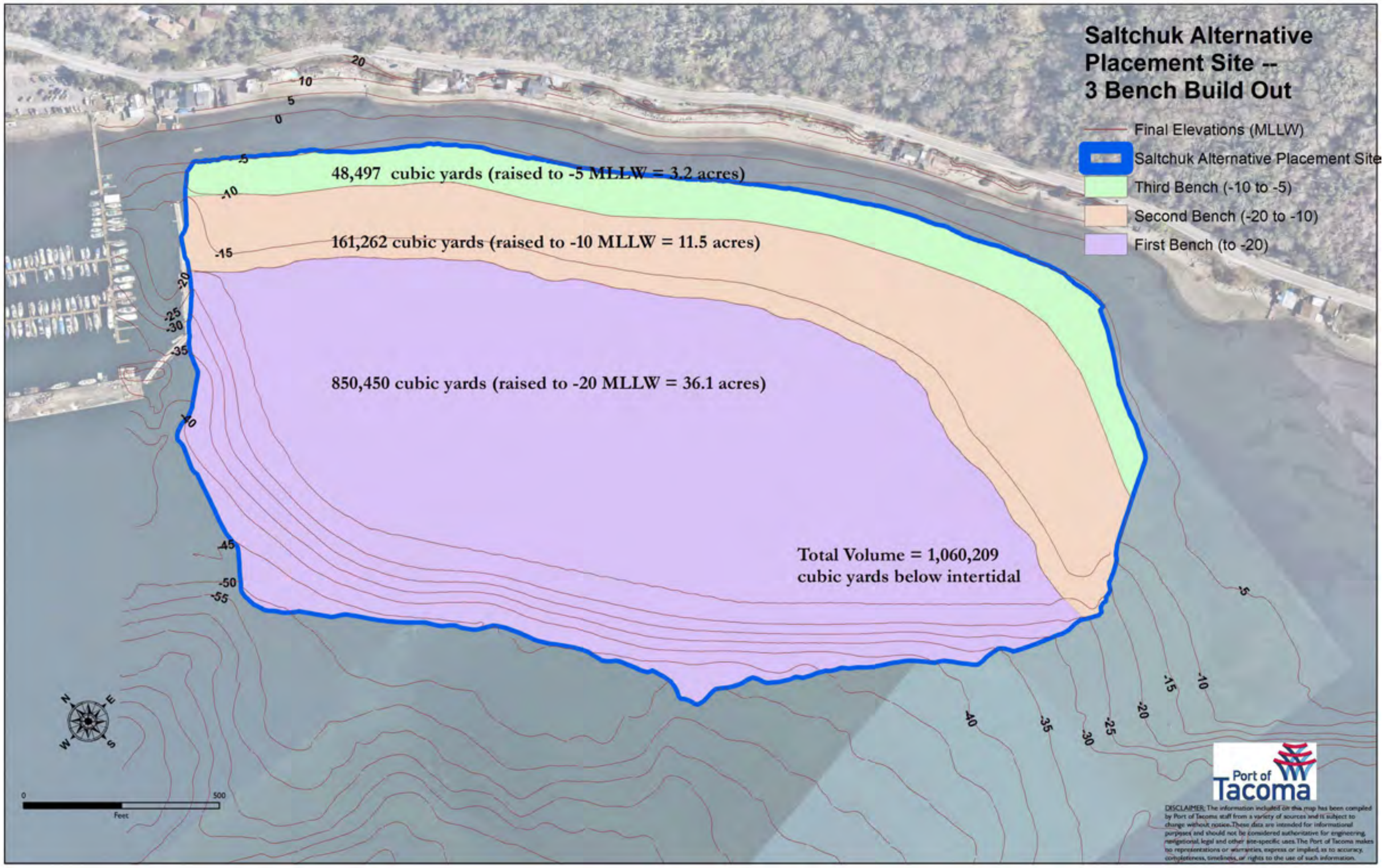

Figure 2. Proposed beneficial use of dredged material at Saltchuk. The first bench (to -20 MLLW) is Scenario B, the second bench (to -10 MLLW) is Scenario C, and the third bench (to -5 MLLW) is Scenario D.

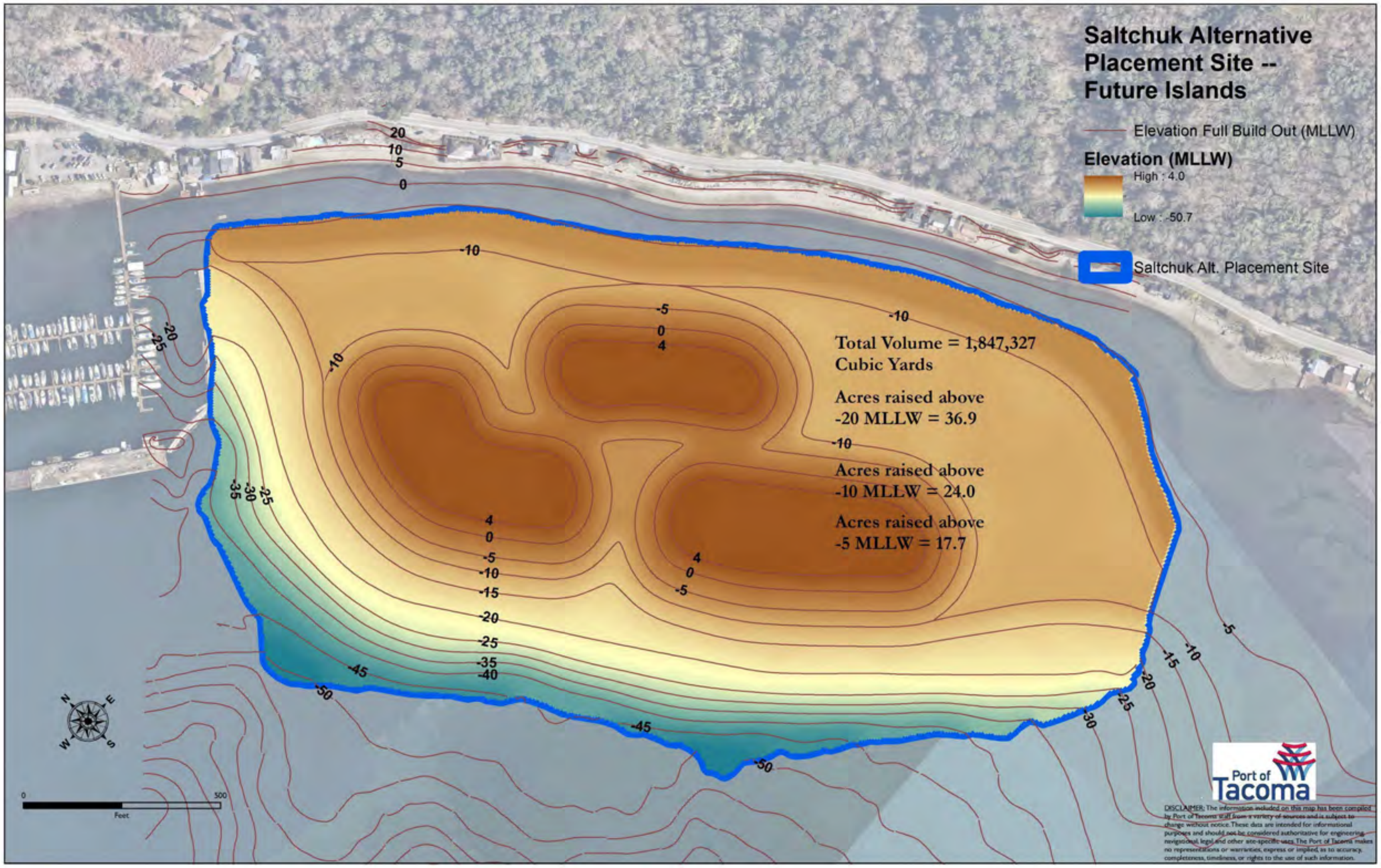

Figure 3. Full build-out of Saltchuk (Scenario E) has islands placed after the three benches (Scenarios B, C, and D) are constructed.

1.1.3 Anticipated Benefits

The majority of the DZ habitat within the project area will be converted to LSZ. LSZ habitat will be extended waterward to replace up to approximately 40.9 acres of DZ habitat under the full build-out Scenario E (Table 1). This habitat type provides the highest functional values in the NHV model.

Beneficial use of dredged material at Saltchuk will accomplish two goals: 1) wood waste will be capped with sediment and 2) additional intertidal and shallow subtidal habitat will be created. Areas that remain as DZ habitat will be configured as a slope ranging from approximately -15 MLLW to -40 MLLW. Proposed benefits within the DZ include decreasing bottom depth and capping existing wood waste, both of which may increase benthic production within this zone.

Placement of clean sediment over the wood debris will improve habitat conditions for benthic invertebrates. The epibenthic invertebrate community at the surface of the substrate is mostly copepods and amphipods that feed on detritus and/or plants (Dames and Moore 1981). Juvenile Chinook, chum (*Oncorhynchus keta*), and coho salmon (*O. kisutch*) in the Commencement Bay estuary feed primarily on epibenthic invertebrates such as copepods, amphipods, and aquatic insect larval and pupal stages; they transition from epibenthic prey to pelagic prey (such as aquatic insects, chironomids, and planktonic prey) with growth (Meyer et al. 1981; Simenstad 2000). Log storage was discontinued to remove the input source for wood waste impacts to the benthic environment.

Several studies have demonstrated that benthic organisms rapidly recolonize habitats disturbed by dredging and dredged materials placement and return these habitats to reference conditions (Wilber and Clarke 2007; Ponti et al. 2009). Recovery begins with the early colonizers and takes less than a year for the short-lived organisms with rapid growth and re-population strategies; this is followed by the longer-lived species that grow larger but have a slower recovery time of two to three years (Newell et al. 1998; Desprez 2000).

At full build-out, the shallow subtidal bench will start at approximately -10 MLLW and slope gradually up to approximately -6 MLLW across the bench. This is the observed elevation range of the eelgrass bed adjacent to the site to the east. Eelgrass may establish in this area naturally from the nearby eelgrass patch, or eelgrass could be artificially propagated through several methods including transplanting and seeding. Increasing potential eelgrass habitat will increase potential spawning habitat for Pacific herring and create important nursery habitat for other marine species.

The target species of the proposed Saltchuk are Chinook salmon, steelhead (*O. mykiss*) and bull trout (*Salvelinus confluentus*); including their prey species such as forage fish and terrestrial and benthic invertebrates. In addition to improving habitat conditions for listed salmonids and their prey, the project will indirectly benefit additional listed species. Chinook salmon is the primary prey of ESA-listed Southern Resident Killer Whales (SRKW; *Orcinus orca*), while Pacific sand lance (*Ammodytes hexapterus*) and Pacific herring (*Clupea pallasii*) are primary prey for ESA-listed marbled murrelets (*Brachyramphus marmoratus*). Although SRKW and marbled murrelets are not expected to occur within the project area, habitat enhancement for their prey species could increase prey populations and, in turn, increase dispersal and migration of these prey species into suitable habitat for SRKW and murrelets. Benefits of the action would accrue to the ecosystem well beyond the project site.

2 Model Background and Purpose

The purpose of this report is to present model evaluation of the Puget Sound Nearshore Habitat Valuation (NHV) Model that was developed by the National Marine Fisheries Service (NMFS) in 2015 (Appendix A). The purpose of the NHV model is to quantify habitat services for threatened juvenile Puget Sound Chinook and Hood Canal summer-run chum salmon in the Puget Sound nearshore zone during ESA consultations (Ehinger et al. 2015). Only benefits to juvenile Chinook salmon will be evaluated at Saltchuk due to the project location in Commencement Bay.

The NHV model uses a checklist scoring system to define habitat value, based primarily on elevation, vegetation, substrate conditions, anthropogenic impacts, and landscape context to provide a criteria-based and repeatable method for establishing habitat value. NMFS provided guidance to use the NHV model with Habitat Equivalency Analysis, but the Seattle District will use the Corps-certified planning model IWR Planning Suite (Section 4) to evaluate beneficial use of dredged material. Appendix A, Chapter 2 describes the NHV model development in detail and is summarized herein (Section 3).

This model will be used to establish base habitat values for the two elevation zones within the assessment area: LSZ and DZ. The Riparian Zone (RZ) and Shallow Subtidal Zone (SSZ) portions of the model will not be used due to real estate limitations and the scope of this proposed beneficial use.

2.1 Model Objectives and Limitations

Model objectives are the following:

- To quantify habitat benefits among proposed material placement alternatives
- “Assess the PCEs present at a project site and derive a habitat value through averaging across the values assigned to PCE functions for Puget Sound Chinook and Hood Canal chum within nearshore strata delineated by elevation relative to the Mean Lower Low Water” (MLLW; Ehinger et al. 2015).

Limitations of this model include that it is not meant to project changes in population numbers of any life stage or species and is meant to capture changes in the ecosystem as result of Corps activities. Additionally, although the parameters were chosen and quantified primarily using the critical habitat features of Chinook and chum salmon, the model is meant to represent suitability of the system for all anadromous and other fish species of concern.

2.2 Conceptual Model

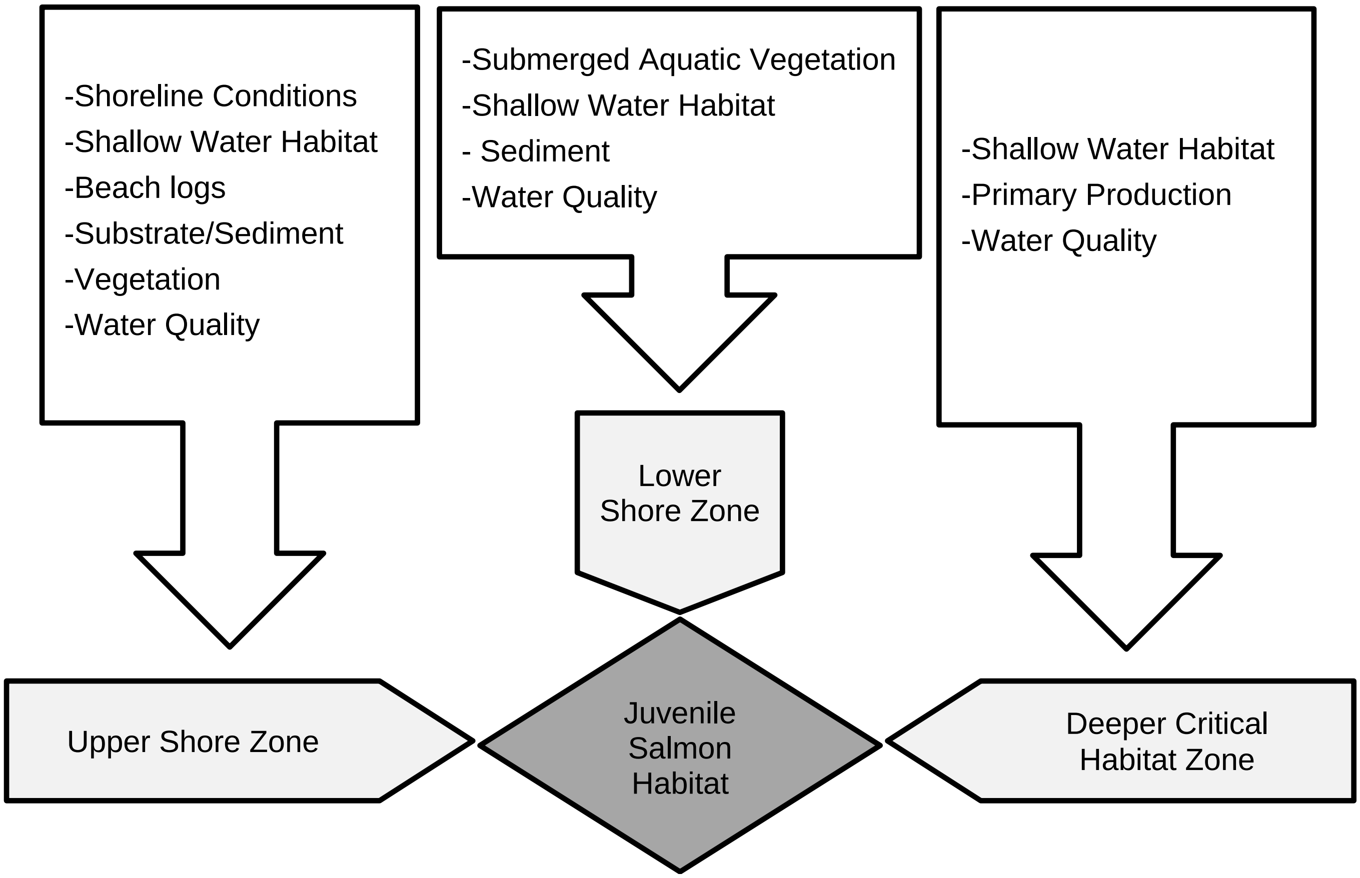

Figure 4. Conceptual model for key habitat considerations in nearshore juvenile salmonid habitat that could be impacted by placement of dredged material.

3 Model Parameters

The NHV Model uses checklists to score PCEs of Puget Sound Chinook and Hood Canal summer-run chum salmon. Ehinger et al. (2015) provided rationale for model parameter inclusion (Appendix A, Chapter 2); this is summarized below and incorporated by reference.

3.1 Depth

Shallow water along natural shorelines in the upper shore zone provides refuge from predators and a migratory corridor. Chinook salmon smolts use the shallow nearshore to avoid predation by piscivorous predators, such as staghorn sculpin and larger salmon. Willette (2001) found that juvenile pink salmon in Prince William Sound leave the shallow nearshore zone when the biomass of large copepods, their food, declined. With the juvenile pink salmon foraging in deeper water, the mean daily individual predator consumption of salmon increased by a factor of five.

Feeding habitats of juvenile salmon shift from the epibenthic zones to neritic (zooplankton) prey during downstream migration, yet focus primarily on shallow-water habitats (Hiss and Boomer 1986). Juvenile Chinook, chum, and coho salmon in Commencement Bay feed primarily on epibenthic invertebrates such as copepods, amphipods, and aquatic insect larval and pupal stages (Meyer et al. 1981). Stomach contents of Chinook salmon less than 90 mm collected east of Saltchuk were primarily planktonic-neritic and marine benthic-epibenthic species, while fish greater than 90 mm fed mostly on marine planktonic-neritic prey species (Olson et al. 2008). Juvenile salmon transition from epibenthic prey to pelagic prey (such as aquatic insects, chironomids, and planktonic prey) with growth (Meyer et al. 1981; Simenstad 2000).

3.1.1 LSZ

Shallow Water Habitat			
#	Indicator of Physical Habitat	Question	Maximum Possible Score
2a	Shallow Water Habitat, Accessibility and Presence	What shallow water area [in sqft] is lost to juvenile rearing? This loss could be the result of the construction of three-dimensional structures that result in the loss of shallow water habitat during some tides. Such structures include piles, bulkheads, and fill, or the conversion of shallow water habitat to deep water habitat via dredging. Not included as impacts to this habitat parameter are low profile structures like boat ramps, rails, and low concrete rubble. The effect of boat ramps and debris are considered with the Substrate rating below.	1
2b	Dredging	Is habitat loss dredging related? Y or N. If so, NHV for LSZ gets multiplied with 0.3, because maximum habitat value for deeper habitat is 0.3.	

3.1.2 DZ

Shallow Water Habitat			
#	Indicator of Physical Habitat	Question	Maximum Possible Score
1	Water Habitat, Accessibility and Presence	What water area [in sqft] is lost to Chinook use? This loss could be the result of the construction of three-dimensional structures that result in the loss of shallow water habitat during some tides. Such structures include piles, bulkheads, and fill.	3

3.2 Sediment

Ecology (2013) describes three main issues that excess wood waste can have on the benthic environment: 1) the physical presence of wood waste, which prevents biota from thriving and recruiting in and on native, healthy substrate; 2) decreased dissolved oxygen due to microbial decomposition, which can create an unhealthy or toxic environment for biota, and; 3) decomposition by-products such as sulfides, ammonia, and phenols, which can cause or contribute to toxicity. Capping the wood waste with native material may initially harm habitat during early consolidation because any infauna and epifauna would be exposed to the pore water forced upwards from the wood waste below. Depending on the nature of the capping material, and the wood waste being capped, this may be a transient, short-lived effect. Post-remediation cap monitoring is recommended to verify the cap integrity and long-term recolonization of the benthic community.

It is assumed that 10% of the wood waste (0.83 acres total) is located in the LSZ.

3.2.1 LSZ Only

Sediment			
#	**Indicator of Physical Habitat**	**Question**	**Maximum Possible Score**
3a	Substrate Size select one	Is the surface substrate in the littoral zone of the action area >25% mud or mixed fines?	0.5
3b		Is the surface substrate in the littoral zone of the action area >25% sand or larger grained gravels?	1
3c		Is the surface substrate in the littoral zone of the action area >25% rocky?	1
	Habitat Loss from Development	**Sediment lost to low and high structures:** What area [in sq ft] is lost to structures including boat ramps, riprap, concrete rubble, jetties, and bulkheads.	
3d	Habitat Degradation Resulting from Development	**Habitat Reduction**: % for entire affected area not covered up by low structures. Is the substrate in the affected area unnaturally compacted or coarsened as a result of a bulkhead or riprap; has the beach grade lowered? Consider effects within the affected area, only, like downdrift part of drift cell. This is the area calculated by dividing habitat loss from development (sq ft) by total area (sq ft).	

3.3 Water Quality

Juvenile salmonids require optimal water quality conditions to support growth and maturation, which include optimal dissolved oxygen levels, minimal sediment and turbidity levels, and free of contaminants. Water quality is a function of several variables that are influenced by the intensity of shoreline development. Nearshore marine water quality is influenced by the level of contaminant inputs from, including but not limited to storm water, waste water treatment plant effluent, residential septic inputs, marina and ferry activities, and long-term Superfund Site cleanup activities.

The NHV model uses a surrogate approach to quantitatively evaluate water quality. In the absence of detailed water quality information, biologists use the surrounding habitat conditions listed above to determine which of the three simplified ratings of poor, medium, or excellent is appropriate. Localized water quality may be improved by covering wood waste, but the overall water quality of Commencement Bay would not change. It is expected the benefits of covering wood waste would be primarily to the benthic community and captured by the sediment variable. This section is a yes or no choice and all cells must be answered.

3.3.1 LSZ

Water Quality			
#	Indicator of Physical Habitat	Question	Maximum Possible Score
4a	Water Quality Condition, select one	Is water quality in action area optimal? Use location as surrogate if no data. If action area is in undeveloped part of Puget Sound choose "yes".	1
4b		Is water quality in action area free of major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated stormwater inputs? Use location as surrogate if no data. If action area is in little to medium developed part of Puget Sound, like Wollochet Bay, Horsehead Bay, Gig Harbor, choose "yes".	0.5
4c		Is WQ impacted by major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated stormwater inputs? Use location, as surrogate if no data. If action area is very developed and has WQ effects from industrial sources, like Commencement Bay, Duwamish, choose "yes".	0

3.3.2 DZ

Water Quality			
#	Indicator of Physical Habitat	Question	Maximum Possible Score
6a	Water Quality, select one	Is water quality in action area optimal? Use location as surrogate if no data. If action area is in undeveloped part of Puget Sound choose "yes".	2
6b		Is water quality in action area free of major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated stormwater inputs? Use location as surrogate if no data. If action area is in little to medium developed part of Puget Sound, like Wollochet Bay, Horsehead Bay, Gig Harbor, choose "yes".	1
6c		Is WQ impacted by major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated stormwater inputs? Use location, as surrogate if no data. If action area is very developed and has WQ effects from industrial sources, like Commencement Bay, Duwamish, choose "yes".	0

3.4 Aquatic Vegetation

Juvenile salmon preferentially select eelgrass (Simenstad 2000; Johnson et al. 2010) and kelp (Johnson et al. 2010), and there is a correlation between salmon abundance and cover density. The preferentially selected eelgrass and kelp habitats provided more cover and vegetative biomass than the habitats (filamentous green algae, non-vegetated habitat) with less salmonid abundance. NMFS uses these studies that show a preference of juvenile salmon for some macroalgae that provide abundant structure to formulate a working hypothesis for the NHV model. The assumption underlying the quantification of SAV value in the NHV model is that the more structure native aquatic macrophytes provide the higher is its value to juvenile Puget Sound Chinook and Hood Canal summer-run chum.

A project goal is to create habitat elevations that will support eelgrass and other macroalgae; however, eelgrass was not historically widespread in Commencement Bay, likely due to the high sediment loads from the Puyallup

River (Kerwin 1999). Additional restoration work such as seeding may be necessary if natural recruitment does not occur.

3.4.1 This section is a yes or no choice and all cells must be answered. LSV

Submerged Aquatic Vegetation (SAV)			
#	Indicator of Physical Habitat	Question	Maximum Possible Score
1a	SAV condition, select one	Aquatic vegetation value high	4
1b		Aquatic vegetation value medium, incl. native oyster beds	3
1c		Aquatic vegetation value medium low	2
1d		Aquatic vegetation value very low	1
1e		Aquatic vegetation value none	0

3.4.2 DZ

Primary Production			
#	Indicator of Physical Habitat	Question	Maximum Possible Score
2	Primary Production	Primary production from algae. Assumed always present.	1

3.5 NHV Scores

The maximum quality score is 0.3 for DZ and 1.0 for LSZ. The LSZ can provide prime rearing conditions for juvenile Chinook salmon. While the DZ provides important migratory and rearing habitat, due to its depth (deeper than -10 MLLW) and lack of submerged aquatic vegetation (SAV), it cannot provide as much cover or produce as much food as the LSZ.

Indicators most strongly associated with at least one of the PCEs assessed receive a maximum score of 4, indicators strongly associated with at least one of the PCEs assessed receive a maximum score of 3, indicators moderately associated with at least one of the PCEs assessed receive a maximum score of 2, indicators little associated with at least one of the PCEs assessed receive a maximum score of 1, and indicators not associated with any of the assessed PCEs receive a score of 0.

To derive the NHV for a subject site, the sum of the points awarded for each "Indicator of Physical Habitat" for the LSZ is divided by the maximum possible points for the zone (Section 3.5.1). This normalization exercise expresses the NHV for each of the zones as a percentage of the maximum possible habitat value, 1. For the DZ (Section 3.5.2), sum of the "Indicator of Physical Habitat" is divided by 20 to normalize the NHV to a maximum of 0.3 (0.3=6/20).

3.5.1 LSV

#	Indicator of Physical Habitat	Maximum Possible Score
1	SAV	4
2	Shallow Water Habitat	1
3	Sediment – Substrate Size	1
4	Water Quality Condition	1
	Total Possible Score	**7**

3.5.2 DZ

#	Indicator of Physical Habitat	Maximum Possible Score
1	Shallow Water Habitat	3
2	Primary Production	1
6	Water Quality Condition	2
	Total Possible Score	**6**
	Number added to divisor to set max possible NHV at 0.3	14
	Divisor for NHV calculation	**20**

For Saltchuk, the DZ scores did not change among the scenarios due to lack of overwater structures and no change to water quality or aquatic vegetation. A large proportion of benefits were derived from having fewer acres of DZ habitat after each scenario, in addition to changes to LSZ habitat quality.

4 Methodology

Table 1 displays acres by elevation stratum for each alternative scenario to be analyzed as part of a cost effectiveness and incremental cost analysis (CE/ICA) using the Corps-certified planning model IWR Planning Suite, version 2.0.9.1. Area, or acres impacted, is one component of habitat unit (HU) calculations where HUs are equal to the acres multiplied by a normalized quality score (i.e. score between 0 and 1). For Corps studies, environmental restoration projects evaluate changes in habitat and HUs over the 50-year planning period of analysis to compute average annual habitat units (AAHUs). AAHUs are computed for each restoration scenario, including the No Action or future without project condition. Benefits of a proposed restoration project are the net change in AAHUs from the No Action scenario.

As shown in the table below, the existing condition, or No Action scenario, includes mostly DZ habitat for a substrate elevation range of -98 to -10 MLLW. As bench and island increments are added, acres shift from lower value DZ to higher value LSZ with an elevation range of -10 to +5 MLLW. The total area possible for the Saltchuk site is 64 acres. The LSZ and DZ acreages shown in red are carried forward to compute HUs.

Table 1. Saltchuk Acres by Habitat Zone

Zone		Acreage After Scenario Implementation					Acreage After Scenario Implementation (Subtotal)		
		LSZ	LSZ	DZ	DZ		LSZ	DZ	
Scenario		≥ -5 MLLW < +5 MLLW	≥ -10 MLLW < -5 MLLW	≥ -20 MLLW < -10 MLLW	≥ -98 MLLW < -20 MLLW	Total Acres	≥ -10 MLLW < +5 MLLW	≥ -98 MLLW < -10 MLLW	Total Acres
A	No Action (Existing/ Future Without Project Condition)	0	3.3	11.7	49	64	3.3	60.7	64
B	Saltchuk – First Bench (raised to -20 MLLW)	0	3.3	48.6	12.1	64	3.3	60.7	64
C	+ Second Bench (raised to -10 MLLW)	0	14.2	36.1	13.7	64	14.2	49.8	64
D	+ Third Bench (raised to -5 MLLW)	3.2	11.5	36.1	13.2	64	14.7	49.3	64
E	+ Islands (Full Build-Out)	21.2	19.7	9	14.1	64	40.9	23.1	64

The evaluation of HU will take into consideration changes over the 50-year period of analysis for the Tacoma Harbor feasibility study with analysis of years 0, 3, and 50. The LSZ indicators are about submerged aquatic vegetation (SAV; e.g., kelp and eelgrass) and shallow water habitat (which includes foraging habitat, i.e., benthic invertebrates). Depth, water quality, and sediment are all immediately functioning. The time to establishment for benthic invertebrates is estimated to take 3 years in the LSZ and DZ. The DZ indicators are similar to LSZ with 3 years for the establishment of benthic invertebrates. The NHV model will be expanded to include quality scores (i.e. normalized habitat quality scores between 0 and 1) for each year and scenario analyzed. The maximum quality score is 0.3 for DZ and 1.0 for LSZ.

Table 2. Habitat types, current values, and years to fully functioning.

Habitat Type	Elevation	Years to Fully Functioning	Source
Lower Shore Zone (LSZ)	From +5 MLLW to -10 MLLW	3	Newell et al. 1998; Desprez 2000; Wilber and Clarke 2007; Ponti et al. 2009
Deeper Critical Habitat Zone (DZ)	From -10 MLLW to -98 MLLW	3	Newell et al. 1998; Desprez 2000; Wilber and Clarke 2007; Ponti et al. 2009

Table 3 displays NHV quality scores that are carried forward for the computation of average annual habitat units. The acres impacted are carried forward from the red cells in Table 1. The NHV quality scores reference the computations in their respective sheets in the Excel file on the ‘DZ’ and ‘LSZ’ tabs.

Table 3. Saltchuk NHV Quantity and Quality Summary*

Metric	Scenario A (No Action)		Scenario B		Scenario C		Scenario D		Scenario E	
	DZ	LSZ	DZ	LSZ	DZ	LSZ	DZ	LSZ	DZ	LSZ
Acres	60.7	3.3	60.7	3.3	49.8	14.2	49.3	14.7	23.1	40.9
Year 0 NHV	0.20	0.34	0.20	0.34	0.20	0.35	0.20	0.43	0.20	0.43
Year 3 NHV	0.20	0.34	0.20	0.48	0.20	0.50	0.20	0.57	0.20	0.57
Year 50 NHV	0.20	0.34	0.20	0.48	0.20	0.50	0.20	0.57	0.20	0.57

As previously mentioned, HUs are quantity multiplied by quality of habitat, where quantity is the acres for a given zone and quality is the NHV quality score. HUs were computed for each scenario, year, and habitat zone as shown in Table 4. The total HU for a scenario and year is the sum of HUs for DZ and LSZ, as shown in the following formula.

$$Total\ HUs_{year\ x} = (DZ\ acres_{year\ x} \times DZ\ NHV_{year\ x}) + (LSZ\ acres_{year\ x} \times LSZ\ NHV_{year\ x})$$

For example, computation of Scenario D HUs for year 0 is as follows:

$$Scenario\ D\ HUs_{year\ 0} = (Scenario\ D\ DZ\ acres_{year\ 0} \times Scenario\ D\ DZ\ NHV_{year\ 0}) + (Scenario\ D\ LSZ\ acres_{year\ 0} \times Scenario\ LSZ\ NHV_{year\ 0})$$

$$= (49.3 \times 0.2) + (14.7 \times 0.43) = 16.2$$

* Values shown in the yellow cells have not yet been computed and are for demonstration purposes only.

Table 4. Saltchuk Alternative HU Inputs

Year	Scenario A (No Action)			Scenario B			Scenario C			Scenario D			Scenario E		
	DZ	LSZ	Total	DZ	LSZ	Total	DZ	LSZ	Total	DZ	LSZ	Total	DZ	LSZ	Total
0	12.1	1.1	13.3	12.1	1.1	13.3	10.0	5.0	15.0	9.9	6.3	16.2	4.6	17.5	22.1
3	12.1	1.1	13.3	12.1	1.6	13.7	10.0	7.0	17.0	9.9	8.4	18.3	4.6	23.4	28.0
50	12.1	1.1	13.3	12.1	1.6	13.7	10.0	7.0	17.0	9.9	8.4	18.3	4.6	23.4	28.0
AAHU*			***13.3***			***13.7***			***16.9***			***18.2***			***27.8***
Net AAHU Gain**			***0***			***0.4***			***3.6***			***4.9***			***14.5***

** AAHU = Average Annual Habitat Units computed in IWR Planning Suite Annualization Calculator*

***Net AAHU Gain = net change in AAHU relative to the Scenario A (No Action). This is the benefit input for the cost effective and incremental cost analysis in IWR Planning Suite.*

Total HU values for each scenario and year are used for computing AAHU using the IWR Planning Suite Annualizer Tool. Years 0, 3, and 50 Total HU values shown in the green cells from Table 4 are input for a given scenario (or Annualization Set) in the NER Outputs tab of the Annualization Calculator. Linear interpolation between years is assumed. Figure 5 displays a screen shot from IWR Planning Suite with the computation of AAHUs for Scenario D. Years 2018 (0), 2021 (3) and 2068 (50) are input. AAHU output over the 50-year period of analysis is 18.237.

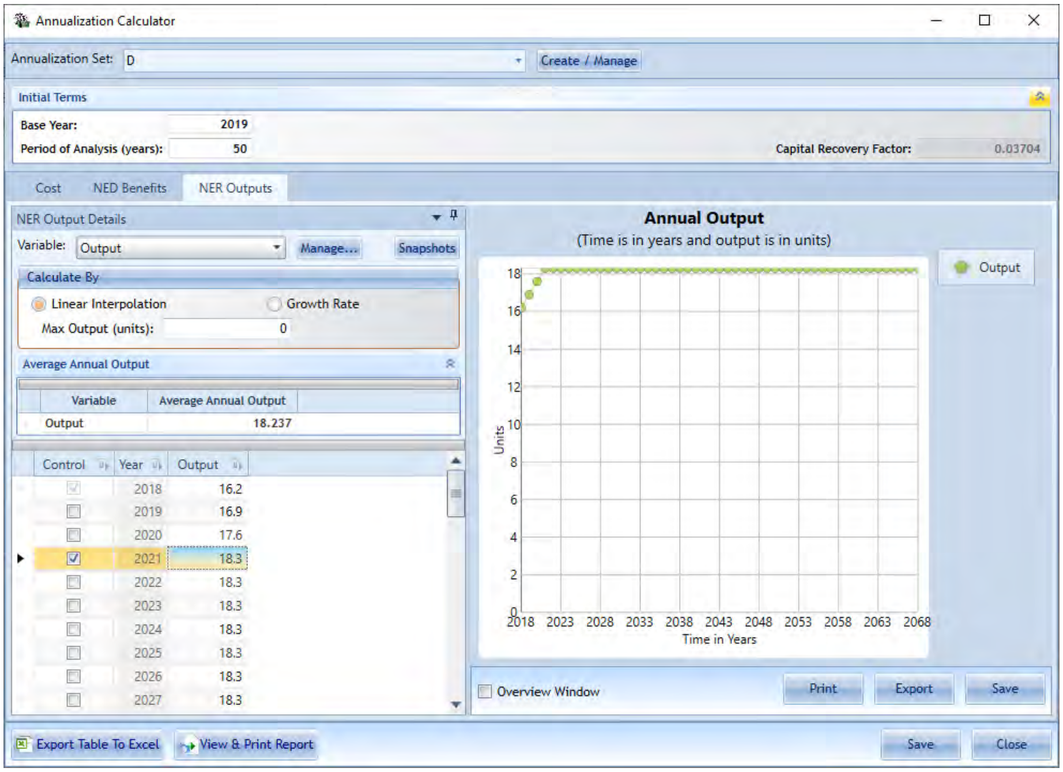

Figure 5. IWR Planning Suite Annualization Worksheet for Scenario D

A CE/ICA analysis will use net AAHU gain relative to the No Action for the benefit input along with incremental average annual costs for beneficial use placement at Saltchuk site above Commencement Bay disposal cost (referred to as the Base Plan) to determine a best buy plan that reasonably maximizes net environmental benefits in a cost effective and efficient manner.

5 References

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For help in using this spreadsheet see:
Ehinger, S.I., J. P. Fisher, R. McIntosh, D. Molenaar and J. Walters. 2015. Working Draft, April 2015: Use of The Puget Sound Nearshore Habitat Values Model with Habitat Equivalency Analysis for Characterizing Impacts and Avoidance Measures for Projects that Adversely Affect Critical Habitat of ESA-Listed Chinook and Chum Salmon.

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Zone		Acreage After Scenario Implementation				
		LSZ	LSZ	DZ	DZ	
Saltchuk Scenarios		≥ -5 MLLW	≥ -10 MLLW < -5 MLLW	≥ -20 MLLW < -10 MLLW	≥ -98 MLLW < -20 MLLW	Total Acres
A	Existing Condition (also No-Action)	0	3.3	11.7	49	64
B	Saltchuk – First Bench (raised to -20 MLLW)	0	3.3	48.6	12.1	64
C	+ Second Bench (raised to -10 MLLW)	0	14.2	36.1	13.7	64
D	+ Third Bench (raised to -5 MLLW)	3.2	11.5	36.1	13.2	64
E	+ Islands (Full Build-Out)	21.2	19.7	9	14.1	64

Notes:
Max NHV scores possible: LSZ (≥ -10 MLLW < +5 MLLW) DZ (≥ -98 MLLW < -10 MLLW)

1.0

0.3

Nearshore Habitat Value Determination Model
Lower Shore Zone < +5 MLLW
Yellow Cells are to fill in.

Affected area	Scenario A (No Action)	Scenario B	Scenario C	Scenario D	Scenario E
Acres	3.3	3.3	14.2	14.7	40.9
Sq. ft.	143,748	143,748	618,552	640,332	1,781,604

				Scenario A (No Action)			Scenario B				
				Years 0, 3, and 50			Year 0			Years 3, 50	
#	Indicator of Physical Habitat	Question	Maximum Possible Points	Site Condition	Project Points	Summary Project Points by Category	Site Condition	Project Points	Summary Project Points by Category	Site Condition	Project Points
Submerged Aquatic Vegetation (SAV)											
1a	SAV condition, select one (y/n)	Aquatic vegetation value high	4	n	0		n	0		n	0
1b		Aquatic vegetation value medium, incl. native oyster beds	3	n	0		n	0		n	0
1c		Aquatic vegetation value medium low	2	n	0		n	0		y	2
1d		Aquatic vegetation value very low	1	y	1		y	1		n	0
1e		Aquatic vegetation value none	0	n	0	1	n	0	1	n	0
Shallow Water Habitat											
2a	Shallow Water Habitat, Accessibility and Presence	What shallow water area [in sqft] is lost to juvenile rearing? This loss could be the result of the construction of three-dimensional structures that result in the loss of shallow water habitat during some tides. Such structures include piles, bulkheads, and fill, or the conversion of shallow water habitat to deep water habitat via dredging. Not included as impacts to this habitat parameter are low profile structures like boat ramps, rails, and low concrete rubble. The effect of boat ramps and debris are considered with the Substrate rating below.	1.00	0	1.00		0	1.00		0	1.00
2b	Dredging	Is habitat loss dredging related? Y or N. If so, NHV for LSZ gets multiplied with 0.3, because maximum habitat value for deeper habitat is 0.3.		n	1.00	1.00	n	1.00	1.00	n	1.00
Sediment											
3a	Substrate Size select one (y/n)	Is the surface substrate in the littoral zone of the action area >25% mud or mixed fines?	0.5	y	0.50		y	0.50		y	0.50
3b		Is the surface substrate in the littoral zone of the action area >25% sand or larger grained gravels?	1	n	0.00		n	0.00		n	0.00
3c		Is the surface substrate in the littoral zone of the action area >25% rocky?	1	n	0.00	0.50	n	0.00	0.50	n	0.00
	Habitat Loss from Development	**Sediment lost to low and high structures:** What area [in sqft] is lost to structures including boat ramps, riprap, concrete rubble, jetties, and bulkheads.		36,100	0.37		36,100	0.37		36,100	0.37
3d	Habitat Degradation Resulting from Development	**Habitat Reduction**: % for entire affected area not covered up by low structures. Is the substrate in the affected area unnaturally compacted or coarsened as a result of a bulkhead or riprap; has the beach grade lowered? Consider effects within the affected area, only, like downdrift part of drift cell. This is the area calculated by dividing habitat loss from development (sq ft) by total area (sq ft).		0.25	0.37	0.37	0.25	0.37	0.37	0.25	0.37
Water Quality											
4a	Water Quality Condition, select one	Is water quality in action area optimal? Use location as surrogate if no data. If action area is in undeveloped part of Puget Sound choose "yes".	1	n	0.00		n	0.00		n	0.00
4b		Is water quality in action area free of major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated storwater inputs? Use location as surrogate if no data. If action area is in little to medium developed part of Puget Sound, like Wollochet Bay, Horshead Bay, Gig Harbor, choose "yes".	0.5	n	0.00		n	0.00		n	0.00
4c		Is WQ impacted by major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated storwater inputs? Use location, as surrogate if no data. If action area is very developed and has WQ effects from industrial sources, like Commencement Bay, Duwamish, choose "yes".	0	y	0.00	0.00	y	0.00	0.00	y	0.00
		Sum of maximum possible points	**7.00**		**Total Points**	**2.37**		**Total Points**	**2.37**		**Total Points**
					NHV	**0.34**		NHV	**0.34**		NHV

Affected area	Scenario A (No Action)	Scenario B	Scenario C	Scenario D	Scenario E
Acres	60.7	60.7	49.8	49.3	23.1
Sq. ft.	2,644,092	2,644,092	2,169,288	2,147,508	1,006,236

Habitat Value Determination Model for Deeper Critical Habitat Zone

The "Deeper Critical Habitat Zone" extends from, 98 feet off shore, or -10 feet, or the lowest extend of

Yellow Cells are to fill in.

				Scenario A (No Action)			Scenario B				
				Years 0, 3, and 50			Year 0			Years 3, 50	
#	Indicator of Physical Habitat	Question	Maximum Possible Points	Site Condition	Project Points	Summary Project Points by Category	Site Condition	Project Points	Summary Project Points by Category	Site Condition	Project Points
Shallow Water Habitat											
1	Water Habitat, Accessibility and Presence	What water area [in sqft] is lost to Chinook use? This loss could be the result of the construction of three-dimensional structures that result in the loss of shallow water habitat during some tides. Such structures include piles, bulkheads, and fill.	3.00	0	3.00	3.00	0.00	3	3.00	0	3
Primary Production											
	Primary Production	Primary production from algae. Assumed always present.	1		1	1		1	1		1
Water Quality											
6a	Water Quality, select one (y/n)	Is water quality in action area optimal? Use location as surrogate if no data. If action area is in undeveloped part of Puget Sound choose "yes".	2	n	0.00		n	0.00		n	0.00
6b		Is water quality in action area free of major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated storwater inputs? Use location as surrogate if no data. If action area is in little to medium developed part of Puget Sound, like Wollochet Bay, Horshead Bay, Gig Harbor, choose "yes".	1	n	0.00		n	0.00		n	0.00
6c		Is WQ impacted by major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated storwater inputs? Use location, as surrogate if no data. If action area is very developed and has WQ effects from industrial sources, like Commencement Bay, Duwamish, choose "yes".	0	y	0.00	0.00	y	0.00	0.00	y	0.00
Sum		Sum of maximum possible points	6.00		Total Points	4.00		Total Points	4.00		Total Points
NHV					NHV	0.20		NHV	0.20		NHV

14	Number added to divisor to set maximum possible NHV at 0.3

Summary of Parameters Needed for NHV and IWR Planning Suite AAHU Computation

Zone		Acreage After Scenario Implementation					Acreage After Scenario		
		LSZ	LSZ	DZ	DZ	Total Acres	LSZ	DZ	Total Acres
Scenario		≥ -5 MLLW < +5 MLLW	≥ -10 MLLW < -5 MLLW	≥ -20 MLLW < -10 MLLW	≥ -98 MLLW < -20 MLLW		≥ -10 MLLW < +5 MLLW	≥ -98 MLLW < -10 MLLW	
A	Existing Condition	0	3.3	11.7	49	64	3.3	60.7	64
B	Saltchuk – First Bench (raised to -20 MLLW)	0	3.3	48.6	12.1	64	3.3	60.7	64
C	+ Second Bench (raised to -10 MLLW)	0	14.2	36.1	13.7	64	14.2	49.8	64
D	+ Third Bench (raised to -5 MLLW)	3.2	11.5	36.1	13.2	64	14.7	49.3	64
E	+ Islands (Full Build-Out)	21.2	19.7	9	14.1	64	40.9	23.1	64

Notes:
NHV cells are populated based on computations in DZ and LSZ sheets.

Quanity and Quality Score Summary Table

Metric	Scenario A (No Action)			Scenario B			Scenario C			Scenario D			Scenario E	
	DZ	LSZ		DZ	LSZ		DZ	LSZ		DZ	LSZ		DZ	LSZ
Acreage	60.7	3.3		60.7	3.3		49.8	14.2		49.3	14.7		23.1	40.9
Year 0 NHV	0.20	0.34		0.20	0.34		0.20	0.35		0.20	0.43		0.20	0.43
Year 3 NHV	0.20	0.34		0.20	0.48		0.20	0.50		0.20	0.57		0.20	0.57
Year 50 NHV	0.20	0.34		0.20	0.48		0.20	0.50		0.20	0.57		0.20	0.57

IWR Planning Suite Habitat Unit (HU) Entry Information for AAHU Calculation (Acres x NHV)

Year	Scenario A (No Action)			Scenario B			Scenario C			Scenario D			Scenario E		
	DZ	LSZ	Total, by Year	DZ	LSZ	Total, by Year	DZ	LSZ	Total, by Year	DZ	LSZ	Total, by Year	DZ	LSZ	Total, by Year
0	12.1	1.1	**13.3**	12.1	1.1	**13.3**	10.0	5.0	**15.0**	9.9	6.3	**16.2**	4.6	17.5	**22.1**
3	12.1	1.1	**13.3**	12.1	1.6	**13.7**	10.0	7.0	**17.0**	9.9	8.4	**18.3**	4.6	23.4	**28.0**
50	12.1	1.1	**13.3**	12.1	1.6	**13.7**	10.0	7.0	**17.0**	9.9	8.4	**18.3**	4.6	23.4	**28.0**
AAHU, computed in IWR Planning Suite	***13.3***			***13.7***			***16.9***			***18.2***			***27.8***		
Net AAHU Gain	***0.0***			***0.4***			***3.6***			***4.9***			***14.5***		

IWR Planning Suite Annualizer tool will be used to compute AAHU for Scenarios A-E using the computed totals by year in the green cells.
Calculation will assume linear interpolation between points.
Computed AAHU scores will be carried forward into a CE/ICA using IWR Planning Suite, where the benefits of Scenarios B-E are the net change in AAHU from the Scenario A (No Action).

Nearshore Habitat Value Determination Model
Lower Shore Zone < +5 MLLW
Yellow Cells are to fill in.

Affected area	Scenario A (No Action)	Scenario B	Scenario C	Scenario D	Scenario E
Acres	3.3	3.3	14.2	14.7	40.9
Sq. ft.	143,748	143,748	618,552	640,332	1,781,604

				Scenario A (No Action)			Scenario B						Scenario C						Scenario D						Scenario E							
				Years 0, 3, and 50			Year 0			Years 3, 50			Year 0			Years 3, 50			Year 0			Years 3, 50			Year 0			Years 3, 50				
#	**Indicator of Physical Habitat**	**Question**	**Maximum Possible Points**	**Site Condition**	**Project Points**	**Summary Project Points by Category**	**Site Condition**	**Project Points**	**Summary Project Points by Category**	**Site Condition**	**Project Points**	**Summary Project Points by Category**	**Site Condition**	**Project Points**	**Summary Project Points by Category**	**Site Condition**	**Project Points**	**Summary Project Points by Category**	**Site Condition**	**Project Points**	**Summary Project Points by Category**	**Site Condition**	**Project Points**	**Summary Project Points by Category**	**Site Condition**	**Project Points**	**Summary Project Points by Category**	**Site Condition**	**Project Points**	**Summary Project Points by Category**	**Elements of Nearshore Marine PCEs addressed**	**Notes**
Submerged Aquatic Vegetation (SAV)																																
1a	**SAV condition, select one (y/n)**	Aquatic vegetation value high	4	n	0		n	0		n	0		n	0		n	0		n	0		n	0		n	0		n	0		M, F, C	Enter "Y" in only one field. Choose condition 1a, 1b, 1c, 1d or 1e. Detailed descriptions in Notes and Documentation.
1b		Aquatic vegetation value medium, incl. native oyster beds	3	n	0		n	0		n	0		n	0		n	0		n	0		n	0		n	0		n	0		M, F, C	
1c		Aquatic vegetation value medium low	2	n	0		n	0		y	2		n	0		y	2		n	0		y	2		n	0		y	2		M, F, C	
1d		Aquatic vegetation value very low	1	y	1		y	1		n	0		y	1		n	0		y	1		n	0		y	1		n	0		M, F, C	
1e		Aquatic vegetation value none	0	n	0	1	n	0	1	n	0	2	n	0	1	n	0	2	n	0	1	n	0	2	n	0	1	n	0	2	M, F, C	
Shallow Water Habitat																																
2a	**Shallow Water Habitat, Accessibility and Presence**	What shallow water area [in sqft] is lost to juvenile rearing? This loss could be the result of the construction of three-dimensional structures that result in the loss of shallow water habitat during some tides. Such structures include piles, bulkheads, and fill, or the conversion of shallow water habitat to deep water habitat via dredging. Not included as impacts to this habitat parameter are low profile structures like boat ramps, rails, and low concrete rubble. The effect of boat ramps and debris are considered with the Substrate rating below.	1.00	0	1.00		0	1.00		0	1.00		0	1.00		0	1.00		0	1.00		0	1.00		0	1.00		0	1.00		F, C, M	Area entered in this cell should correspond to B 13 in Shade Imp LSZ preadsheet, unless dredging. The maximum score possible for this element is lower than for the USZ, to keep the relative importance in light of the total maximum score the same. For both zones, this score is about 20% of the total score.
2b	**Dredging**	Is habitat loss dredging related? Y or N. If so, NHV for LSZ gets multiplied with 0.3, because maximum habitat value for deeper habitat is 0.3.		n	1.00	1.00	n	1.00	1.00	n	1.00	1.00	n	1.00	1.00	n	1.00	1.00	n	1.00	1.00	n	1.00	1.00	n	1.00	1.00	n	1.00	1.00		We plan on further developing how the model tracks dredging and appreciate your feedback for our next version.
Sediment																																
3a	**Substrate Size select one (y/n)**	Is the surface substrate in the littoral zone of the action area >25% mud or mixed fines?	0.5	y	0.50		y	0.50		y	0.50		y	0.50		y	0.50		n	0.00		n	0.00		n	0.00		n	0.00		F, C, M	Enter "Y" in only one field. Choose condition 1a, 1b, 1c, or 1d.
3b		Is the surface substrate in the littoral zone of the action area >25% sand or larger grained gravels?	1	n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		y	1.00		y	1.00		y	1.00		y	1.00		F, C, M	
3c		Is the surface substrate in the littoral zone of the action area >25% rocky?	1	n	0.00	0.50	n	0.00	0.50	n	0.00	0.50	n	0.00	0.50	n	0.00	0.50	n	0.00	1.00	n	0.00	1.00	n	0.00	1.00	n	0.00	1.00	F, C, M	The maximum points possible for this element are fewer than for the USZ. This keeps the relative importance in light of the total maximum points the same. For both zones, this point from the substrate contribute about 15% to the total points.
	Habitat Loss from Development	**Sediment lost to low and high structures:** What area [in sqft] is lost to structures including boat ramps, riprap, concrete rubble, jetties, and bulkheads.		36,100	0.37		36,100	0.37		36,100	0.37		36,100	0.47		36,100	0.47		0	1.00		0	1.00		0	1.00		0	1.00		F, C, M	
3d	**Habitat Degradation Resulting from Development**	**Habitat Reduction**: % for entire affected area not covered up by low structures. Is the substrate in the affected area unnaturally compacted or coarsened as a result of a bulkhead or riprap; has the beach grade lowered? Consider effects within the affected area, only, like downdrift part of drift cell. This is the area calculated by dividing habitat loss from development (sq ft) by total area (sq ft).		0.25	0.37	0.37	0.25	0.37	0.37	0.25	0.37	0.37	0.06	0.47	0.47	0.06	0.47	0.47	-	1.00	1.00	-	1.00	1.00	-	1.00	1.00	-	1.00	1.00		
Water Quality																																
4a	**Water Quality Condition, select one**	Is water quality in action area optimal? Use location as surrogate if no data. If action area is in undeveloped part of Puget Sound choose "yes".	1	n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		Q	Chose one condition, a, b, or c. Construction of a PRF and associated boat usually reduces the WQ in the small action area by one category, one point.
4b		Is water quality in action area free of major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated storwater inputs? Use location as surrogate if no data. If action area is in little to medium developed part of Puget Sound, like Wollochet Bay, Horshead Bay, Gig Harbor, choose "yes".	0.5	n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		Q	
4c		Is WQ impacted by major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated storwater inputs? Use location, as surrogate if no data. If action area is very developed and has WQ effects from industrial sources, like Commencement Bay, Duwamish, choose "yes".	0	y	0.00	**0.00**	y	0.00	**0.00**	y	0.00	**0.00**	y	0.00	**0.00**	y	0.00	**0.00**	y	0.00	**0.00**	y	0.00	**0.00**	y	0.00	**0.00**	y	0.00	**0.00**	Q	
		Sum of maximum possible points	**7.00**		**Total Points**	**2.37**		**Total Points**	**2.37**		**Total Points**	**3.37**		**Total Points**	**2.47**		**Total Points**	**3.47**		**Total Points**	**3.00**		**Total Points**	**4.00**		**Total Points**	**3.00**		**Total Points**	**4.00**		
					NHV	**0.34**		NHV	**0.34**		NHV	**0.48**		NHV	**0.35**		NHV	**0.50**		NHV	**0.43**		NHV	**0.57**		NHV	**0.43**		NHV	**0.57**		

Tacoma Harbor, WA Navigation Improvement Project
Water Quality Monitoring Plan
Blair Waterway and Saltchuk at Port of Tacoma
November 2019

DRAFT FOR PRE-SUBMITTAL COORDINATION

Constituents Monitored

Based on WAC 173-201A-260(3)(e), in brackish waters of estuaries, where different criteria for the same use occurs for fresh and marine waters, the decision to use the fresh water or the marine water criteria must be selected and applied on the basis of vertically averaged daily maximum salinity, referred to below as "salinity."

i. The fresh water criteria must be applied at any point where ninety-five percent of the salinity values are less than or equal to one part per thousand, except that the fresh water criteria for bacteria applies when the salinity is less than ten parts per thousand; and
ii. The marine water criteria must apply at all other locations where the salinity values are greater than one part per thousand, except that the marine criteria for bacteria applies when the salinity is ten parts per thousand or greater.

Therefore, the water quality standards for marine waters will apply to this project.

The Tacoma Harbor, WA Navigation Improvement Project is located in Water Resources Inventory Area (WRIA) 10 (Puyallup/White), in Puget Sound. The project is in a marine area listed as "good quality" for Aquatic Life use designation, which requires monitoring the following parameters pursuant to WAC 173-201A-612, Table 612 (2012).

- Aquatic life **Turbidity** applicable criteria:
  - Turbidity readings shall not exceed 10 NTU (nephelometric turbidity units) over background when the background is 50 NTU or less, or a 20 percent increase in turbidity when the background turbidity is more than 50 NTU.
- Aquatic life **Dissolved Oxygen (DO)** criteria:
  - DO concentrations are measured as a 1-day minimum in milligrams per liter. DO readings shall not be lower than the lowest 1-Day Minimum 5.0 mg/L.
- Aquatic life **Temperature** criteria:
  - Temperature is measured as a 1-day maximum temperature (1-DMax). Temperature readings shall not exceed the highest 1-DMax 19°C (66.2°F).

Washington State Department of Ecology Turbidity Monitoring Conditions

- Placeholder for specific water quality monitoring conditions from the Washington State Department of Ecology (Ecology).

Request for Extension of Area of Mixing

The Corps may submit a request that the 150 down-current sample location be moved to 300 feet down-current; the 150 down-current sample location would become an early warning station. This only applies to areas in which material has been determined suitable for aquatic disposal. Further project refinement during Preconstruction Engineering and Design phase is needed before a request is submitted; this draft water quality monitoring plan would be revised accordingly to reflect this request.

Sampling Approach

- The contractor shall establish water quality conditions according to the following:
  - The contractor shall measure turbidity, temperature, and DO using a meter (HydroLab or similar), starting at least one hour after the dredging equipment has been operating, to ensure readings and observations are reflective of conditions during active operations.
  - The contractor shall verify the calibration of the meter and calibrate as necessary with standardized samples prior to the start of each day's monitoring, per the manufacturer's specifications.
  - The contractor shall collect readings within the water strata:
    - near the surface (~ 2 feet below)
    - mid-depth
    - near the bottom (~2 feet above)
- The contractor shall compare water quality readings taken at the point of compliance to background levels within the water column strata (i.e., surface level at points of compliance compared to surface level at background stations) to determine compliance with constituent standards.
- The contractor shall visually monitor turbidity beyond the point of compliance and record the findings at the same time the turbidity levels are measured.
- The contractor shall visually monitor turbidity within the disposal area and record the findings every disposal action during daylight hours.

Background Conditions

- Measurements of turbidity, dissolved oxygen, and temperature will be recorded using a water quality meter (HydroLab or similar). Sampling will start about one hour after the dredging equipment has been operating, to ensure samples are reflective of water quality conditions during active operations. Determination of background water quality conditions will be made according to the following:
  - The water quality meter will be calibrated with standardized samples prior to the start of each day's monitoring, per the manufacturer's specifications.
  - Samples will be collected at least 150 feet up-current of the area to be dredged (background location), in an area where there is no influence from the dredging activity.
  - Samples will be collected near the surface (~ 2 feet below), mid-depth, and near the bottom (~2 feet above) at each background monitoring location.

Monitoring Locations

- The area of mixing Point of Compliance for turbidity, DO, and temperature during clamshell dredging is 150 feet down-current from the point of clamshell dredging and thus will move as the dredging progresses.
- The Monitoring Points shall be the following:
  - Measured Background: A minimum of 150 feet up-current from the dredging where there is no influence of the dredging activity as described above.
  - Measured Downstream Early Warning – 75 feet down-current of the dredging.
  - Measured Downstream Point of Compliance – 150 feet down current of the dredging.
  - Visual Downstream of Point of Compliance – monitor and record any visual turbidity beyond 150 feet down current of the dredging at the same time the turbidity levels are measured.
- The contractor shall establish channel transect Monitoring Points across the navigation channel for the Early Warning station (75 feet down-current) and the Point of Compliance (150 feet down-current of the dredge) to determine the lateral extent of turbidity. This transect shall be:
  - Monitored twice per day.
  - Located at a minimum of three (3) points spaced roughly equidistant across the navigation channel.
    - Collect three (3) readings within the water strata**:** Samples will be collected from near the surface (~ 2 feet below), mid-depth, and near the bottom (~2 feet above) of the water column.
  - Visually monitor downstream of the Point of Compliance.
- Samples collected at the mid-point and at the Point of Compliance shall be adjusted within the depth range to target the turbidity plume which will be tracked visually. If no distinct turbidity plume can be identified within the depth range, the samples will be taken at the standard depths.
- Turbidity, dissolved oxygen, and temperature samples taken at the Early Warning station and the Point of Compliance station and compared to background levels within each water column strata (i.e., surface level at points of compliance compared to surface level at background stations) to determine compliance with water quality standards.
- The contractor shall monitor and record visible turbidity within the disposal area for every disposal action during daylight hours.

Frequency of Monitoring

- The contractor's dredging equipment shall be operating for at least one hour prior to the collection of turbidity, DO, and temperature readings to ensure readings and observations are representative of water quality conditions during active operations.
- The contractor's water quality monitoring will correspond with; 1) slack tide and 2) strong ebb or flood tidal conditions to the extent these times adequately reflect periods of active dredging and occur during daylight hours.

- The contractor shall monitor for turbidity, instrument-measured and visually; for DO and temperature, instrument-measured, daily, during daylight hours:
  - Record data as described above, twice per day for the first five (5) consecutive days of dredging, assuming no exceedances.
  - Record visible turbidity down-current of the Point of Compliance at each reading collected at the Point of Compliance the first five (5) consecutive days of dredging, assuming no exceedances.
  - Record visible turbidity within the disposal area at every disposal action during daylight hours the first five (5) consecutive days of dredging, assuming no exceedances.
  - No monitoring shall occur before sunrise or after sunset unless authorized by the Corps.
- Upon completion of the instrument measured monitoring days, the contractor shall send the monitoring data report to the Corps within 24 hours of completion of monitoring activity.
  - If there are no exceedances in water quality within the five (5) consecutive days, the contractor shall discontinue instrument monitoring, unless otherwise directed by the Corps, if required by Ecology.
  - If there are exceedances in water quality within the five (5) consecutive days, the contractor shall continue monitoring following the steps listed in "Exceedances and Exceedances Protocol."
- The contractor shall continue to monitor and record (written) daily visual monitoring at the Point of Compliance every day the dredge is in operation. If at any point, visual monitoring indicates an exceedance, the contractor shall take a physical reading to confirm/verify if an exceedance has occurred. If an exceedance is confirmed/verified through physical monitoring, the protocol outlined under "Exceedances and Exceedances Protocol" shall be followed.
- Upon completion of the instrument measured monitoring days, the contractor shall send the monitoring data report to the Corps within 24 hours of completion of monitoring activity. If there are exceedances in water quality during the dredging of the unsuitable material, the contractor shall follow the steps listed in "Exceedances and Exceedances Protocol."

<u>Locations and Frequency for Unsuitable Material</u>

- The contractor shall follow all steps and directions as listed above for Locations and Frequency of Monitoring with the following changes:
  - The contractor's water quality monitoring will occur three (3) times per day and will correspond with 1) as soon as safely possible after sunrise, 2) mid-day, and 3) the latest in the day that is safely possible before sunset.
  - The area of mixing Point of Compliance for turbidity, DO, and temperature is 150 feet down-current from the point of clamshell dredging and thus will move as the dredging progresses.

<u>Exceedances and Exceedance Protocol</u>

- If measurements taken at the down-current location show that recorded turbidity is greater than 10 NTU over background where the background is less than 50 NTU, or if more than a 20 percent increase in turbidity when the background turbidity is more than 50 NTU, occurring at the outer limit of the mixing zone, the Corps will notify Ecology within 24 hours and, assuming dredging continues, will continue to monitor per the exceedance protocol below. If there are exceedances in dissolved oxygen, the exceedance procedures detailed below will also be followed.

- ❖ If the 75-ft early warning sample is in exceedance (> 10 NTU), then the water quality monitor shall notify the Corps project manager immediately, who will then notify the dredge operator supervisor who will check to ensure best management practices (BMPs) are being followed, that the dredge bucket is closing properly and the barge dewatering process is functioning properly.
- ❖ The Corps shall be responsible for notifying Ecology of any exceedance of the turbidity standard at the point of compliance sample site (150-ft down current).

Step 1: Verification of the problem

- If monitoring indicates an exceedance in turbidity levels, immediately take another series of samples (~ 2 feet below), mid-depth, and near the bottom (~2 feet above) in the same location.
- If the exceedance still exists ('strike one'), then another series of samples must be taken at the nearest upstream background station to determine if the exceedance is caused by the dredging and disposal or by a change in background conditions (for example due to a heavy rainfall event).
- The Corps will notify Ecology by phone within 24 hours after there has been a measured exceedance.
- The Corps will then notify the dredging contractor that a measured exceedance occurred and request that the dredging contractor implement BMPs, as appropriate and applicable, to reduce turbidity.
- In the event of exceedances such that dredging is temporarily stopped during the first 5 days of monitoring, the Corps will consult with Ecology to determine the number of additional days of monitoring required with no exceedances to terminate monitoring.

Step 2: Increased monitoring

- Another sample will be taken no more than one (1) hour after the exceedance is recorded to verify the dredging operation has been altered to reduce the exceedance to within acceptable limits.
- If the second sample, taken 1 hour later, still shows an exceedance ('strike two'), the Corps will again notify the dredging contractor of the situation and request that all measures possible be taken to reduce turbidity.
- Finally, a third sample will be taken no more than two (2) hours after the first exceedance is recorded.

Step 3: Stop dredging or disposal

- If the third sample, taken two (2) hours later, still shows an exceedance ('strike three'), the Corps will order the contractor to stop work. The Corps will then notify Ecology of the situation.

Step 4: Continued sampling until compliance is achieved

- After the dredging contractor has stopped work, samples will be collected at hourly intervals until turbidity and dissolved oxygen levels return to background. For safety reasons, no water quality sampling will take place between sunset and sunrise.
- Once compliance has again been achieved, the Corps will order the dredging contractor to resume work.
- The Corps' Project Manager or Biologist will notify Ecology that work has resumed.
- The normal schedule of water quality sampling will resume as per specific requirements above.

Step 5: Reporting

- Ecology must be informed by phone within 24 hours for an exceedance at the point of compliance. Turbidity elevated at the warning point does not need to be reported within 24 hours, as long as the dredge supervisor was informed and the processed checked to ensure BMPs are still working properly.
- Any shut downs will be documented with an incident report, which will be transmitted to Ecology by email and by mail within 2 working days of the incident.
- The incident report will document any exceedances and will include the date, time, location, activity, water quality data collected, name of person collecting the data, names of persons notified of the exceedance, and summary of how the exceedance was resolved following the above protocol.
- Incident reports will be transmitted to the Corps' Contracting Officer, Project Manager, or Biologist within 24 hours of the exceedance.
- Ecology may require additional days of monitoring based on the monitoring report and/or incident report.
- Within 60 days of termination of the dredging and disposal activities, the Corps will submit the water quality monitoring data and a summary report to Ecology.

Responsibility and Communication Plan

- The Corps will oversee turbidity monitoring conducted by the contractor.
- The Corps will be responsible for coordinating with Ecology and submitting the Turbidity Monitoring Reports and data provided by the contractor.
- The Corps will notify Ecology within 24 hours if an exceedance occurs.
- The Corps will coordinate with the dredging contractor.
- The contractor shall provide a Turbidity Monitoring Report and data to the Corps, as directed.
- The contractor shall notify the Corps within 2 hours if an exceedance occurs.
- The Corps Contracting Officer is Elizabeth Chien, Coastal Program Manager (206-316-3968).
- The Corps Point of Contact for turbidity monitoring is Katie Whitlock, Environmental Coordinator (206-764-3576).
- The Ecology Point of Contact is NAME, Federal Permit Coordinator (phone number).
- The Contractor will supply the Corps and Ecology with their Points of Contact for the project.

June 25, 2019

Prepared by:
Dredged Material Management Office
Seattle District, U.S. Army Corps of Engineers

MEMORANDUM FOR: RECORD

SUBJECT: DMMP ADVISORY DETERMINATION REGARDING THE POTENTIAL SUITABILITY OF PROPOSED DREDGED MATERIAL FROM THE BLAIR WATERWAY IN TACOMA HARBOR FOR UNCONFINED OPEN-WATER DISPOSAL AT THE COMMENCEMENT BAY DISPOSAL SITE OR FOR BENEFICIAL USE.

1. Introduction. This memorandum reflects the consensus advisory determination of the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, Washington State Department of Ecology, Washington State Department of Natural Resources, and the Environmental Protection Agency) regarding the potential suitability of up to 2.5 million cubic yards (cy) of dredged material from the Blair Waterway for open-water disposal at the Commencement Bay disposal site or for potential beneficial use.

   The DMMP agencies cooperatively manage eight open-water disposal sites in Puget Sound. The disposal site in closest proximity to Tacoma Harbor is the non-dispersive site located in Commencement Bay. Dredged material evaluation guidelines for disposal at the Commencement Bay site can be found in the DMMP Dredged Material Evaluation and Disposal Procedures User Manual (DMMP, 2018). These procedures are summarized in Exhibit A of this memorandum.

   Blair Waterway is an authorized federal navigation channel located in Tacoma, Washington. The existing authorized dimensions of the waterway are 520 ft wide from the mouth to 11th Street, 345 ft wide through the 11th Street reach, 520 ft from 11th Street to Lincoln Avenue, 330 ft from Lincoln Avenue to the turning basin, and a 1300 ft turning basin, all to a depth of -51 feet MLLW. During the last deepening event in 2000-2001, the waterway was dredged to -51 feet MLLW, plus 2 ft of overdepth. Due to minimal accumulation of sediments since then, mudline elevations within the existing navigation channel remain at -51 ft MLLW or deeper.

   The U.S. Army Corps of Engineers (USACE) and Port of Tacoma (POT) are conducting a feasibility study to investigate potential deepening and widening alternatives for the Blair Waterway (Figure 1). Depths up to -58 feet MLLW, plus 2 feet of overdepth, are being evaluated. This DMMP memorandum presents and evaluates sediment characterization data collected from Blair Waterway with the purpose of advising USACE and POT regarding the probable suitability of sediment from Blair Waterway for open-water disposal or beneficial use.

   Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the U.S. EPA designated the Commencement Bay Nearshore/Tideflats Superfund site in 1983. The site includes three main components: remediation of the sediments and source control for Commencement Bay waterways, remediation of Tacoma Tar Pits, and remediation of the Asarco Smelter Facility and surrounding impacted areas. Multiple waterways within Commencement Bay are covered under the sediment operable unit for the Superfund Site. Blair Waterway was originally included under the sediment and source control operable unit, but was delisted by the U.S. EPA in 1996 because it was

cleaned up under an agreement known as the Puyallup Land Claim Settlement between EPA, the Port of Tacoma, and the Puyallup Tribe. Another notable Superfund action in Blair Waterway included dredging of tributyltin (TBT) contaminated sediments at Pier 4 as part of a Time Critical Removal Action. This action was completed in 2016 under the regulatory authority of the U.S. EPA and included removal of 71,000 cubic yards of contaminated sediment in conjunction with the redevelopment of Pier 4.

Project summary and tracking information is shown in Table 1.

Table 1. Project Summary

Project ranking	Channel: Low-moderate
	Sideslopes: Moderate
Proposed dredging volume	2.5 million cy
Maximum proposed dredging depth	- 58 ft MLLW, plus 2 feet overdepth
Sampling Dates	February 18 – February 22, 2019
EIM Study ID	POTBD19

2. Sediment Evaluation Strategy for the Tacoma Harbor Feasibility Study. Several factors were taken into consideration in development of a sediment evaluation strategy for the Blair Waterway.

DMMP Recency Guidelines – The DMMP recency guidelines specify the length of time that sediment characterization data remain adequate and valid for decision-making without further testing. The length of the recency period is determined by the rank of a project, the rank being driven by the available information on chemical and biological-response characteristics of project sediments and the number, kinds, and proximity of chemical sources (existing and historical). Blair Waterway has a split ranking; the existing navigation channel is ranked low and areas outside the navigation channel have project-specific rankings based on site characteristics (DMMP, 2018). For the purpose of this advisory evaluation, the DMMP agencies agreed to consider the entire project area as having an overall rank of low-moderate. The recency period for low-moderate-ranked areas is six years. Since it was unlikely that construction would occur within six years following sediment sampling for the feasibility study, a decision was made to wait until the Preconstruction Engineering Design (PED) phase of the project to conduct a full DMMP characterization for final decision-making. More limited sediment characterization would be done during this feasibility study.

Level of Effort – Since full DMMP characterization will not be completed until PED, the study team needed to determine the level of effort that would be adequate to support the evaluation of alternatives during feasibility. In consultation with the DMMP agencies, the study team decided that a 20% level of effort would suffice. Additionally, bioassays and bioaccumulation testing were not conducted for this effort. This level of effort was selected to provide a meaningful representation of levels and patterns of contamination in Blair Waterway, without incurring the expense of a full characterization.

3. <u>DMMP Sampling and Testing Requirements</u>. DMMP sampling and testing requirements are dependent on the rank of the project. As indicated previously, Blair Waterway was ranked “low-moderate” for this evaluation in order to determine the appropriate level of sampling. For low-moderate-ranked projects, one field sample must be taken for every 8,000 cy of sediment.

   Typically the dredge prism would be divided up into dredged material management units (DMMUs) based on the design of the project. A DMMU is a volume of sediment that can be independently dredged from adjacent sediment and for which a separate disposal decision can be made. Allowed volumes per DMMU are based on rank, surface versus subsurface DMMUs, and homogeneity/heterogeneity of the sediments. However, since the study is in the feasibility phase a specific dredge design has not been developed. The dredged material volume and prism associated with the selected alternative will not be known until the feasibility study has been completed.

   For the purposes of sediment characterization conducted during feasibility, the dredged material volume associated with maximum proposed dredging was calculated, along with the number of field samples required for full DMMP characterization, see Table 2 below. The number of field samples required for full characterization was multiplied by 0.20 (for a 20% level of effort), resulting in a need for 63 field samples for the advisory-level characterization.

Table 2
Sampling Rationale

Waterway	Total Volume (cubic yards)[1]	Rank[2]	Total Number of Cores	Total Number of Samples Required for Full Characterization	20% of Total Number of Samples Required for Advisory-level Characterization
Blair Navigation Channel	2,247,500	Low-moderate: 8,000 cy/sample	20 (2 to 3 samples analyzed per core)	313	63
Side slopes	209,500		5 (2 to 3 samples analyzed per core)		

Notes:
1. The total estimated volume including navigation channel and side slopes is 2,457,000 cy.

   To provide higher-resolution data for the feasibility study, a decision was made to not composite individual samples, as is often done in DMMP sediment characterization, but to instead analyze individual field samples. To get a good spatial distribution, 25 sampling locations were identified throughout the waterway (Figure 2). The location of the sampling stations was determined in coordination with the Port of Tacoma, the Port’s contractor, the DMMP agencies and the Puyallup Tribe. Due to elevated concern over the quality of the material in the sideslopes, 5 sampling locations were placed in the side slopes in to characterize these areas at a sampling intensity closer to a moderate-rank level. For a moderate-rank project one sample is required for every 4,000 cy of material. The estimated volume of the sideslopes is 209,500 cy – so 11 samples are needed to sample the sideslopes at 20% of the “moderate-ranked” intensity. Thus the 5 identified cores, with 2 to 3 samples each (a single core can provide multiple depth interval samples), was sufficient to meet the 20% level of effort for the side slopes. The additional samples collected in the side slopes were subtracted from the total number of samples needed in the rest of the waterway, so that the total number of samples analyzed equaled 63.

Native Material – An additional goal of sampling was to determine the elevation of the native horizon. Previous deepening of Blair Waterway was to -51 ft MLLW plus 2 ft of overdepth. The native horizon was expected to be around -53 ft MLLW.

The native horizon was identified based on evaluation of the core lithology by sampling personnel familiar with the characteristics of the native sediments in Tacoma Harbor. Based on review of uplands geotechnical boring and available sediment cores in the Blair Waterway, the native unit was expected to consist of moist, medium dense to dense, gray to grayish brown, fine to medium sand with various amounts of silt and trace shell hash and occasional interbeds of moist, medium stiff, light gray, clayey silt.

4. Sampling. Field sampling took place February 18-22, 2019 using a vibracore sampler. Cores were processed at the Port of Tacoma facility at the head of the Sitcum Waterway in Tacoma, WA and samples were then transported to ARI in Tukwila, WA and submitted for analysis. Figure 2 shows the target and actual coring locations and Table 3 gives the station coordinates and other core collection data. Samples were collected within 10 feet of the target location coordinates, with the following exceptions:
    - Location C-8 was moved 85 feet northeast due to core refusal on a hard, uneven bottom, likely riprap
    - Location C-13 was moved 41 feet to the southeast to avoid contact with buried sewer lines
    - Location C-25 was shifted 84 feet due to the presence of a cargo vessel for the extent of field sampling operations

The approved sampling and analysis plan (Anchor QEA, 2019a) was followed to the maximum extent possible. Additional deviations from the SAP were reported in the final sediment characterization report (Anchor QEA, 2019b), including:
- Holding cores overnight before processing, which was done to minimize the number of field sampling days. Cores held overnight were securely stored upright on the sampling vessel behind a locked gate. Ambient overnight temperatures during the sampling period ranged from 3.3 to 5 ºC, with an average of 4.3 ºC. These holding conditions are in accordance with standard custody and temperature requirements for holding sediment cores.
- As a result of holding cores overnight, additional compaction of some cores occurred between the time they were collected and processed. This additional compaction was not accounted for in the core logs and depths reported in the data report and in this advisory memo.
- Due to the difficulty of collecting cores in the sideslopes, only three cores were collected from sideslopes instead of the five that were originally planned. During SAP development C-1 was initially considered a sideslope sample, but during finalization of the sampling plan that location was moved to the edge of navigation channel and therefore was not considered a side slope sample. Location C-8 was moved out of the sideslopes during sampling due to difficulty coring. Nine samples were analyzed for the full DMMP list of chemicals from the three sideslope samples (C-12, C-13, and C-17) in Round 1, and an additional four samples were analyzed for conventionals and dioxins/furans in Round 2. In total, 13 sideslope samples were analyzed, sufficient to meet the sampling intensity for a moderate rank.

Core intervals collected for sampling were determined based on the core lithology to avoid excessive testing of the native material while simultaneously ensuring that the native material was adequately tested. The following guidelines were used:

- At least two samples (depth intervals) from each core were analyzed.
- Samples were analyzed from the top down, and no more than three samples per core were analyzed.
- Minimum sample size was a 2-foot interval, in order to have sufficient volume of sediment for all analyses.
- The length of the top non-native interval was determined by the depth of the native horizon. As many 2-foot intervals as could be delineated were collected and analyzed from the non-native layer.
- At a minimum the surface non-native or mixed interval and the top interval of native material were analyzed.
- In sideslope samples, the first interval of native material was analyzed as long as it was within the top three depth intervals of the core. If not, the native intervals were archived and analysis was only triggered if there were SL or BT exceedances in the shallower interval.

6. Chemical Analysis.

To avoid excessive testing of native sediments a tiered testing approach was used. Analysis by the analytical laboratory occurred in two rounds. Round 1 included 57 samples identified based on the core lithology. All Round 1 samples included testing of the full suite of DMMP COCs, including conventionals, metals, semivolatiles, pesticides, PCBs, bulk TBT and dioxins/furans. Table 4 lists the sediment samples that were analyzed in Round 1 and Round 2. Six analyses were triggered for Round 2 based on the results of Round 1, as described below:

- Location C-2: This location did not have any SL or BT exceedances, but TBT increased with depth from 7.35 µg/kg in the 0-2 ft sample to 17.3 µg/kg in the 2-4 ft sample. Based on proximity to historically elevated TBT concentrations at depth (2016 EPA TBT Time Critical Removal Action) and the observed increasing concentrations with depth, Round 2 chemistry results were triggered in the next two deeper samples to evaluate the chemical trend. Results were non-detect in both intervals.
- Location C-12: Dioxin/furan concentrations were above 10 pptr TEQ in the 0-2 ft, 2-4 ft, and 4-6 ft intervals (56.21, 54.47, and 17.74 pptr TEQ, respectively). Round 2 chemistry samples were triggered in the next two deeper samples and were below the SL of 4 pptr TEQ. Additionally, total PCBs were above the SL of 130 µg/kg in the 0-2 ft interval (173.3 µg/kg), but below the SL in the 2-4 ft interval.
- Location C-13: Dioxin/furan concentrations were above 4 pptr TEQ in the 0-2 and 2-4 ft intervals (5.34 and 7.73 pptr TEQ, respectively) and above 10 pptr TEQ in the 4-6 ft interval (11.88 pptr TEQ). Round 2 chemistry samples were triggered in the next two deeper samples. The 6-8 ft. interval was above 4 pptr TEQ (7.64 pptr TEQ), and the 8-10 interval was below 4 pptr TEQ.

Tables 5 and 6 present the sediment conventionals and chemistry results, respectively. Figure 3 shows boxplots of TOC, percent sand and percent fines for the project. Samples were grouped into one of three categories based on core lithology: 1) samples that were identified as native, 2) samples from cores where the native layer was undetermined and 3) samples identified as non-native material.

Samples identified as native have a higher percentage of sand and lower percentage of fines than the non-native and unidentified material, consistent with the expected characteristics of the native material. The depth (in ft MLLW) of the native layer as identified during core processing is shown in Figure 4.

A total of 8 cores out of the 25 collected contained one or more samples with at least one SL or BT exceedance. The other 17 cores did not contain any samples with SL or BT exceedances. Figure 5 provides a summary of all the detected and undetected SL exceedances from all analytical results. The non-native surface intervals of C-3 and C-11 had nondetected exceedances of the SL for total chlordane (when all five total chlordane constituents were reported at the lower method detection limit). There were three cores with detected exceedances of SLs: C-7 was above the SL for hexachlorobutadiene in the 2-4 foot (native) interval, C-10 was above the BT for TBT in the 2-4 foot (non-native) interval, and C-12 was above the SL for total PCBs in the non-native surface interval.

Dioxin/furan results are summarized in Table 7. Elevated dioxins/furans were found throughout the mouth and middle sections of the waterway. Dioxin concentrations above 4 pptr TEQ and less than 10 pptr TEQ were found in non-native samples in cores C-7, C-8, C-10, C-11 and C-12. Dioxin concentrations above the bioaccumulation trigger of 10 pptr TEQ were found in three cores: C-12, C-13 and C-15. As mentioned above, additional samples from C-12 and C-13 were triggered in Round 2 to identify the vertical extent of elevated dioxin/furan concentrations. In all cores, samples were analyzed at deeper intervals until dioxin/furan concentrations less than 4 pptr TEQ were found. All native samples contained dioxins/furans less than 4 pptr TEQ, and all samples (both non-native and native) from the head of the waterway had dioxin/furan concentrations less than 4 pptr TEQ.

7. <u>DMMP Advisory Suitability Evaluation</u>. A DMMP suitability determination is typically based solely on the evaluation guidelines found in the DMMP User Manual current at the time of testing. However, the dredged material evaluation guidelines used by the DMMP agencies are constantly evolving as technological and scientific advances are made. Those changes could include updates to the bioaccumulation triggers or testing guidelines. However, there are no such changes currently pending. Therefore the DMMP agencies used the current evaluation guidelines to determine the potential suitability of Blair Waterway sediments for open-water disposal.

Tables 8 and 9 present the results of the DMMP evaluation, along with the rationale for determining the potential suitability or unsuitability of each sample for open-water disposal. In these tables, samples were separated into those identified as native sediment (Table 9) and those identified as non-native or undetermined sediment (Table 8). Sample ID refers to the intervals of sediment core starting with A at the top of each core. For each station/interval tested, one of the following determinations was provided:

Suitable – No SL or BT exceedances; dioxins/furans below 4 pptr TEQ.

Likely Suitable – No SL or BT exceedances occurred; dioxins/furans below 10 pptr TEQ but above 4 pptr TEQ.

Possibly Suitable – Detected or undetected SL exceedances and dioxins/furans < 10 pptr TEQ.

Unsuitable – BT exceedance and/or dioxins/furans > 10 pptr TEQ, with or without other SL exceedance.

To facilitate the use of this information in the estimation of quantities of suitable and unsuitable dredged material for the Tacoma Harbor Deepening feasibility study, the DMMP agencies adopted a probability approach for the Blair Waterway. Sampling stations with similar suitability characteristics in the non-native intervals of sediment were grouped to form three distinct sections within the waterway (Table 8; Figure 6) regardless of whether they were on the sideslope or in the channel. To establish a logical segmentation of the waterway for planning purposes, numerical probabilities were assigned to each station and those probabilities averaged and rounded down to the nearest 5%. Numeric probabilities were assigned as follows:

- suitable = 100% probability of being suitable for open-water disposal
- likely suitable = 75%
- possibly suitable = 50%
- unsuitable = 0%

At the head of the waterway all samples in all cores were below SLs and dioxins/furans were less than 4 pptr TEQ. All of this material was classified as suitable and the average suitability probability was 100%.

The middle portion of the waterway had the lowest suitability probabilities. Three cores, C-12, C-13 and C-15 contained unsuitable material due to dioxins/furans above 10 pptr TEQ and one core, C-10, contained unsuitable material due to TBT. One sample in core C-11 contained possibly unsuitable material due to a non-detect exceedance of total chlordane and dioxins/furans between 4-10 pptr TEQ. In all of these cores, lower intervals of the core were analyzed until clean material was confirmed. Overall, the average suitability probability for surface non-native material in the middle portion of the waterway is 63.6%.

The mouth of the waterway was largely suitable, with only one sample (C-3) with a possibly suitable classification due to a single non-detect exceedance of total chlordane. The average suitability probability for surface non-native material in the mouth of the waterway is 92.9%.

The same probability approach was applied to the native sediments. Among all sediments throughout the waterway that were identified as native material, only one sample was classified as possibly suitable (due to a single exceedance of hexachlorobutadiene in C-7) and the rest were classified as suitable. Therefore, the average suitability probability of identified native sediments is 98.1%

The predictive ability of the feasibility-level sediment characterization completed for the deepening study does not match the mathematical precision of the calculated probability averages. Therefore, the calculated averages were rounded down to the nearest 5%. The rounded probability values are found in Tables 8 and 9 and illustrated in Figures 6 and 7.

In summary, the non-native sediments showed a range of contaminant concentrations. The probability of suitability for open-water disposal was estimated by the DMMP agencies in the non-native sediments to be 90% suitable in mouth, 60% suitable in the middle and 100% suitable in the head, as shown in

Figure 6. Nearly all identified native sediment is suitable for open-water disposal, with an average probability of being suitable for open-water disposal of 95%.

This advisory determination only applies to the areas identified and documented in this document. Additional areas not considered here, especially in the sideslopes and/or near outfalls, may have a different sediment contaminant profile. The results from the sideslope samples in this study as well as historical information from cutback projects throughout Blair Waterway give a strong indication that material outside of the navigation channel (i.e. closer to shore) considered in this advisory memo is more likely to be unsuitable. The DMMP agencies recommend a more conservative assumption of the probability of suitability for areas outside the areas evaluated in this advisory memo.

8. Suitability for Beneficial Use. The DMMP agencies do not determine the suitability of material for beneficial use projects. It is up to the project proponents, the site receiving the material, and other interested stakeholders including applicable resource agencies and Tribes to determine the physical and chemical suitability of dredged materials for a beneficial use site.

However, typically the first step taken to evaluate sediments for beneficial use is comparison against the State's Sediment Quality Standards (SQS), which has been done in Tables 10 and 11. Many of the SQS standards are in organic carbon normalized units. Ecology's recommendation for organic carbon normalizing is to only use this approach for sediments with TOC concentrations between 0.5 – 3.5% (Ecology, 2017). Samples were divided into two groups, those with TOC between 0.5 – 3.5% (12 samples) and those with TOC less than 0.5% (51 samples). There were no samples with TOC greater than 3.5%.

For the 12 samples with TOC greater than 0.5%, results are compared to SQS and are shown in Table 10. Non-detect results for two chemicals, 1,2,4-trichlorobenzene and hexachlorobenzene, were above the SQS as initially reported by the laboratory. As is typically done by the DMMP agencies when there is a non-detect exceedance, the results are re-evaluated by the analytical laboratory to see if there was any evidence that the compounds of interest were detected at levels between the method detection limit (MDL) and the method reporting limit (MRL). If there is no evidence, then the results are reported as non-detect at the lower MDL. For these samples (and all samples in the project) there was no evidence that 1,2,4-trichlorobenzene or hexachlorobenzene were detected above the MDL, so the results for these two compounds were reported at the lower level, as indicated in Table 10.

11 of the 12 samples in Table 10 were less than the SQS. Sample C-12-A exceeds the SQS for PCBs and is not suitable for beneficial use. All other samples are below SQS, indicating that they would likely be suitable for beneficial use.

For the 51 samples with TOC less than 0.5%, results are compared to the dry weight based SQS values and are shown in Table 11. The dry-weight SQS values are based on the same apparent effects thresholds (AET) as the DMMP SLs, and are the same for all but two chemicals. The dry-weight SQS for pentachlorophenol is 360 µg/kg, lower than the DMMP SL of 400 µg/kg, and the dry-weight SQS for acenaphthylene is 1300 µg/kg, higher than the DMMP SL of 560 µg/kg. With only one exception, all samples for all chemicals, including pentachlorophenol, are less than the dry-weight SQS, indicating these sediments would likely be suitable for beneficial use. Sample C-7-B had a

detected concentration of hexachlorobutadiene above the dry-weight SQS, indicating that this material is likely not suitable for beneficial use.

Comparison to SQS is not the only consideration in assessing beneficial use. Based on initial coordination with other resource agencies and the Puyallup Tribe, the following assumptions were also taken into consideration:

- If material is unsuitable for the Commencement Bay open-water disposal site then it is also unsuitable for beneficial use
- NMFS' proposed PAH level for the protection of fish of 2,000 µg/kg[1] is appropriate for aquatic beneficial use
- Only material with dioxin less than 4 pptr TEQ is appropriate for beneficial use

Table 12 shows the average percent likelihood of suitability for beneficial use of this material based on all these considerations. The results are summarized below:

Table 12. Summary of Beneficial Use Suitability for Tacoma Harbor

Area	Average percent likelihood of suitability for beneficial use
Mouth	85%
Middle	40%
Head	100%
Native	95%

9. Sediment Exposed by Dredging. The sediment to be exposed by dredging must either meet the State of Washington Sediment Quality Standards (SQS) or the State's Antidegradation standard (Ecology, 2013) as outlined by DMMP guidance (DMMP, 2008).

This sediment core characterization in the Blair Waterway clearly demonstrated that contamination decreases with depth. With the exception of cores C-7, C-10, and C-13, the highest COC concentrations were found at the top of the core with contamination decreasing with depth. For C-7, there was elevated hexachlorobutadiene in the 2-4 foot layer that was not observed at the surface, but the layer below, representing -54 to -56 ft MLLW, was less than SL and SQS. For C-10, TBT was elevated (but below screening levels) in the 2-4 foot layer but decreased with depth and was no longer detected at depths below -53 ft MLLW. For the sideslope sample C-13, dioxins appeared to be highest in the 4-6 foot layer (11.88 pptr TEQ), and was below 4 pptr TEQ in the 8-10 foot layer (-47 to -49 ft MLLW).

At the current level of sampling density and dredge design, it is difficult to determine antidegradation within the side slope regions, although the data gathered in this characterization indicates that antidegradation can be met without need for cover. This uncertainty is being addressed by new rankings for sideslopes during full characterization.

The available information indicates that it is highly likely that antidegradation will be met in the

[1] The National Marine Fisheries Service (NMFS) proposed a screening level of 2,000 µg/kg total PAH for the protection of fish at the Regional Sediment Evaluation Team annual meeting in November 2014.

navigation channel once native material is reached.

10. Underlying Assumptions. Several key assumptions were made by the DMMP agencies in conducting this advisory suitability evaluation. These assumptions are discussed in the following paragraphs.

    Dioxins/Furans - Samples with concentrations of dioxins/furans at or below 4 pptr TEQ were deemed suitable for open-water disposal, as this concentration is the site management objective for nondispersive disposal sites. Concentrations of dioxins/furans between 4 and 10 pptr TEQ were considered likely to be eligible for open-water disposal because there is a large volume of clean native material that would be dredged during deepening, and this material can be used to bring the project volume-weighted average below the site management objective of 4 pptr TEQ. USACE planners will need to plan for the additional volume of clean sediment required to meet the volume-weighted average guidelines at the Commencement Bay disposal site. This will likely reduce the amount of material available for beneficial use. It was also assumed that dredging and disposal will be sequenced such that suitable dredged material with relatively higher concentrations of dioxins/furans will be placed first at the Commencement Bay site, followed by native material with very low concentrations, thereby leaving a surface layer of sediment at the disposal site with a low dioxin/furan concentration. Dioxin/furan concentrations above 10 pptr TEQ were determined to be unsuitable for open-water disposal. DMMUs with dioxin/furan concentrations above 10 pptr TEQ would need to pass bioaccumulation testing in order to qualify for open-water disposal. The DMMP agencies made the conservative assumption for the purpose of this evaluation that either bioaccumulation testing for dioxins/furans would not be conducted or, if tested, these samples would fail bioaccumulation testing.

    Bioassays – Bioassay testing was not conducted for this advisory-level characterization due to schedule restrictions. Therefore the assignment of potential suitability of samples with SL exceedances was based on the experience and best professional judgment of the DMMP agencies assuming that bioassays would be conducted during full characterization. There were only two samples with SL exceedances with no other exceedances (i.e. they did not have dioxin above 4 pptr TEQ or other BT exceedance) – one detected exceedance of hexachlorobutadiene and one non-detect exceedance of total chlordane. Based on prior experience testing sediments with minor SL exceedances of these chemicals, the DMMP assigned both of these samples a 50% chance of being suitable for open-water disposal.

11. DMMP Guidance for Full Characterization and Dredging. As indicated previously, full characterization of potential dredged material from the Blair Waterway must be completed in order to complete a suitability determination for this project prior to dredging. The testing results from this feasibility study indicated that the appropriate ranking for full characterization is variable throughout the waterway. Therefore, unless new information becomes available in the interim, sampling requirements for full characterization will be based on rank according to the following chart:

Sediment Category	Waterway Area	Rank
Sideslopes	Head	Moderate to High
	Middle	High
	Mouth	Moderate to High
Surface material	Head	Low-Moderate
	Middle	Moderate to High
	Mouth	Low-Moderate to Moderate
Confirmed native material	Throughout waterway	No further testing, except for confirmatory testing around C-7 and where full characterization identifies SL/BT failures at the native/non-native boundary

Two of the three side slope cores (C12, C13) were determined to be unsuitable without further testing (bioaccumulation for dioxins for both; PCB toxicity for C12). Since most of the nearshore areas are not often dredged, and are closer to sources of contamination, DMMP is assigning ranks to the sideslopes that are higher than originally assigned for sampling for this advisory determination. For the full determination, it will be important to have sufficient dredge design details to inform where sideslopes will either be dredged or will slough due to dredging along the base of the slope, so that appropriate sediment locations and depths are characterized.

The concentrations of chemicals of concern in the identified native material were far below the DMMP SLs, with only one exception. There was a detected exceedance of SL for one chemical in a single sample in the middle section of the waterway (C-7). Therefore, throughout the project area, confirmed native sediment will be assumed to be suitable for open-water disposal by the DMMP agencies and will be exempt from analysis during full characterization with two exceptions: native material around C-7 which will require confirmatory testing to verify its suitability, and where full characterization identifies SL/BT failures at the native/non-native boundary. Samples from native material DMMUs will need to be collected and archived pending results of overlying DMMUs.

There is also a high probability of encountering BT exceedances for dioxin, and to a lesser extent TBT, during full characterization, particularly in the middle portion of the waterway and in sideslopes. Bioaccumulation testing requires large volumes of sediment and the testing is costly. Whether and when to collect adequate volumes of sediment to conduct this testing will be up to USACE and the Port of Tacoma.

DMMUs that are found unsuitable for open-water disposal will need to be disposed in an appropriate upland facility. To ensure that the unsuitable material is separated from the suitable material during dredging, a minimum one-foot vertical buffer and an appropriate horizontal buffer will need to be added to the unsuitable portions of the dredge prism. This means that in areas where the top four feet are found unsuitable for open-water disposal, at minimum the top five feet of sediment will need to be dredged and taken upland. The one-foot vertical buffer is not the same as the overdepth allowance. If the dredging contract includes one foot of overdepth, the dredge cut would be five feet, plus one foot of overdepth. USACE planners will need to include the horizontal and vertical buffers in volume calculations for upland disposal.

Since the last deepening of the Blair Waterway in 2000/2001, maintenance dredging has not occurred in the navigation channel, and has occurred in the berthing areas three times for different areas: at GP Gypsum, Husky Terminal and Washington United Terminal. Therefore, there is a good chance that debris will be encountered during dredging. This debris must be removed from sediment prior to disposal at the Commencement Bay open-water disposal site. The dredger will likely be required to screen the surface non-native sediments in areas with suitable material using a grid with a maximum opening size of 12 inches by 12 inches. Native material and material found unsuitable for open-water disposal will not need to be screened. However, if large (greater than 12 inches by 12 inches) woody debris or other large natural debris is found in native sediments, this debris will need to be removed from the dredged material prior to disposal at the Commencement Bay open-water disposal site.

The DMMP agencies are in the process of revising the disposal site monitoring program for all disposal sites in Puget Sound. The process is expected to be completed within a few years, but there are many unknowns at this time. Currently the following changes are reasonably likely to have an impact on future use of the disposal sites:

Disposal tipping fees - DNR is likely to pursue an increase in the disposal tipping fee within the next 5-10 years. The current tipping fee of $0.45/cy was last increased in 1994. It is premature to estimate what the increased fee might be.

Preventing off-site migration of dredged material - Off-site migration has historically been an issue at the Commencement Bay disposal site, even resulting in the need to temporarily shut down use of the site after significant off-site migration. For projects disposing of a large amount of material in a short period of time there is an increased concern over off-site migration.

In 2009 the DMMP agencies completed a supplemental EIS (SAIC, 2009) for reauthorization of the Commencement Bay open-water disposal site. The preferred alternative chosen for management of the disposal site, Alternative 2, included increasing the cumulative disposal volume of the site to 23 million cubic yards (mcy) with three coordinate shifts within the target area and consideration of the need to implement institutional controls on disposal to better manage the site. Institutional controls considered and studied included specific requirements for tug/barge orientation or direction during disposal and disposal during a specified portion of the tidal cycle.

Due to the potential large volume of material from this project that could be disposed at the Commencement Bay site, additional measures will need to be taken to ensure that the disposed material is not migrating off-site. The DMMP agencies recommend physical monitoring of the site before the start of the project to get a baseline and subsequent physical monitoring of the site after every 500,000 cy disposed or at the end of each dredging year, whichever is more frequent. Physical monitoring includes a multibeam bathymetric survey and SPI monitoring.

If results of the physical monitoring indicate that significant off-site migration is occurring, the DMMP agencies will consider implementation of institutional controls to better manage the site.

12. References.

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SAIC, 2009. *Reauthorization of Dredged Material Management Program Disposal Site at Commencement Bay, Supplemental Environmental Impact Statement.* Prepared by SAIC for the Dredged Material Management Program, August 2009.

10. Agency Signatures.

The signed copy is on file in the Dredged Material Management Office.

Concur:

Date — Kelsey van der Elst - Seattle District Corps of Engineers

Date — Justine Barton - Environmental Protection Agency

Date — Laura Inouye, Ph.D. - Washington Department of Ecology

Date — Abby Barnes - Washington Department of Natural Resources

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Exhibit A – DMMP Evaluation Procedures

The DMMP evaluation procedures are fully described in DMMP (2018). This exhibit includes information about several key elements relevant for the Blair Waterway suitability evaluation.

Ranking:

For DMMP dredged material evaluations, dredging projects are assigned to one of four possible ranks: high, moderate, low-moderate, or low. These ranks reflect the potential for adverse biological effects or elevated concentrations of chemicals of concern. The higher the rank, the higher the concern, and the more intense the sampling and testing requirements needed to adequately characterize the dredged material. Project or area ranking is based on the available information on chemical and biological-response characteristics of the sediments, as well as the number, kinds, and proximity of chemical sources (existing and historical).

DMMUs:

Tiered testing is conducted for smaller units within the area to be dredged. These units are termed Dredged Material Management Units (DMMUs). A DMMU is the smallest volume of dredged material capable of being dredged independently from adjacent units and for which a separate disposal decision can be made.

Full Characterization:

Full DMMP characterization includes minimum sampling and testing requirements, which are typically based on the rank, volume and depth of the dredging project. For example, in a moderate-ranked area, field samples are restricted to representing no more than 4,000 cubic yards and each DMMU can represent no more than 16,000 cubic yards of dredged material in the surface layer (0-4 feet below mudline). In subsurface sediment (> 4 feet below mudline), field samples are restricted to representing no more than 4,000 cubic yards, but DMMUs can represent up to 24,000 cubic yards, depending on site-specific conditions. Best professional judgment may need to be applied in addressing certain scenarios, for example areas with increasing contamination with depth or adjacent to a cleanup site. Full characterization typically results in a DMMP suitability determination.

Tiered Testing:

The DMMP dredged material suitability determination process consists of four tiers of evaluation and testing. A brief discussion of these tiers follows.

Tier 1 analysis involves the review of existing sediment data and site history, including all potential sources (e.g., outfalls, spills, etc.) for sediment contamination. The Tier 1 evaluation informs the sediment evaluation process for the project.

Tier 2 analysis consists of chemical testing of sediment samples. Table 5 includes the chemicals of concern analyzed in DMMP projects at the time of the Blair Waterway sediment characterization

in 2019. This list includes metals, semivolatiles, pesticides and PCBs, which are all considered standard chemicals of concern. Certain other chemicals of concern, including dioxins/furans and tributyltin, are analyzed in areas that are of concern for these chemicals.

Tier 3 consists of biological testing. DMMUs with exceedances of the chemical screening levels (SLs) or bioaccumulation triggers (BTs) listed in Table 5 require biological testing in Tier 3 to determine their toxicity and/or bioaccumulation potential respectively.

If the Tier 2 analysis indicates that all chemical concentrations are below the SLs and BTs, then no biological testing is necessary. If there is one or more SL exceedance, the DMMU is subjected to a suite of Tier 3 bioassays, consisting of an amphipod mortality test, a larval development test, and the juvenile infaunal growth test. If one or more BT is exceeded, the DMMU is subjected to bioaccumulation testing for the chemical/s exceeding BT.

Tier 4 evaluations are conducted only if standard chemical and biological evaluations are insufficient to determine the suitability of dredged material for open-water disposal. A Tier 4 assessment is a special, non-routine evaluation which might include time-sequenced bioaccumulation or tissue analysis of organisms collected from the area to be dredged. Tier 4 could also include a risk assessment. Tier 4 assessments are rarely needed.

Dioxin Guidelines:

The DMMP agencies implemented revised dioxin/furan guidelines in 2010 for dredged material disposed at the eight multiuser open-water disposal sites in Puget Sound. Implementation of the revised guidelines followed a 3-year study, which included analysis of dioxins/furans in sediment and tissue samples collected from the five non-dispersive sites, as well as determination of background sediment concentrations of dioxins/furans at non-urban sites throughout the Sound (including Hood Canal, the San Juan Islands and the Strait of Juan de Fuca).

The background sediment concentration was determined to be 4 pptr TEQ. The TEQ is the summation of all 17 congeners of dioxins/furans having 2005 World Health Organization Toxic Equivalency Factors. The revised dioxin guidelines for Puget Sound disposal sites are based on this background concentration.

The non-dispersive site management objective is 4 pptr TEQ. DMMUs with dioxin/furan concentrations below 10 pptr TEQ are allowed for disposal as long as the volume-weighted average concentration of dioxins/furans in material from the entire dredging project does not exceed 4 pptr TEQ. DMMUs exceeding 10 pptr may still be placed at non-dispersive sites if they pass bioaccumulation testing that show that the dioxins/furans are not bioavailable. The dioxin concentrations of DMMUs passing bioaccumulation testing are not included in the volume-weighted average.

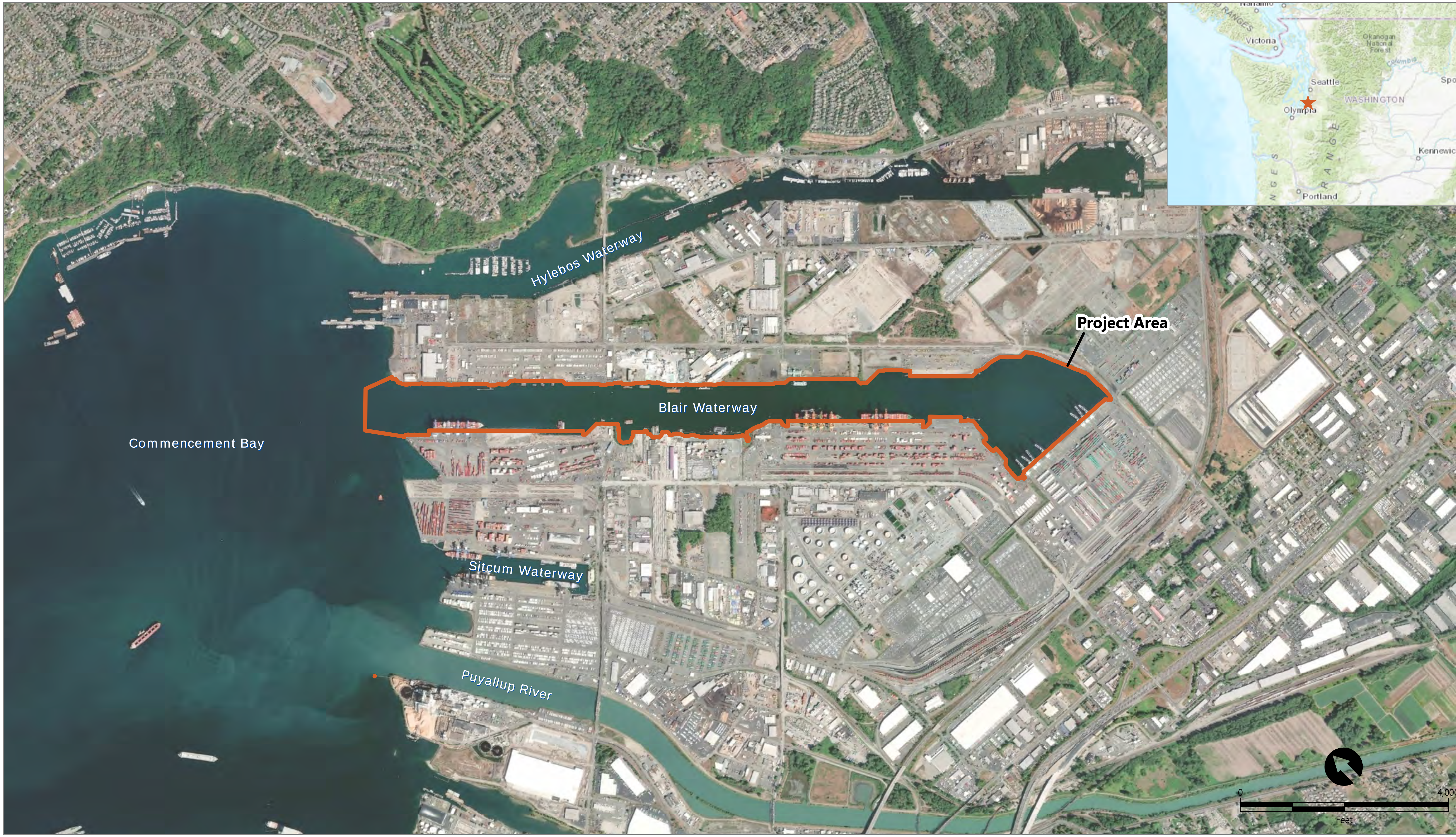
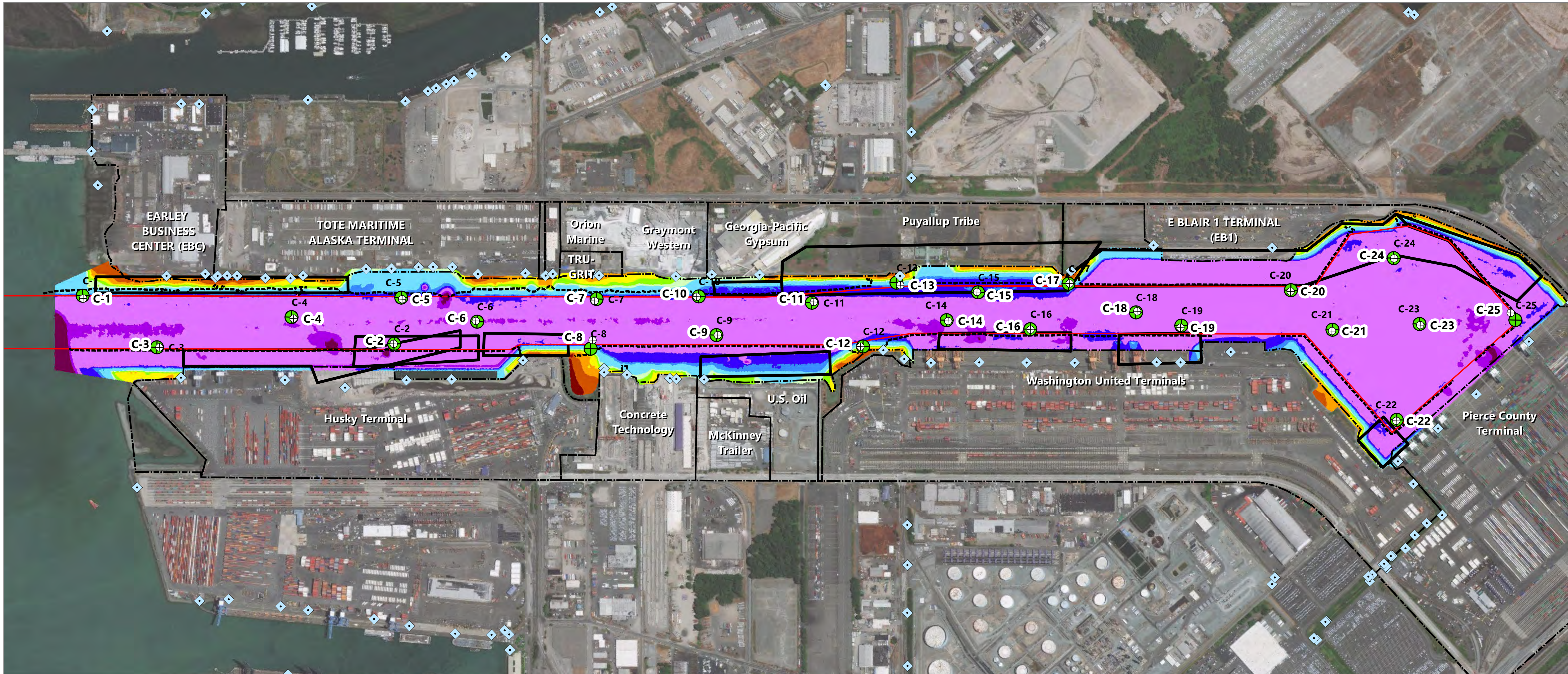


Figure 1
Site Map and Study Area

Tacoma Harbor Deepening Study



LEGEND:

- Outfall
- Actual Sampling Location
- Proposed Sampling Location
- Proposed Navigation Channel Boundary
- Property Boundary
- Historical Dredged Material Characterization Area
- Approximate 2H:1V Daylight Limits

MLLW Elevation (Feet)

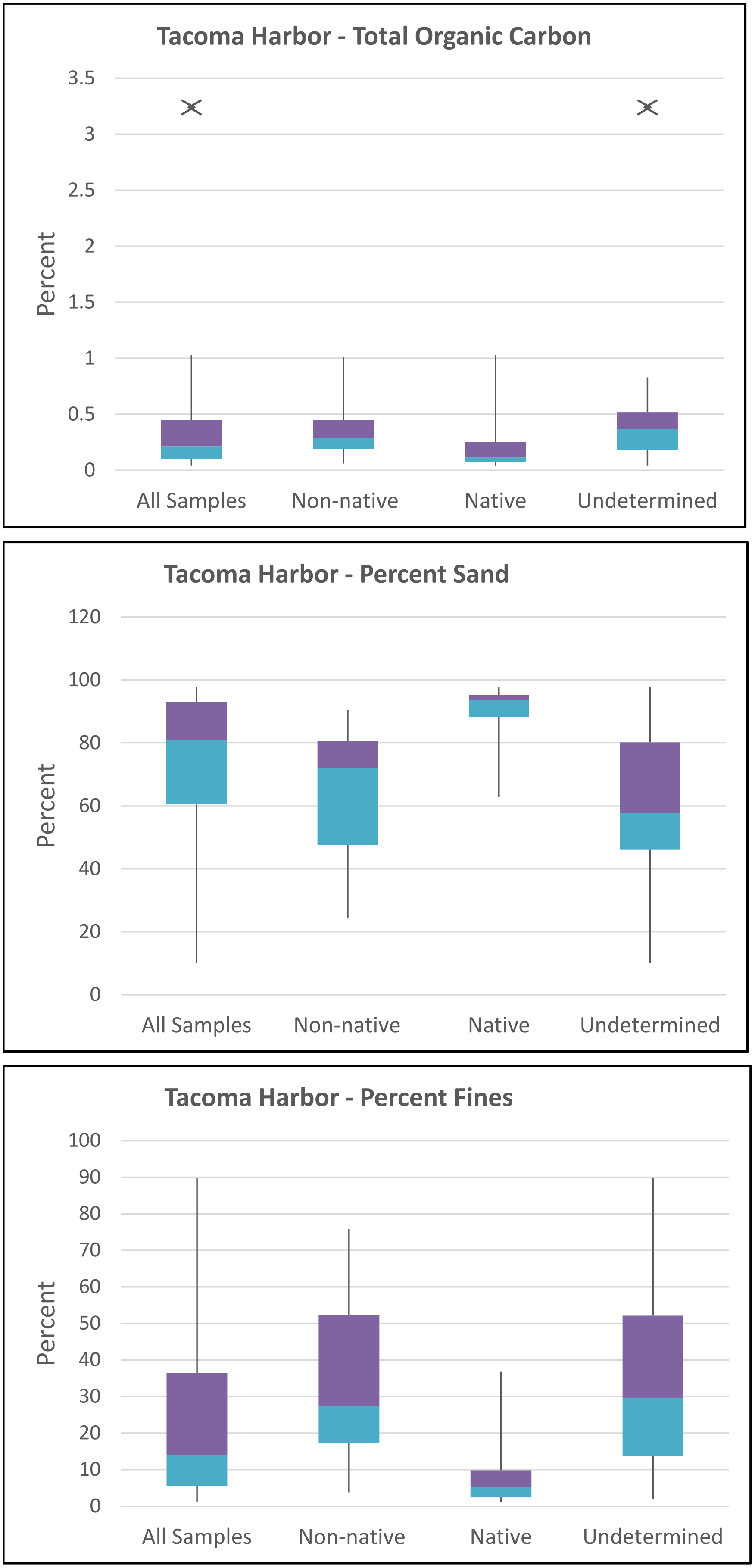
- < -58
- -58 - -55
- -55 - -50
- -50 - -45
- -45 - -40
- -40 - -25
- -25 - -20
- -20 - -15
- -15 - -10
- -10 - -5
- -5 - 0
- 0 - 20

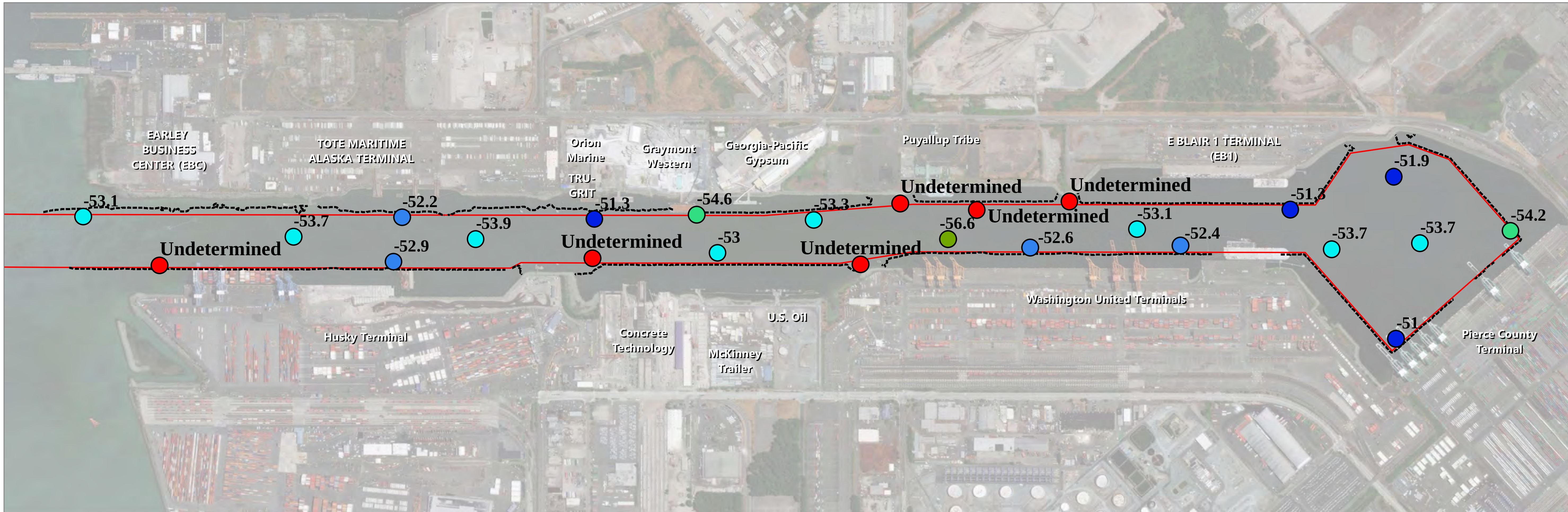
NOTES:
1. Bathymetry from November 2018.

0 2,000
Feet

Figure 2
Proposed and Actual Sampling Locations
Tacoma Harbor Deepening Study

Figure 3. Boxplots of conventionals results from Tacoma Harbor Deepening Study





LEGEND:

Native Horizon (ft MLLW)

- -56.6 - -55.0
- -54.99- -54.0
- -53.99- -53.0
- -52.99- -52.0
- -51.99 - -51.0
- Native Horizion Unknown
- Proposed Navigation Channel Boundary
- Approximate 2H:1V Daylight Limits

0 2,000
Feet

Figure 4
Depth of Native Horizon (ft MLLW)
Tacoma Harbor Deepening Study

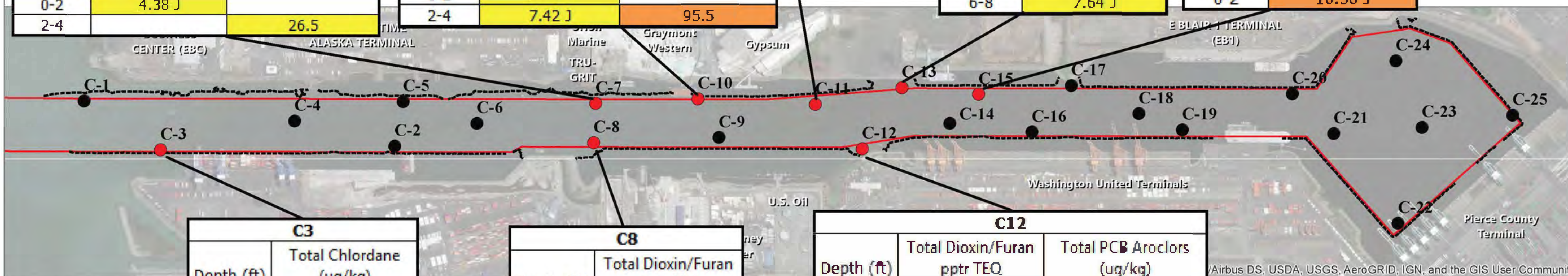
C11		
Depth (ft)	Total Dioxin/Furan pptr TEQ	Total Chlordane (ug/kg)
0-2	5.92 J	21.9 U

C13	
Depth (ft)	Total Dioxin/Furan pptr TEQ
0-2	5.34 J
2-4	7.73 J
4-6	11.88 J
6-8	7.64 J

C7		
Depth (ft)	Total Dioxin/Furan pptr TEQ	Hexachlorobutadiene (ug/kg)
0-2	4.38 J	
2-4		26.5

C10		
Depth (ft)	Total Dioxin/Furan pptr TEQ	TBT (ug/kg)
0-2	8.79 J	
2-4	7.42 J	95.5

C15	
Depth (ft)	Total Dioxin/Furan pptr TEQ
0-2	10.56 J



C3	
Depth (ft)	Total Chlordane (ug/kg)
0-2.7	24.9 U

C8	
Depth (ft)	Total Dioxin/Furan pptr TEQ
0-2	5.00 J

C12		
Depth (ft)	Total Dioxin/Furan pptr TEQ	Total PCB Aroclors (ug/kg)
0-2	56.21 J	173.3 J
2-4	54.47 J	
4-6	17.74 J	

LEGEND:

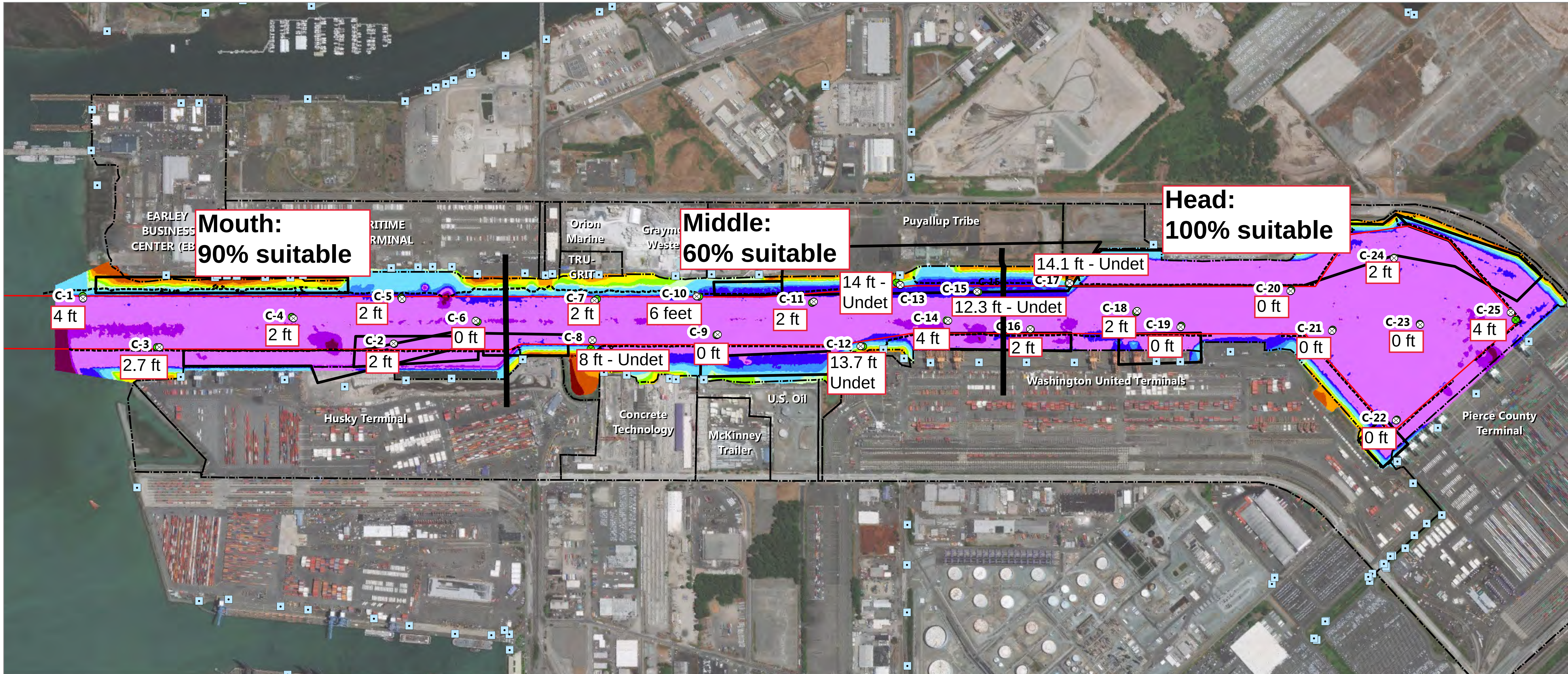
- Suitable
- Unsuitable
- Proposed Navigation Channel Boundary
- Approximate 2H:1V Daylight Limits

NOTES:
1. Bathymetry from November 2018.

(yellow)	Detected concentration is greater than DMMP SL screening level
(orange)	Detected concentration is greater than DMMP bioaccumulation trigger(BT)
(blue)	Non-detected concentration is above one or more identified screening levels

0 2,000
Feet

Figure 5
Summary of SL/BT Exceedances
Tacoma Harbor Deepening



LEGEND:

- Outfall
- Actual Sampling Location
- Proposed Sampling Location
- Proposed Navigation Channel Boundary
- Property Boundary
- Historical Dredged Material Characterization Area
- Approximate 2H:1V Daylight Limits

MLLW Elevation (Feet)

- < -58
- -58 - -55
- -55 - -50
- -50 - -45
- -45 - -40
- -40 - -25
- -25 - -20
- -20 - -15
- -15 - -10
- -10 - -5
- -5 - 0
- 0 - 20

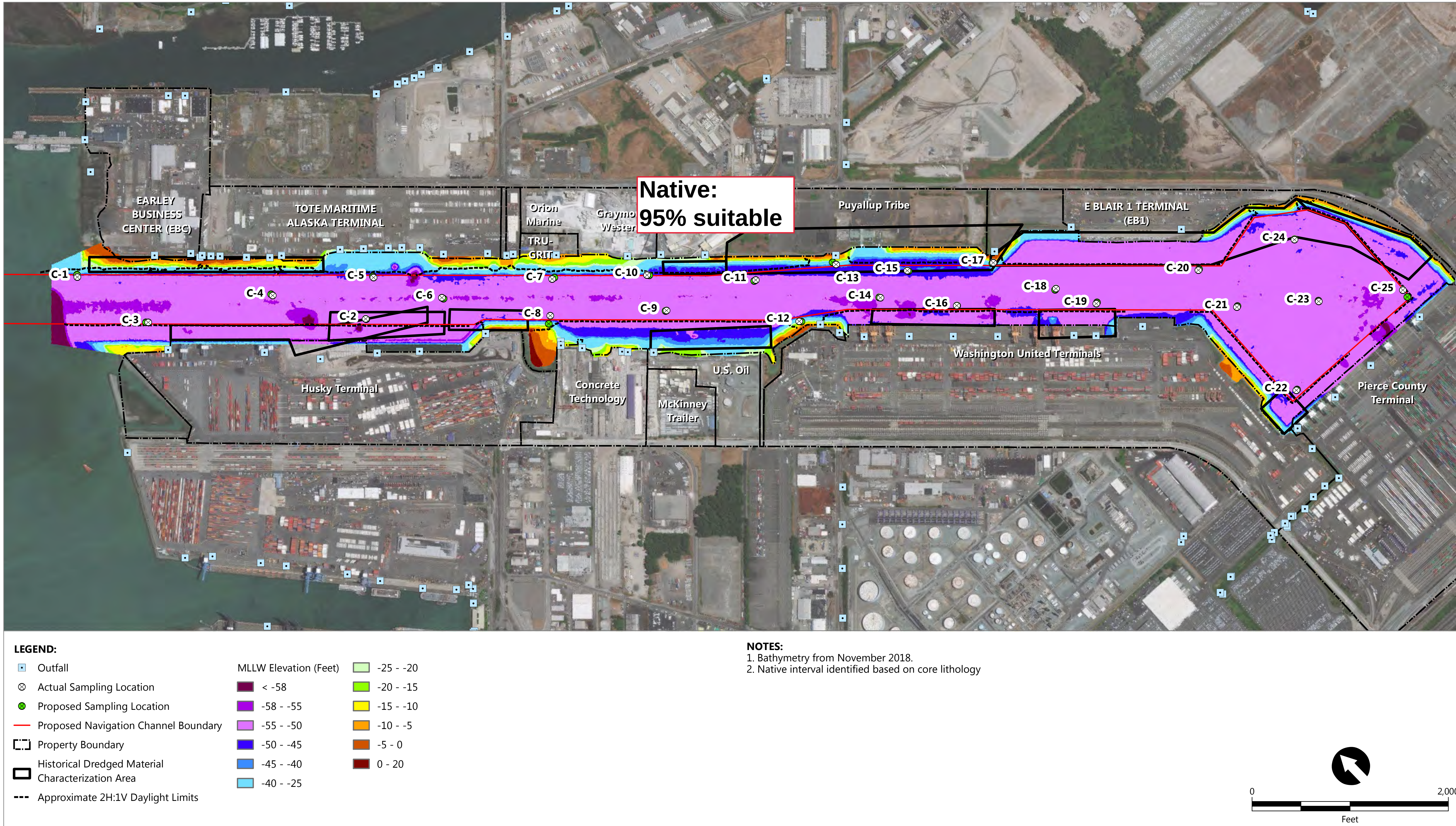
ft indicates the depth of the non-native layer based on core samples.

NOTES:
1. Bathymetry from November 2018.

0 2,000
Feet

Figure 6
Probability of Suitability for Open-Water Disposal of Non-Native Material

Tacoma Harbor Deepening Study



NOTES:
1. Bathymetry from November 2018.
2. Native interval identified based on core lithology

Figure 7
Probability of Suitability for Open-Water Disposal for Native Material

Tacoma Harbor Deepening Study

Table 3
Sample Coordinates and Core Collection Data

Station	Date	Location[1]		Measured Water Depth (feet)	Water Level (ft MLLW)[2]	Mudline Elevation (feet MLLW)	Drive Penetration (feet)	Collection Recovery Measurement (feet)	Recovery[3] (%)	Native Horizon Elevation (feet MLLW)
		X Coordinate	Y Coordinate							
C-1	2/18/2019	1165157.4	715708.8	61.7	11.8	-49.9	13.5	13.1	97.0	-53.1
C-2	2/18/2019	1166970.1	713363.2	63.2	11.8	-51.4	11.0	9.7	88.2	-52.9
C-3	2/18/2019	1165354.3	714876.0	59.2	6.7	-52.5	12.0	11.9	99.2	Undetermined
C-4	2/18/2019	1166455.2	714192.3	61.5	7.8	-53.7	9.7	9.7	100.0	-53.7
C-5	2/20/2019	1167320.0	713610.6	58.5	7.0	-51.5	14.6	14.0	95.9	-52.2
C-6	2/18/2019	1167677.8	712979.4	65.6	11.7	-53.9	10.0	9.6	96.0	-53.9
C-7	2/20/2019	1168617.2	712335.3	59.2	8.8	-50.4	13.8	13.5	97.8	-51.3
C-8	2/21/2019	1168345.9	712082.2	55.8	3.8	-52.0	11.0	9.5	86.4	Undetermined
C-9	2/20/2019	1169230.3	711295.5	59.4	6.4	-53.0	9.7	9.5	97.9	-53.0
C-10	2/20/2019	1169339.5	711694.4	59.9	10.9	-49.0	13.5	13.4	99.3	-54.6
C-11	2/20/2019	1170100.3	710890.6	56.7	5.1	-51.6	13.9	13.0	93.5	-53.3
C-12	2/22/2019	1170124.7	710281.3	27.7	5.0	-22.7	14.7	14.7	100.0	Undetermined
C-13	2/22/2019	1170797.6	710436.2	48.4	9.4	-39.0	14.7	14.3	97.3	Undetermined
C-14	2/21/2019	1170888.7	709878.9	57.0	4.4	-52.6	9.6	9.2	95.8	-56.6
C-15	2/22/2019	1171275.8	709886.8	57.3	11.7	-45.6	14.7	12.6	85.7	Undetermined
C-16	2/22/2019	1171390.8	709280.6	62.2	11.6	-50.6	9.7	9.6	99.0	-52.6
C-17	2/22/2019	1171960.3	709337.6	31.2	9.5	-21.7	15.0	14.5	96.7	Undetermined
C-18	2/19/2019	1172236.9	708704.3	63.4	11.2	-52.2	9.0	7.1	78.9	-53.1
C-19	2/19/2019	1172424.4	708310.0	62.7	10.3	-52.4	9.6	8.0	83.3	-52.4
C-20	2/19/2019	1173409.8	707832.4	57.0	5.7	-51.3	13.8	13.6	98.6	-51.3
C-21	2/19/2019	1173431.1	707291.8	59.4	5.7	-53.7	9.6	8.6	89.6	-53.7
C-22	2/19/2019	1173278.7	706259.8	56.7	5.7	-51.0	13.2	13.0	98.5	-51.0
C-23	2/21/2019	1174069.4	706752.9	64.1	10.4	-53.7	8.5	7.5	88.2	-53.7
C-24	2/22/2019	1174329.1	707378.1	61.2	10.1	-51.1	9.7	9.3	95.9	-51.9
C-25	2/22/2019	1174764.8	706243.0	56.7	5.3	-51.4	9.7	9.6	99.0	-54.2

Notes

1. Coordinates are in North American Datum of 1983 Washington State Plane South, U.S. feet.

2. Water level obtained using real-time kinematic GPS.

3. Percent recovery calculated based on collection measurement.

MLLW: mean lower low water

Table 4
Core Sampling Intervals and Analysis

Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Round 1 Sampling Status[1]	Round 2 Analyses
C-1	C-1-A-190219	0 to 2	-49.9 to -51.9	Full Suite	
	C-1-B-190219	2 to 4	-51.9 to -53.9	Full Suite	
	C-1-C-190219	4 to 6	-53.9 to -55.9	Full Suite	
	C-1-D-190219	6 to 8	-55.9 to -57.9	Archive	
	C-1-E-190219	8 to 9.9	-57.9 to -59.8	Archive	
C-2	C-2-A-190219	0 to 2	-51.4 to -53.4	Full Suite	
	C-2-B-190219	2 to 4	-53.4 to -55.4	Full Suite	
	C-2-C-190219	4 to 6	-55.4 to -57.4	Archive	Conventionals and TBT
	C-2-D-190219	6 to 8.6	57.4 to -60.0	Archive	Conventionals and TBT
C-3	C-3-A-190218	0 to 2.7	-52.5 to -55.2	Full Suite	
	C-3-B-190218	2.7 to 5.8	-55.2 to -58.3	Full Suite	
	C-3-C-190218	5.8 to 7.5	-58.3 to -60.0	Archive	
	C-3-Z-190218	7.5 to 9.5	-60.0 to -62.0	Archive	
	C-3-Z2-190218	9.5 to 11.2	-62.0 to -63.7	Archive	
C-4	C-4-A-190218	0 to 2	-53.6 to -55.6	Full Suite	
	C-4-B-190218	2 to 4	-55.6 to -57.6	Full Suite	
	C-4-C-190218	4 to 6	-57.6 to -59.6	Archive	
	C-4-Z-190218	6 to 8.2	-59.6 to -61.8	Archive	
C-5	C-5-A-190221	0 to 2	-51.5 to -53.5	Full Suite	
	C-5-B-190221	2 to 4	-53.5 to -55.5	Full Suite	
	C-5-C-190221	4 to 6	-55.5 to -57.5	Archive	
	C-5-D-190221	6 to 8.5	-57.5 to -60.0	Archive	
	C-5-Z-190221	8.5 to 10.5	-60.0 to -62.0	Archive	
C-6	C-6-A-190219	0 to 2	-53.9 to -55.9	Full Suite	
	C-6-B-190219	2 to 4	-55.9 to -57.9	Full Suite	
	C-6-C-190219	4 to 6.1	-57.9 to -60.0	Archive	
	C-6-Z-190219	6.1 to 8.1	60.0 to -62.0	Archive	
C-7	C-7-A-190221	0 to 2	-50.4 to -52.4	Full Suite	
	C-7-B-190221	2 to 4	-52.4 to -54.4	Full Suite	
	C-7-C-190221	4 to 6	-54.4 to -56.4	Full Suite	
	C-7-D-190221	6 to 8	-56.4 to -58.4	Archive	

Table 4
Core Sampling Intervals and Analysis

Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Round 1 Sampling Status[1]	Round 2 Analyses
	C-7-E-190221	8 to 9.6	-58.4 to -60.0	Archive	
	C-7-Z-190221	9.6 to 11.6	-60.0 to -62.0	Archive	
C-8	C-8-A-190221	0 to 2	-52.0 to -54.0	Full Suite	
	C-8-B-190221	2 to 4	-54.0 to -56.0	Full Suite	
	C-8-C-190221	4 to 6	-56.0 to -58.0	Archive	
	C-8-D-190221	6 to 8	-58.0 to -60.0	Archive	
	C-8-Z-190221	8 to 8.3	-60.0 to -60.3	Archive	
C-9	C-9-A-190220	0 to 2	-53.0 to -55.0	Full Suite	
	C-9-B-190220	2 to 4	-55.0 to -57.0	Full Suite	
	C-9-C-190220	4 to 7	-57.0 to -60.0	Archive	
	C-9-Z-190220	7 to 9	-60.0 to -62.0	Archive	
C-10	C-10-A-190221	0 to 2	-49.0 to -51.0	Full Suite	
	C-10-B-190221	2 to 4	-51.0 to -53.0	Full Suite	
	C-10-C-190221	4 to 6	-53.0 to -55.0	Full Suite	
	C-10-D-190221	6 to 8	-55.0 to -57.0	Archive	
	C-10-E-190221	8 to 11	-57.0 to -60.0	Archive	
	C-10-Z-190221	11 to 13	-60.0 to -62.0	Archive	
C-11	C-11-A-190220	0 to 2	-51.6 to -53.6	Full Suite	
	C-11-B-190220	2 to 4	-53.6 to -55.6	Full Suite	
	C-11-C-190220	4 to 6.3	-55.6 to -57.9	Archive	
	C-11-D-190220	6.3 to 8.4	-57.9 to -60.0	Archive	
	C-11-Z-190220	8.4 to 10.4	-60.0 to -62.0	Archive	
C-12	C-12-A-190223	0 to 2	-22.7 to -24.7	Full Suite	
	C-12-B-190223	2 to 4	-24.7 to -26.7	Full Suite	
	C-12-C-190223	4 to 6	-26.7 to -28.7	Full Suite	
	C-12-D-190223	6 to 8	-28.7 to -30.7	Archive	conventionals and D/F
	C-12-E-190223	8 to 10	-30.7 to -32.7	Archive	conventionals and D/F
	C-12-F-190223	10 to 12	-32.7 to -34.7	Archive	
	C-12-G-190223	12 to 13.7	-34.7 to -36.4	Archive	
C-13	C-13-A-190223	0 to 2	-39.0 to -41	Full Suite	
	C-13-B-190223	2 to 4	-41.0 to -43.0	Full Suite	

Table 4
Core Sampling Intervals and Analysis

Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Round 1 Sampling Status[1]	Round 2 Analyses
	C-13-C-190223	4 to 6	-43.0 to -45.0	Full Suite	
	C-13-D-190223	6 to 8	-45.0 to -47.0	Archive	conventionals and D/F
	C-13-E-190223	8 to 10	-47.0 to -49.0	Archive	conventionals and D/F
	C-13-F-190223	10 to 12	-49.0 to -51.0	Archive	
	C-13-G-190223	12 to 14	-51.0 to -53.0	Archive	
C-14	C-14-A-190221	0 to 2	-52.6 to -54.6	Full Suite	
	C-14-B-190221	2 to 4	-54.6 to -56.6	Full Suite	
	C-14-C-190221	4 to 6	-56.6 to -58.6	Archive	
	C-14-C-190221	6 to 7.4	-58.6 to -60.0	Archive	
	C-14-Z-190221	7.4 to 7.6	-60.0 to -60.6	Archive	
C-15	C-15-A-190222	0 to 2	-45.6 to -47.6	Full Suite	
	C-15-B-190222	2 to 4	-47.6 to -49.6	Full Suite	
	C-15-C-190222	4 to 6	-49.6 to -51.6	Full Suite	
	C-15-D-190222	6 to 8	-51.6 to -53.6	Archive	
	C-15-E-190222	8 to 10	-53.6 to -55.6	Archive	
	C-15-F-190222	10 to 12.3	-55.6 to -57.9	Archive	
C-16	C-16-A-190223	0 to 2	-50.6 to -52.6	Full Suite	
	C-16-B-190223	2 to 4	-52.6 to -54.6	Full Suite	
	C-16-C-190223	4 to 6.5	-54.6 to -57.1	Archive	
C-17	C-17-A-190222	0 to 2	-19.7 to -21.7	Full Suite	
	C-17-B-190222	2 to 4	-21.7 to -23.7	Full Suite	
	C-17-C-190222	4 to 8	-23.7 to -25.7	Full Suite	
	C-17-D-190222	8 to 10	-25.7 to -27.7	Archive	
	C-17-E-190222	10 to 12	-27.7 to -29.7	Archive	
	C-17-F-190222	12 to 14.1	-29.7 to -31.8	Archive	
C-18	C-18-A1-190220	0 to 2.3	-52.2 to -54.5	Full Suite	
	C-18-B1-190220	3.9 to 6.3	-54.5 to -56.9	Full Suite	
C-19	C-19-A-190220	0 to 2	-52.4 to -54.4	Full Suite	
	C-19-B-190220	2 to 4	-54.4 to -56.4	Full Suite	
	C-19-C-190220	4 to 6	-56.4 to -58.4	Archive	
	C-19-D-190220	6 to 7.9	-58.4 to -60.3	Archive	

Table 4
Core Sampling Intervals and Analysis

Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Round 1 Sampling Status[1]	Round 2 Analyses
C-20	C-20-A-190219	0 to 2	-51.3 to -53.3	Full Suite	
	C-20-B-190219	2 to 4	-53.3 to -55.3	Full Suite	
	C-20-C-190219	4 to 6	-55.3 to -57.3	Archive	
	C-20-D-190219	6 to 8.7	-57.3 to -60.0	Archive	
	C-20-Z-190219	8.7 to 10.6	-60.0 to -61.9	Archive	
C-21	C-21-A-190219	0 to 2	-53.7 to -55.7	Full Suite	
	C-21-B-190219	2 to 4	-55.7 to -57.7	Full Suite	
	C-21-C-190219	4 to 6.3	-57.7 to -60.0	Archive	
	C-21-Z-190219	6.3 to 8.3	-60.0 to -62.0	Archive	
C-22	C-22-A-190219	0 to 2	-51.0 to -53.0	Full Suite	
	C-22-B-190219	2 to 4	-53.0 to -55.0	Full Suite	
	C-22-C-190219	4 to 6	-55.0 to -57.0	Archive	
	C-22-D-190219	6 to 9	-57.0 to -60.0	Archive	
	C-22-Z-190219	9 to 11	-60.0 to -62.0	Archive	
C-23	C-23-A1-190222	0 to 2	-53.7 to -55.7	Full Suite	
	C-23-B1-190222	2 to 4	-55.7 to -57.7	Full Suite	
C-24	C-24-A-190223	0 to 2	-51.1 to -53.1	Full Suite	
	C-24-B-190223	2 to 4	-53.1 to -55.1	Full Suite	
	C-24-C-190223	4 to 6.6	-55.1 to -57.7	Archive	
C-25	C-25-A-190222	0 to 2	-51.4 to -53.4	Full Suite	
	C-25-B-190222	2 to 4	-53.4 to -55.4	Full Suite	
	C-25-C-190222	4 to 6	-55.4 to -57.4	Archive	
	C-25-D-190222	6 to 8.6	-57.4 to -60.0	Archive	
	C-25-Z-190222	8.6 to 9.3	-60.0 to -60.7	Archive	

Notes:

1. The full suite of testing parameters include semivolatile organic compounds, polycyclic aromatic hydrocarbons, pesticides, polychlorinated biphenyls, metals, sulfide, ammonia, total organic carbon, grain size, total volatile solids, and total solids, dioxins and furans, and tributytin.

MLLW: mean lower low water

Table 5
Sample Results Summary - Conventionals and Physical Tests

Sample ID / Depth / Analyte	Method	C-1-A-190219 0 - 2 ft	C-1-B-190219 2 - 4 ft	C-1-C-190219 4 - 6 ft	C-2-A-190219 0 - 2 ft	C-2-B-190219 2 - 4 ft	C-2-C-190219 4 - 6 ft	C-2-D-190219 6 - 8.6 ft	C-3-A-190218 0 - 2.7 ft	C-3-B-190218 2.7 - 5.8 ft	C-4-A-190218 0 - 2 ft
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	SM4500NH3H	**2.09**	**0.81**	**0.68**	**2.64**	**2.24**	--	--	**3.01**	**8.74**	**0.63**
Sulfide	SM4500S2D	**388**	**104**	**93.3**	**117**	**1.89**	--	--	**529**	**115**	**29.6**
Conventional Parameters (%)											
Total organic carbon	SW9060A	**0.71**	**0.21**	**0.09**	**0.37**	**0.26**	**1.03**	**0.45**	**0.49**	**0.27**	**0.15**
Total solids	SM2540G	**71.88**	**80.16**	**78.63**	**74.57**	**78.53**	**73.42**	**80.56**	**68.43**	**77.92**	**78.72**
Total volatile solids	PSEP-TVS	**2.4**	**1.34**	**1.23**	**1.88**	**1.45**	--	--	**2.1**	**1.56**	**1.35**
Grain Size (%)											
Gravel	PSEP-PS	**0**	**0.3**	**0**	**0.5**	**0.1**	**0.4**	**0.5**	**0**	**0.1**	**0.1**
Sand, very coarse	PSEP-PS	**0.2**	**0.6**	**0.7**	**0.5**	**0.9**	**0.7**	**0.9**	**0.7**	**0.1**	**0.2**
Sand, coarse	PSEP-PS	**3.1**	**9.1**	**8.9**	**7**	**12.9**	**2.9**	**6.2**	**3.2**	**0.2**	**3.3**
Sand, medium	PSEP-PS	**12.5**	**33.4**	**38.9**	**28.6**	**38.4**	**17.6**	**32.3**	**8.3**	**1**	**25**
Sand, fine	PSEP-PS	**13.6**	**25.1**	**31.1**	**24.8**	**18.7**	**36.8**	**38.7**	**15.8**	**26.5**	**46**
Sand, very fine	PSEP-PS	**12.5**	**12.4**	**10.4**	**11.1**	**5.1**	**20.7**	**9.4**	**16**	**42.4**	**16**
Total Sand	PSEP-PS	**41.9**	**80.6**	**90**	**72**	**76**	**78.7**	**87.5**	**44**	**70.2**	**90.5**
Silt, coarse	PSEP-PS	**12.9**	**5.3**	**3.7**	**7.3**	**6.1**	**9.3**	**3.8**	**11.2**	**8**	**4.3**
Silt, medium	PSEP-PS	**14.3**	**4.6**	**1.8**	**6**	**6.7**	**4.5**	**2.5**	**12.9**	**8.6**	**1.3**
Silt, fine	PSEP-PS	**11**	**3.3**	**1.4**	**4.8**	**4.5**	**2.3**	**1.7**	**11.1**	**3.3**	**1**
Silt, very fine	PSEP-PS	**5.6**	**1.6**	**0.7**	**2.6**	**2.5**	**1.4**	**1.1**	**4.7**	**2.4**	**0.5**
Clay, coarse	PSEP-PS	**4.2**	**1.2**	**0.6**	**1.8**	**1.3**	**0.9**	**0.8**	**4.6**	**2**	**0.5**
Clay, medium	PSEP-PS	**3**	**0.9**	**0.4**	**1.5**	**0.8**	**0.7**	**0.5**	**3.6**	**1.6**	**0.4**
Clay, fine	PSEP-PS	**6.9**	**2.2**	**1.3**	**3.5**	**2**	**1.8**	**1.5**	**7.8**	**3.8**	**1.4**
Total Fines	PSEP-PS	**57.9**	**19.1**	**9.9**	**27.5**	**23.9**	**20.9**	**11.9**	**55.9**	**29.7**	**9.4**

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 5
Sample Results Summary - Conventionals and Physical Tests

Analyte / Sample ID / Depth	C-4-B-190218 2 - 4 ft	C-5-A-190221 0 - 2 ft	C-5-B-190221 2 - 4 ft	C-6-A-190219 0 - 2 ft	C-6-B-190219 2 - 4 ft	C-7-A-190221 0 - 2 ft	C-7-B-190221 2 - 4 ft	C-7-C-190221 4 - 6 ft	C-8-A-190221 0 - 2 ft	C-8-B-190221 2 - 4 ft	C-9-A-190220 0 - 2 ft
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	0.5 U	**3.9**	**14.8**	0.41 U	**1.58**	**4.01**	**1.06**	**1.18**	**6.98**	**27.9**	**5.97**
Sulfide	**8.33**	**32.9**	**6.35**	**13.5**	1.11 U	**258**	**7.28**	0.887 U	**153**	**4.52**	0.984 U
Conventional Parameters (%)											
Total organic carbon	**0.12**	**0.28**	**0.74 J**	**0.22**	**0.71**	**0.55**	**0.44**	**0.2**	**0.54**	**0.39**	**0.11**
Total solids	**79.07**	**80.52**	**74.08**	**90.85**	**77.91**	**60.4**	**79.72**	**81.42**	**74.91**	**74.88**	**84.21**
Total volatile solids	**1.07**	**3.39**	**2.45**	**1.36**	**2.26**	**1.33**	**1.57**	**1.28**	**1.95**	**2.13**	**0.92**
Grain Size (%)											
Gravel	**0.3**	**0.1**	**0.5**	**1.1**	**0.5**	**0.4**	**0.3**	**0.2**	**3.6**	**0**	**0.1**
Sand, very coarse	**0.3**	**0.7**	**2.2**	**1**	**0.9**	**0.4**	**0.9**	**0.4**	**0.6**	**0.2**	**0.5**
Sand, coarse	**5.2**	**8.4**	**14.2**	**16.9**	**4.5**	**2.5**	**4.4**	**2.9**	**2**	**0.3**	**8.4**
Sand, medium	**34.2**	**28.9**	**19.1**	**51**	**34.4**	**21.9**	**36.5**	**26.4**	**7**	**0.4**	**35.9**
Sand, fine	**45.5**	**26.2**	**18.7**	**21.5**	**42.8**	**28**	**44.9**	**49.2**	**14.8**	**1.4**	**33**
Sand, very fine	**10.3**	**11.5**	**16.6**	**3.7**	**11.3**	**11.3**	**6.9**	**13.9**	**18.7**	**8.4**	**9.3**
Total Sand	**95.5**	**75.7**	**70.8**	**94.1**	**93.9**	**64.1**	**93.6**	**92.8**	**43.1**	**10.7**	**87.1**
Silt, coarse	4.1 U	**8.5**	**9.6**	**1.4**	**1.1**	**7.9**	**1.5**	**3.1**	**16.3**	**17.7**	**3.8**
Silt, medium	4.1 U	**5.4**	**8**	**1**	**1.2**	**8.4**	**1.1**	**1.1**	**11.7**	**24.6**	**3**
Silt, fine	4.1 U	**3.4**	**3.8**	**0.7**	**1**	**6.3**	**0.8**	**0.6**	**8.1**	**17.4**	**2.3**
Silt, very fine	4.1 U	**2.1**	**2**	**0.4**	**0.5**	**3.9**	**0.6**	**0.3**	**5**	**10.4**	**1.1**
Clay, coarse	4.1 U	**1.4**	**1.4**	**0.4**	**0.2**	**2.8**	**0.5**	**0.4**	**3.5**	**5.8**	**0.5**
Clay, medium	4.1 U	**0.9**	**1**	**0.3**	**0.3**	**1.8**	**0.3**	**0.2**	**2.4**	**4.1**	**0.4**
Clay, fine	4.1 U	**2.5**	**2.7**	**0.7**	**1.2**	**4.6**	**1.4**	**1.2**	**6.4**	**9.3**	**1.5**
Total Fines	4.1 U	**24.2**	**28.5**	**4.9**	**5.5**	**35.7**	**6.2**	**6.9**	**53.4**	**89.3**	**12.6**

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 5
Sample Results Summary - Conventionals and Physical Tests

Sample ID / Depth / Analyte	C-9-B-190220 2 - 4 ft	C-10-A-190221 0 - 2 ft	C-10-B-190221 2 - 4 ft	C-10-C-190221 4 - 6 ft	C-11-A-190220 0 - 2 ft	C-11-B-190220 2 - 4 ft	C-12-A-190223 0 - 2 ft	C-12-B-190223 2 - 4 ft	C-12-C-190223 4 - 6 ft	C-12-D-190223 6 - 8 ft	C-12-E-190223 8 - 10 ft
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	**36.4**	**8.44**	**8.05**	**11.9**	**4.27**	**0.95**	**3.31**	**4.36**	**12**	--	--
Sulfide	1.03 U	**627**	**592**	0.989 U	**605**	1.12 U	**57.1**	**104**	**113**	--	--
Conventional Parameters (%)											
Total organic carbon	**0.19**	**1.01**	**0.45**	**0.19**	**0.86**	**0.14**	**0.61 J**	**0.37 J**	**0.75 J**	**0.1**	**0.21**
Total solids	**78.65**	**66.64**	**73.29**	**99.27**	**68.52**	**80.63**	**72.61**	**74.39**	**75.94**	**82.52**	**81.81**
Total volatile solids	**1.34**	**2.88**	**1.92**	**1.67**	**2.45**	**1.06**	**2.13**	**2.08**	**1.86**	--	--
Grain Size (%)											
Gravel	**0.2**	**0.7**	**0.1**	**0.2**	**0.2**	**0.3**	**3.5**	**2.9**	**0.6**	**2.8**	**13.7**
Sand, very coarse	**0.3**	**0.2**	**0.2**	**0.5**	**0.4**	**0.3**	**2.5**	**1.8**	**0.5**	**4**	**13.9**
Sand, coarse	**2.7**	**0.9**	**2.1**	**6.5**	**2.5**	**3.9**	**14.5**	**8.5**	**3.5**	**34**	**26.5**
Sand, medium	**9.2**	**5**	**7.2**	**19.8**	**12.5**	**35.6**	**16.9**	**14.2**	**10.5**	**29.5**	**15.9**
Sand, fine	**22**	**12.9**	**15.5**	**20.1**	**20.1**	**43.9**	**13.1**	**17**	**18.8**	**11.8**	**10.6**
Sand, very fine	**28.6**	**12.9**	**19.7**	**12.8**	**12.1**	**9.4**	**10.7**	**12.9**	**15.1**	**4.6**	**8.8**
Total Sand	**62.8**	**31.9**	**44.7**	**59.7**	**47.6**	**93.1**	**57.7**	**54.4**	**48.4**	**83.9**	**75.7**
Silt, coarse	**9.3**	**13.8**	**14.3**	**9.7**	**10.7**	**2**	**9.7**	**9.2**	**10.5**	**3.2**	**3.5**
Silt, medium	**9.2**	**14.5**	**13.5**	**8.9**	**14.2**	**1.1**	**8.2**	**9.9**	**13.3**	**2.7**	**1.7**
Silt, fine	**7.6**	**13.4**	**9.9**	**7.1**	**11.9**	**0.7**	**6.2**	**7.4**	**8.7**	**2.2**	**1.5**
Silt, very fine	**3.5**	**7.5**	**5.1**	**4.1**	**5.8**	**0.6**	**3.9**	**4.6**	**5.5**	**1.5**	**1.2**
Clay, coarse	**2.4**	**5.7**	**3.7**	**3**	**3**	**0.4**	**2.9**	**3.3**	**3.6**	**1.1**	**0.9**
Clay, medium	**1.5**	**3.4**	**2.1**	**1.9**	**1.7**	**0.3**	**2.5**	**2.6**	**2.9**	**0.8**	**0.7**
Clay, fine	**3.3**	**9.2**	**6.7**	**5.5**	**4.9**	**1.5**	**5.4**	**5.7**	**6.4**	**1.8**	**1.1**
Total Fines	**36.8**	**67.5**	**55.3**	**40.2**	**52.2**	**6.6**	**38.8**	**42.7**	**50.9**	**13.3**	**10.6**

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 5
Sample Results Summary - Conventionals and Physical Tests

Sample ID / Depth / Analyte	C-13-A-190223 0 - 2 ft	C-13-B-190223 2 - 4 ft	C-13-C-190223 4 - 6 ft	C-13-D-190223 6 - 8 ft	C-13-E-190223 8 - 10 ft	C-14-A-190221 0 - 2 ft	C-14-B-190221 2 - 4 ft	C-15-A-190222 0 - 2 ft	C-15-B-190222 2 - 4 ft	C-15-C-190222 4 - 6 ft	C-16-A-190223 0 - 2 ft
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	**4.85**	**19.3**	**23.8**	--	--	**8.62**	**20.3**	**2.33**	**2.08**	**2.4**	**2.82**
Sulfide	**402**	**339**	**5.5**	--	--	**11.4**	1.1 U	**224**	1.12 U	1.07 U	**203**
Conventional Parameters (%)											
Total organic carbon	**0.59 J**	**0.39 J**	**0.18 J**	**0.19**	**0.04**	**0.09**	**0.15**	**0.25 J**	**0.1 J**	**0.17 J**	**0.25 J**
Total solids	**77.45**	**74.72**	**83.95**	**84.57**	**85.03**	**86.15**	**84.18**	**75.49**	**82.44**	**83.22**	**94.31**
Total volatile solids	**1.73**	**1.92**	**1.12**	--	--	**0.88**	**1.27**	**1.69**	**1.08**	**1.23**	**18.98**
Grain Size (%)											
Gravel	**24.4**	**0.9**	**4.4**	**7.9**	**0.2**	**10.8**	**1.2**	**4.3**	**6.5**	**1.1**	**1.4**
Sand, very coarse	**3.6**	**1.5**	**3.8**	**4**	**1.7**	**6.9**	**3.8**	**3**	**5.9**	**3.5**	**1.8**
Sand, coarse	**10.1**	**8.6**	**16.1**	**18.5**	**18.5**	**25.9**	**16.9**	**14.2**	**21.2**	**19.6**	**13.3**
Sand, medium	**19.6**	**18.8**	**33.2**	**35.9**	**56.2**	**34.3**	**34.1**	**31.2**	**37.9**	**38.7**	**40.7**
Sand, fine	**14.8**	**15.4**	**20**	**14.9**	**19.9**	**15.3**	**23.5**	**22.3**	**16.9**	**20.9**	**18.7**
Sand, very fine	**6.5**	**12.5**	**8.1**	**3.4**	**1.4**	**2.9**	**6.9**	**8.5**	**4.7**	**5.8**	**5.7**
Total Sand	**54.6**	**56.8**	**81.2**	**76.7**	**97.7**	**85.3**	**85.2**	**79.2**	**86.6**	**88.5**	**80.2**
Silt, coarse	**4.2**	**9.7**	**4.7**	**1.6**	2 U	**0.7**	**4.6**	**3.2**	**2.3**	**2.8**	**3.8**
Silt, medium	**4.3**	**9**	**2.6**	**3.6**	2 U	**0.5**	**2.5**	**3.6**	**1.1**	**1.9**	**3.4**
Silt, fine	**4.5**	**7.2**	**2.1**	**3.3**	2 U	**0.6**	**1.8**	**4.1**	**0.8**	**1.4**	**4.1**
Silt, very fine	**2**	**4.2**	**1.5**	**2.4**	2 U	**0.5**	**1.3**	**1.4**	**0.8**	**1.1**	**1.9**
Clay, coarse	**1.7**	**3.6**	**0.9**	**1.4**	2 U	**0.5**	**1**	**0.9**	**0.4**	**0.9**	**1.3**
Clay, medium	**1.5**	**2.7**	**0.7**	**1**	2 U	**0.3**	**0.8**	**0.8**	**0.4**	**0.6**	**1.2**
Clay, fine	**2.9**	**5.8**	**1.8**	**2**	2 U	**0.7**	**1.8**	**2.3**	**1.2**	**1.7**	**2.6**
Total Fines	**21.1**	**42.2**	**14.3**	**15.3**	2 U	**3.8**	**13.8**	**16.3**	**7**	**10.4**	**18.3**

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 5

Sample Results Summary - Conventionals and Physical Tests

Sample ID / Depth / Analyte	C-16-B-190223 2 - 4 ft	C-17-A-190222 0 - 2 ft	C-17-B-190222 2 - 4 ft	C-17-C-190222 4 - 8 ft	C-18-A1-190220 0 - 2.3 ft	C-18-B1-190220 3.9 - 6.3 ft	C-19-A-190220 0 - 2 ft	C-19-B-190220 2 - 4 ft	C-20-A-190219 0 - 2 ft	C-20-B-190219 2 - 4 ft	C-21-A-190219 0 - 2 ft
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	**1.8**	**9.64**	**24.6**	**21.8**	**1.73**	**0.88**	**0.41**	**0.62**	**3.61**	**3.17**	0.44 U
Sulfide	1.11 U	**491**	1.73 U	1.07 U	**98.7**	0.97 U	1.01 U	**4.57**	**27.1**	1.01 U	**7.09**
Conventional Parameters (%)											
Total organic carbon	**0.05 J**	**0.83 J**	**3.24 J**	**0.39 J**	**0.29 J**	**0.13 J**	**0.09**	**0.1**	**0.08**	**0.04**	**0.49**
Total solids	**82.56**	**66.23**	**52.51**	**72.42**	**79.18**	**89.34**	**96.68**	**84.76**	**83.46**	**88.17**	**86.32**
Total volatile solids	**0.98**	**3.54**	**9.48**	**6.55**	**1.34**	**1.55**	**0.85**	**1.11**	**0.96**	**0.96**	**1.72**
Grain Size (%)											
Gravel	**1.5**	**0**	**0.2**	**0**	**1.1**	**3.1**	**2.1**	**2.5**	**1.1**	**4.7**	**1.1**
Sand, very coarse	**4.1**	**0.8**	**3.1**	**0.1**	**3.7**	**9.1**	**8.8**	**7**	**7.2**	**9.7**	**4.1**
Sand, coarse	**20.2**	**1.3**	**1.7**	**0.4**	**21.6**	**33.5**	**40.9**	**25.7**	**31**	**46.7**	**17.2**
Sand, medium	**55.6**	**2.1**	**1.7**	**1.5**	**36.5**	**44.3**	**33.7**	**33.7**	**32.6**	**31.8**	**43.2**
Sand, fine	**14.1**	**2.5**	**2.4**	**5.6**	**14.9**	**7.3**	**10.4**	**17.7**	**15.4**	**5.5**	**31.1**
Sand, very fine	**1.6**	**3.3**	**5.2**	**21.7**	**4.8**	**0.6**	**1.6**	**3.6**	**6.1**	**0.5**	**2.1**
Total Sand	**95.6**	**10**	**14.1**	**29.3**	**81.5**	**94.8**	**95.4**	**87.7**	**92.3**	**94.2**	**97.7**
Silt, coarse	2.8 U	**5.5**	**6.8**	**20.2**	**3.8**	2 U	2.4 U	**2.3**	**2.5**	1.2 U	1.3 U
Silt, medium	2.8 U	**12.9**	**13.7**	**18.6**	**3.7**	2 U	2.4 U	**2.5**	**1.2**	1.2 U	1.3 U
Silt, fine	2.8 U	**18.7**	**18.5**	**11.3**	**3**	2 U	2.4 U	**1.8**	**0.8**	1.2 U	1.3 U
Silt, very fine	2.8 U	**19.4**	**17**	**7.2**	**2.3**	2 U	2.4 U	**0.9**	**0.5**	1.2 U	1.3 U
Clay, coarse	2.8 U	**13.6**	**10.9**	**4.5**	**1.4**	2 U	2.4 U	**0.5**	**0.4**	1.2 U	1.3 U
Clay, medium	2.8 U	**7.6**	**6.9**	**2.8**	**1.2**	2 U	2.4 U	**0.3**	**0.3**	1.2 U	1.3 U
Clay, fine	2.8 U	**12.2**	**12**	**6**	**2**	2 U	2.4 U	**1.4**	**1**	1.2 U	1.3 U
Total Fines	2.8 U	**89.9**	**85.8**	**70.6**	**17.4**	2 U	2.4 U	**9.7**	**6.7**	1.2 U	1.3 U

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 5
Sample Results Summary - Conventionals and Physical Tests

Sample ID / Depth / Analyte	C-21-B-190219	C-22-A-190219	C-22-B-190219	C-23-A1-190222	C-23-B1-190222	C-24-A-190223	C-24-B-190223	C-25-A-190222	C-25-B-190222
Depth	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Conventional Parameters (mg/kg)									
Ammonia as nitrogen	0.45 U	**1.95**	**2.19**	0.41 U	0.38 U	**1.68**	**1.79**	**36.7**	**41.9**
Sulfide	1.19 U	1.01 U	1.07 U	1.01 U	1.07 U	**1.76**	1 U	1.31 U	1.17 U
Conventional Parameters (%)									
Total organic carbon	**0.11**	**0.07**	**0.04**	**0.07**	**0.04**	**0.06 J**	**0.04 J**	**0.29 J**	**0.44 J**
Total solids	**87**	**91.38**	**90.92**	**91.48**	**90.58**	**84.92**	**90.11**	**77.35**	**75.07**
Total volatile solids	**1.1**	**0.83**	**0.93**	**1.01**	**0.83**	**1.05**	**0.98**	**1.66**	**2.67**
Grain Size (%)									
Gravel	**0.4**	**0.4**	**0.4**	**2.6**	**4.1**	**15.3**	**4.5**	**0.1**	**0.5**
Sand, very coarse	**4.2**	**2.2**	**2.4**	**11.4**	**13.8**	**13.7**	**18.3**	**0.4**	**0.5**
Sand, coarse	**17.3**	**19.9**	**22.9**	**42.4**	**48.7**	**26.9**	**33**	**2**	**2.8**
Sand, medium	**43.5**	**45.3**	**47.6**	**32.9**	**26.9**	**26.7**	**34.2**	**5.3**	**31.1**
Sand, fine	**30.5**	**25.3**	**22.5**	**5.4**	**3.7**	**9.5**	**7.9**	**6.9**	**24.2**
Sand, very fine	**1.6**	**2.6**	**2.1**	**0.8**	**0.6**	**2.4**	**0.6**	**9.6**	**5.9**
Total Sand	**97.1**	**95.3**	**97.5**	**92.9**	**93.7**	**79.2**	**94**	**24.2**	**64.5**
Silt, coarse	2.5 U	**1.4**	2 U	**0.9**	2.1 U	**1.1**	1.4 U	**19.7**	**6.2**
Silt, medium	2.5 U	**0.9**	2 U	**0.6**	2.1 U	**1**	1.4 U	**25.3**	**12.2**
Silt, fine	2.5 U	**0.8**	2 U	**0.9**	2.1 U	**0.9**	1.4 U	**13.8**	**6.9**
Silt, very fine	2.5 U	**0.3**	2 U	**0.7**	2.1 U	**0.7**	1.4 U	**6.4**	**3.6**
Clay, coarse	2.5 U	**0.2**	2 U	**0.5**	2.1 U	**0.5**	1.4 U	**3.1**	**1.9**
Clay, medium	2.5 U	**0.1**	2 U	**0.2**	2.1 U	**0.4**	1.4 U	**2.2**	**1.4**
Clay, fine	2.5 U	**0.6**	2 U	**0.5**	2.1 U	**1.1**	1.4 U	**5.3**	**2.9**
Total Fines	2.5 U	**4.3**	2 U	**4.3**	2.1 U	**5.7**	1.4 U	**75.8**	**35.1**

Notes:

Bold: Detected result

ft: feet

J: Estimated value

mg/kg: milligram per kilogram

U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	DMMP SL	DMMP BT	C-1-A-190219 0 - 2 ft	C-1-B-190219 2 - 4 ft	C-1-C-190219 4 - 6 ft	C-2-A-190219 0 - 2 ft	C-2-B-190219 2 - 4 ft	C-2-C-190219 4 - 6 ft	C-2-D-190219 6 - 8.6 ft
Metals (mg/kg)									
Antimony	150	--	0.28 UJ	0.23 UJ	0.23 UJ	0.25 UJ	0.24 UJ	--	--
Arsenic	57	507.1	**3.24**	**1.67**	**1.06**	**4.97**	**1.95**	--	--
Cadmium	5.1	--	**0.09 J**	0.11 U	0.12 U	**0.05 J**	**0.05 J**	--	--
Chromium	260	--	**14.7**	**11**	**9.49**	**12.5**	**12.7**	--	--
Copper	390	--	**26.7**	**13.7**	**10.3**	**18.3**	**16.6**	--	--
Lead	450	975	**6.01**	**2.33**	**1.33**	**3.46**	**2.15**	--	--
Mercury	0.41	1.5	**0.0423**	**0.025**	**0.0114 J**	**0.0249 J**	**0.0167 J**	--	--
Selenium	--	3	**0.97**	**0.72**	**0.69**	**0.95**	**1.11**	--	--
Silver	6.1	--	**0.12 J**	**0.06 J**	**0.03 J**	**0.08 J**	**0.05 J**	--	--
Zinc	410	--	**33.3**	**19.3**	**14.9**	**27**	**23.7**	--	--
Organometallic Compounds (µg/kg)									
Tributyltin (ion)	--	73	**0.913 J**	3.42 U	3.49 U	**7.35**	**17.3**	3.6 U	3.43 U
Semivolatile Organics (µg/kg)									
1,2,4-Trichlorobenzene	31	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
1,2-Dichlorobenzene	35	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
1,4-Dichlorobenzene	110	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
2,4-Dimethylphenol	29	--	24.9 UJ	24 UJ	24.1 UJ	24.4 UJ	24.3 UJ	--	--
2-Methylphenol (o-Cresol)	63	--	**3 J**	4.8 U	4.8 U	4.9 U	4.9 U	--	--
4-Methylphenol (p-Cresol)	670	--	**5**	4.8 U	4.8 U	**2.9 J**	4.9 U	--	--
Benzoic acid	650	--	**84.7 J**	95.9 UJ	96.3 UJ	97.5 UJ	97 UJ	--	--
Benzyl alcohol	57	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
bis(2-Ethylhexyl)phthalate	1300	--	49.8 U	47.9 U	48.2 U	48.8 U	48.5 U	--	--
Butylbenzyl phthalate	63	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Diethyl phthalate	200	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Dimethyl phthalate	71	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
Di-n-butyl phthalate	1400	--	**37.3**	**22.5**	**22.4**	**40.6**	**14.9 J**	--	--
Di-n-octyl phthalate	6200	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Hexachlorobenzene	22	168	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
Hexachlorobutadiene	11	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
n-Nitrosodiphenylamine	28	--	5 U	4.8 U	4.8 U	4.9 U	4.9 U	--	--
Pentachlorophenol	400	504	19.9 UJ	19.2 UJ	19.3 UJ	19.5 UJ	19.4 UJ	--	--
Phenol	420	--	13.5 U	4.8 U	4.8 U	7.8 U	4.9 U	--	--
Polycyclic Aromatic Hydrocarbons (µg/kg)									
2-Methylnaphthalene	670	--	**24.7**	**8.6 J**	19.3 U	19.5 U	**6.4 J**	--	--
Acenaphthene	500	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Acenaphthylene	560	--	19.9 U	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Anthracene	960	--	**14.8 J**	19.2 U	19.3 U	**7.7 J**	19.4 U	--	--
Benzo(a)anthracene	1300	--	**24.1**	**16.6 J**	19.3 U	**17.5 J**	**5.2 J**	--	--
Benzo(a)pyrene	1600	--	**20.3**	**16.7 J**	19.3 U	**16.3 J**	19.4 U	--	--
Benzo(b,j,k)fluoranthenes	--	--	**57.7**	**35.3 J**	38.5 U	**38.8 J**	38.8 U	--	--
Benzo(g,h,i)perylene	670	--	**14.6 J**	**8 J**	19.3 U	**10.1 J**	19.4 U	--	--
Chrysene	1400	--	**37.5**	**21.2**	19.3 U	**24**	**6.7 J**	--	--
Dibenzo(a,h)anthracene	230	--	**4.4 J**	**3.7 J**	4.8 U	**2.7 J**	4.9 U	--	--
Dibenzofuran	540	--	**8.7 J**	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Fluoranthene	1700	4600	**47.4**	**22**	19.3 U	**32.1**	**7.7 J**	--	--
Fluorene	540	--	**8.3 J**	19.2 U	19.3 U	19.5 U	19.4 U	--	--
Indeno(1,2,3-c,d)pyrene	600	--	**13.4 J**	**7.4 J**	19.3 U	**8.3 J**	19.4 U	--	--
Naphthalene	2100	--	**21.5**	**8.7 J**	19.3 U	**11.7 J**	**5.3 J**	--	--
Phenanthrene	1500	--	**45.7**	**13.6 J**	19.3 U	**24.9**	**13 J**	--	--
Pyrene	2600	11980	**61.5**	**27.1**	19.3 U	**39.5**	**9.3 J**	--	--
Total Benzofluoranthenes (b,j,k) (U = 0)	3200	--	**57.7**	**35.3 J**	38.5 U	**38.8 J**	38.8 U	--	--
Total HPAH (DMMP) (U = 0)[1]	12000	--	**280.9 J**	**158 J**	38.5 U	**189.3 J**	**28.9 J**	--	--
Total LPAH (DMMP) (U = 0)[2]	5200	--	**90.3 J**	**22.3 J**	19.3 U	**44.3 J**	**18.3 J**	--	--
Total PAH (DMMP) (U = 0)	--	--	**371.2 J**	**180.3 J**	38.5 U	**233.6 J**	**47.2 J**	--	--
Pesticides (µg/kg)[3]									
4,4'-DDD (p,p'-DDD)	16	--	0.31 U	0.31 U	0.32 U	0.32 U	0.32 U	--	--
4,4'-DDE (p,p'-DDE)	9	--	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	--	--
4,4'-DDT (p,p'-DDT)	12	--	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	--	--
Aldrin	9.5	--	0.36 U	0.36 U	0.36 U	0.37 U	0.37 U	--	--
Chlordane, alpha- (Chlordane, cis-)	--	--	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	--	--
Chlordane, beta- (Chlordane, trans-)	--	--	2.04 U	0.97 U	0.32 U	0.33 U	0.32 U	--	--
Dieldrin	1.9	--	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	--	--
Heptachlor	1.5	--	0.05 U	0.04 U	0.05 U	0.05 U	0.05 U	--	--
Nonachlor, cis-	--	--	0.2 U	0.2 U	0.21 U	0.21 U	0.21 U	--	--
Nonachlor, trans-	--	--	0.22 U	0.22 U	0.22 U	0.23 U	0.23 U	--	--
Oxychlordane	--	--	0.12 U	0.12 U	0.13 U	0.13 U	0.13 U	--	--
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	--	50	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	--	--
Total DMMP Chlordane (U = 0)[5]	2.8	37	2.04 U	0.97 U	0.32 U	0.33 U	0.32 U	--	--
PCB Aroclors (µg/kg)									
Aroclor 1016	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1221	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1232	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1242	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1248	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1254	--	--	**3 J**	3.9 U	4 U	**2 J**	4 U	--	--
Aroclor 1260	--	--	**2.1 J**	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1262	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Aroclor 1268	--	--	3.9 U	3.9 U	4 U	4 U	4 U	--	--
Total DMMP PCB Aroclors (U = 0)	130	--	**5.1 J**	3.9 U	4 U	**2 J**	4 U	--	--
PCB Aroclors (mg/kg-OC)[6]									
Total DMMP PCB Aroclors (U = 0)	--	38	**0.72 J**	1.86 U	4.44 U	**0.54 J**	1.54 U	--	--

Notes:

(yellow)	Detected concentration is greater than DMMP SL screening level
(orange)	Detected concentration is greater than DMMP BT screening level
(blue)	Non-detected concentration is above one or more identified screening levels
(grey)	TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	C-3-A-190218 0 - 2.7 ft	C-3-B-190218 2.7 - 5.8 ft	C-4-A-190218 0 - 2 ft	C-4-B-190218 2 - 4 ft	C-5-A-190221 0 - 2 ft	C-5-B-190221 2 - 4 ft	C-6-A-190219 0 - 2 ft	C-6-B-190219 2 - 4 ft
Metals (mg/kg)								
Antimony	0.29 UJ	0.25 UJ	0.25 UJ	0.24 UJ	0.23 UJ	0.25 UJ	0.21 UJ	0.26 UJ
Arsenic	**3.7**	**1.77**	**1.12**	**1.01**	**1.59**	**1.63**	**1.14**	**1.41**
Cadmium	**0.06 J**	0.12 U	0.12 U	0.12 U	**0.04 J**	**0.05 J**	**0.12**	0.13 U
Chromium	**12.3**	**10.9**	**11.8**	**10.8**	**11.3**	**12.7**	**9.11**	**11.1**
Copper	**25.5**	**14.9**	**11.9**	**10.8**	**14.4**	**16.9**	**10.3**	**15.6**
Lead	**6.26**	**1.55**	**1.26**	**1.21**	**2.25**	**1.86**	**1.42**	**1.46**
Mercury	**0.0599 J**	0.0231 UJ	0.026 UJ	0.0254 UJ	0.0269 U	0.0227 U	0.0241 U	**0.00982 J**
Selenium	**0.93**	**0.81**	0.61 U	**0.77**	**0.79**	**0.76**	**0.77**	**0.74**
Silver	**0.12 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.06 J**	**0.06 J**	**0.04 J**	**0.06 J**
Zinc	**34.4**	**19.9**	**20**	**19.4**	**21.1**	**24**	**17.9**	**18.8**
Organometallic Compounds (µg/kg)								
Tributyltin (ion)	**2.16 J**	3.54 UJ	3.49 UJ	3.79 UJ	**0.768 J**	3.48 U	**1.05 J**	**0.477 J**
Semivolatile Organics (µg/kg)								
1,2,4-Trichlorobenzene	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
1,2-Dichlorobenzene	4.8 U	4.9 U	4.9 U	4.7 U	5 U	**0.9 J**	5 U	4.9 U
1,4-Dichlorobenzene	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
2,4-Dimethylphenol	24.1 UJ	24.6 UJ	24.3 UJ	23.6 UJ	24.9 U	24.4 U	24.8 UJ	24.6 UJ
2-Methylphenol (o-Cresol)	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
4-Methylphenol (p-Cresol)	**5.4**	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
Benzoic acid	**85.1 J**	**15.8 J**	**16.8 J**	94.3 UJ	**21.2 J**	**56.2 J**	99.1 UJ	**37.8 J**
Benzyl alcohol	**13.4 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
bis(2-Ethylhexyl)phthalate	**29.5 J**	49.2 U	48.6 U	47.1 U	49.8 U	48.9 U	49.5 U	49.2 U
Butylbenzyl phthalate	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Diethyl phthalate	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Dimethyl phthalate	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
Di-n-butyl phthalate	**118**	**69.7**	**96.1**	**108**	19.9 U	23.3 U	**43.4**	**56.1**
Di-n-octyl phthalate	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Hexachlorobenzene	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
Hexachlorobutadiene	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
n-Nitrosodiphenylamine	4.8 U	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
Pentachlorophenol	19.3 UJ	19.7 UJ	19.4 UJ	18.9 UJ	**5.4 J**	**5.5 J**	19.8 UJ	19.7 UJ
Phenol	**30**	6.1 U	5.6 U	4.7 U	6.4 U	8.1 U	5 U	6.4 U
Polycyclic Aromatic Hydrocarbons (µg/kg)								
2-Methylnaphthalene	**18.4 J**	**8 J**	19.4 U	18.9 U	19.9 U	**17.2 J**	19.8 U	**21.3**
Acenaphthene	**7 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Acenaphthylene	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Anthracene	**13.9 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Benzo(a)anthracene	**20.7**	19.7 U	19.4 U	18.9 U	**7.4 J**	**5.2 J**	19.8 U	19.7 U
Benzo(a)pyrene	**26.8**	19.7 U	19.4 U	18.9 U	**8.5 J**	19.5 U	19.8 U	19.7 U
Benzo(b,j,k)fluoranthenes	**75.9**	39.4 U	38.9 U	37.7 U	**26.9 J**	39.1 U	39.6 U	39.3 U
Benzo(g,h,i)perylene	**20.1**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Chrysene	**34.4**	**5.3 J**	19.4 U	18.9 U	**11.7 J**	**7.1 J**	19.8 U	**7.4 J**
Dibenzo(a,h)anthracene	**7.6**	4.9 U	4.9 U	4.7 U	5 U	4.9 U	5 U	4.9 U
Dibenzofuran	**12 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	**5.4 J**
Fluoranthene	**38.3**	19.7 U	19.4 U	18.9 U	**11.9 J**	19.5 U	19.8 U	19.7 U
Fluorene	**11 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Indeno(1,2,3-c,d)pyrene	**16.7 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.5 U	19.8 U	19.7 U
Naphthalene	**31**	19.7 U	19.4 U	18.9 U	19.9 U	**7.9 J**	19.8 U	**11.1 J**
Phenanthrene	**36.9**	**13 J**	**5.9 J**	18.9 U	**12.9 J**	**19.1 J**	19.8 U	**23.7**
Pyrene	**63.5**	19.7 U	19.4 U	18.9 U	**15.9 J**	19.5 U	**6.3 J**	19.7 U
Total Benzofluoranthenes (b,j,k) (U = 0)	**75.9**	39.4 U	38.9 U	37.7 U	**26.9 J**	39.1 U	39.6 U	39.3 U
Total HPAH (DMMP) (U = 0)[1]	**304 J**	**5.3 J**	38.9 U	37.7 U	**82.3 J**	**12.3 J**	**6.3 J**	**7.4 J**
Total LPAH (DMMP) (U = 0)[2]	**99.8 J**	**13 J**	**5.9 J**	18.9 U	**12.9 J**	**27 J**	19.8 U	**34.8 J**
Total PAH (DMMP) (U = 0)	**403.8 J**	**18.3 J**	**5.9 J**	37.7 U	**95.2 J**	**39.3 J**	**6.3 J**	**42.2 J**
Pesticides (µg/kg)[3]								
4,4'-DDD (p,p'-DDD)	1.59 U	0.32 U	1.58 UJ	1.54 U	0.32 U	0.32 U	0.32 U	0.32 U
4,4'-DDE (p,p'-DDE)	0.67 U	0.13 U	0.67 U	0.65 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	1.62 U	0.32 U	1.6 UJ	1.57 U	0.32 U	0.32 UJ	0.32 U	0.32 U
Aldrin	1.84 U	0.37 U	1.82 U	1.78 U	0.37 U	0.37 U	0.37 U	0.37 U
Chlordane, alpha- (Chlordane, cis-)	0.55 U	0.11 U	0.55 U	0.54 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	24.9 U	0.33 U	1.61 U	1.58 U	0.33 U	0.33 U	0.32 U	0.33 U
Dieldrin	0.57 U	0.11 U	0.57 U	0.55 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.23 U	0.05 U	0.23 U	0.22 U	0.05 U	0.05 U	0.05 U	0.05 U
Nonachlor, cis-	1.04 U	0.21 U	1.04 UJ	1.01 U	0.21 U	0.21 U	0.21 U	0.21 U
Nonachlor, trans-	1.13 U	0.23 U	1.13 UJ	1.1 U	0.23 U	0.23 U	0.23 U	0.23 U
Oxychlordane	0.64 U	0.13 U	0.63 UJ	0.62 U	0.13 U	0.13 U	0.13 U	0.13 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	1.62 U	0.32 U	1.6 UJ	1.57 U	0.32 U	0.32 UJ	0.32 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	24.9 U	0.33 U	1.61 UJ	1.58 U	0.33 U	0.33 U	0.32 U	0.33 U
PCB Aroclors (µg/kg)								
Aroclor 1016	4 U	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1221	4 U	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1232	4 U	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1242	4 U	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1248	4 U	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1254	4 U	4 U	4 U	3.9 U	3.8 U	4 U	**1.9 J**	4 U
Aroclor 1260	**3.8 J**	4 U	4 U	3.9 U	**0.8 J**	4 U	3.9 U	4 U
Aroclor 1262	4 UJ	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Aroclor 1268	4 UJ	4 U	4 U	3.9 U	3.8 U	4 U	3.9 U	4 U
Total DMMP PCB Aroclors (U = 0)	**3.8 J**	4 U	4 U	3.9 U	**0.8 J**	4 U	**1.9 J**	4 U
PCB Aroclors (mg/kg-OC)[6]								
Total DMMP PCB Aroclors (U = 0)	**0.78 J**	1.48 U	2.67 U	3.25 U	**0.29 J**	0.54 U	**0.86 J**	0.56 U

Notes:

- (yellow) Detected concentration is greater than DMMP SL screening level
- (orange) Detected concentration is greater than DMMP BT screening level
- (blue) Non-detected concentration is above one or more identified screening levels
- (grey) TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	C-7-A-190221 0 - 2 ft	C-7-B-190221 2 - 4 ft	C-7-C-190221 4 - 6 ft	C-8-A-190221 0 - 2 ft	C-8-B-190221 2 - 4 ft	C-9-A-190220 0 - 2 ft	C-9-B-190220 2 - 4 ft
Metals (mg/kg)							
Antimony	0.32 UJ	0.23 UJ	0.24 UJ	0.26 UJ	0.25 UJ	0.23 UJ	0.24 UJ
Arsenic	**4.52**	**1.76**	**1.39**	**4.3**	**2.66**	**2.08**	**2.58**
Cadmium	**0.08 J**	0.12 U	0.12 U	**0.07 J**	**0.07 J**	0.11 U	**0.09 J**
Chromium	**16.3**	**8.75**	**9.6**	**13.6**	**16.8**	**11.3**	**11.8**
Copper	**25.2**	**10.1**	**9.06**	**24.4**	**28.3**	**10.7**	**14.4**
Lead	**6.14**	**1.11**	**1.06**	**5.97**	**3.39**	**1.25**	**1.61**
Mercury	**0.0278 J**	0.0266 U	0.0214 U	**0.0351 J**	**0.0183 J**	0.0217 U	**0.00517 J**
Selenium	**1.05**	**0.66**	**0.56 J**	**0.89**	**0.94**	**0.76**	**0.84**
Silver	**0.11 J**	**0.04 J**	**0.03 J**	**0.11 J**	**0.09 J**	**0.04 J**	**0.06 J**
Zinc	**37.2**	**16.4**	**16.7**	**34.1**	**32.1**	**18**	**19.7**
Organometallic Compounds (µg/kg)							
Tributyltin (ion)	**2.55 J**	3.45 U	3.76 U	**3.45 J**	3.65 U	3.85 UJ	3.79 UJ
Semivolatile Organics (µg/kg)							
1,2,4-Trichlorobenzene	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
1,2-Dichlorobenzene	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
1,4-Dichlorobenzene	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
2,4-Dimethylphenol	24.8 U	24.3 U	24.7 U	24.4 U	24.9 U	24.8 UJ	23.8 UJ
2-Methylphenol (o-Cresol)	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
4-Methylphenol (p-Cresol)	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
Benzoic acid	**26.5 J**	97.1 U	98.8 U	**37.1 J**	99.5 U	99.1 UJ	95.3 UJ
Benzyl alcohol	19.9 U	19.4 U	19.8 U	19.5 U	19.9 U	**10.1 J**	**9.7 J**
bis(2-Ethylhexyl)phthalate	**29.9 J**	48.6 U	49.4 U	48.8 U	49.8 U	49.5 U	47.7 U
Butylbenzyl phthalate	19.9 U	19.4 U	19.8 U	19.5 U	19.9 U	19.8 U	19.1 U
Diethyl phthalate	19.9 U	19.4 U	25.5 U	67 U	27.7 U	19.8 U	19.1 U
Dimethyl phthalate	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
Di-n-butyl phthalate	48.3 U	19.4 U	30.6 U	19.5 U	19.9 U	**23.4**	**40.5**
Di-n-octyl phthalate	19.9 U	19.4 U	19.8 U	19.5 U	19.9 U	19.8 U	19.1 U
Hexachlorobenzene	5 U	**3 J**	4.9 U	4.9 U	5 U	5 U	4.8 U
Hexachlorobutadiene	5 U	**26.5**	4.9 U	4.9 U	5 U	5 U	4.8 U
n-Nitrosodiphenylamine	5 U	4.9 U	4.9 U	4.9 U	5 U	5 U	4.8 U
Pentachlorophenol	19.9 UJ	19.4 UJ	19.8 UJ	19.5 UJ	19.9 UJ	19.8 UJ	19.1 UJ
Phenol	6.2 U	5.4 U	4.9 U	4.9 U	5 U	5 U	5.3 U
Polycyclic Aromatic Hydrocarbons (µg/kg)							
2-Methylnaphthalene	19.9 U	**7.8 J**	**9.8 J**	**35.1**	**9.8 J**	19.8 U	19.1 U
Acenaphthene	19.9 U	19.4 U	19.8 U	**7.7 J**	19.9 U	19.8 U	19.1 U
Acenaphthylene	19.9 U	19.4 U	19.8 U	**6.4 J**	19.9 U	19.8 U	19.1 U
Anthracene	**13.2 J**	19.4 U	19.8 U	**20.1**	19.9 U	19.8 U	19.1 U
Benzo(a)anthracene	**29.8**	19.4 U	19.8 U	**38.4**	**5.4 J**	19.8 U	19.1 U
Benzo(a)pyrene	**37.8**	19.4 U	19.8 U	**41.8**	19.9 U	19.8 U	19.1 U
Benzo(b,j,k)fluoranthenes	**121**	38.8 U	39.5 U	**98.7**	39.8 U	39.6 U	38.1 U
Benzo(g,h,i)perylene	**29.3**	19.4 U	19.8 U	**27.1**	19.9 U	19.8 U	19.1 U
Chrysene	**50.8**	19.4 U	19.8 U	**71.7**	**17.6 J**	19.8 U	19.1 U
Dibenzo(a,h)anthracene	**8.8**	4.9 U	4.9 U	**11.8**	5 U	5 U	4.8 U
Dibenzofuran	19.9 U	19.4 U	19.8 U	**12.3 J**	19.9 U	19.8 U	19.1 U
Fluoranthene	**47.3**	19.4 U	19.8 U	**64.5**	19.9 U	19.8 U	19.1 U
Fluorene	**5.8 J**	19.4 U	19.8 U	**10.3 J**	19.9 U	19.8 U	19.1 U
Indeno(1,2,3-c,d)pyrene	**27.7**	19.4 U	19.8 U	**25.1**	19.9 U	19.8 U	19.1 U
Naphthalene	**17 J**	19.4 U	**8.5 J**	**26**	19.9 U	19.8 U	19.1 U
Phenanthrene	**33.8**	**14.7 J**	19.8 U	**59.9**	**22.6**	19.8 U	**14.7 J**
Pyrene	**65.8**	19.4 U	19.8 U	**81.6**	19.9 U	19.8 U	19.1 U
Total Benzofluoranthenes (b,j,k) (U = 0)	**121**	38.8 U	39.5 U	**98.7**	39.8 U	39.6 U	38.1 U
Total HPAH (DMMP) (U = 0)[1]	**418.3**	38.8 U	39.5 U	**460.7**	**23 J**	39.6 U	38.1 U
Total LPAH (DMMP) (U = 0)[2]	**69.8 J**	**14.7 J**	**8.5 J**	**130.4 J**	**22.6**	19.8 U	**14.7 J**
Total PAH (DMMP) (U = 0)	**488.1 J**	**14.7 J**	**8.5 J**	**591.1 J**	**45.6 J**	39.6 U	**14.7 J**
Pesticides (µg/kg)[3]							
4,4'-DDD (p,p'-DDD)	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.31 U
4,4'-DDE (p,p'-DDE)	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
Aldrin	0.37 U	0.36 U	0.37 U	0.37 U	0.37 U	0.37 U	0.36 U
Chlordane, alpha- (Chlordane, cis-)	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	0.32 U	0.32 U	0.32 U	0.33 U	0.33 U	0.33 U	0.32 U
Dieldrin	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Nonachlor, cis-	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Nonachlor, trans-	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.23 U	0.22 U
Oxychlordane	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	0.32 U	0.32 U	0.32 U	0.33 U	0.33 U	0.33 U	0.32 U
PCB Aroclors (µg/kg)							
Aroclor 1016	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Aroclor 1221	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Aroclor 1232	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Aroclor 1242	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Aroclor 1248	**3.4 J**	4 U	4 U	**3.8 J**	3.9 U	4 U	3.9 U
Aroclor 1254	**3.9 J**	4 U	4 U	**5**	3.9 U	4 U	3.9 U
Aroclor 1260	**2.1 J**	4 U	4 U	**3 J**	3.9 U	4 U	3.9 U
Aroclor 1262	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Aroclor 1268	4 U	4 U	4 U	4 U	3.9 U	4 U	3.9 U
Total DMMP PCB Aroclors (U = 0)	**9.4 J**	4 U	4 U	**11.8 J**	3.9 U	4 U	3.9 U
PCB Aroclors (mg/kg-OC)[6]							
Total DMMP PCB Aroclors (U = 0)	**1.71 J**	0.91 U	2 U	**2.19 J**	1 U	3.64 U	2.05 U

Notes:

Detected concentration is greater than DMMP SL screening level

Detected concentration is greater than DMMP BT screening level

Non-detected concentration is above one or more identified screening levels

TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	C-10-A-190221 0 - 2 ft	C-10-B-190221 2 - 4 ft	C-10-C-190221 4 - 6 ft	C-11-A-190220 0 - 2 ft	C-11-B-190220 2 - 4 ft	C-12-A-190223 0 - 2 ft	C-12-B-190223 2 - 4 ft	C-12-C-190223 4 - 6 ft
Metals (mg/kg)								
Antimony	0.28 UJ	0.25 UJ	0.2 UJ	0.28 UJ	0.25 UJ	0.27 UJ	0.25 UJ	0.25 UJ
Arsenic	**5.95**	**3.4**	**1.88**	**4.8**	**1.3**	**6.8**	**5.07**	**5.07**
Cadmium	**0.13 J**	**0.12 J**	**0.1**	**0.09 J**	0.12 U	**0.14**	**0.13**	**0.14**
Chromium	**15.6**	**11.3**	**8.23**	**14.3**	**10.7**	**16.3**	**16.2**	**16.7**
Copper	**31.8**	**19.1**	**11.8**	**27.3**	**11.1**	**29.2**	**23.8**	**24.7**
Lead	**8.1**	**4.2**	**1.46**	**6.34**	**1.33**	**14.8**	**6.32**	**5.11**
Mercury	**0.0428 J**	**0.0271 J**	**0.00691 J**	**0.0352**	0.0241 U	**0.0703**	**0.0607**	**0.0549**
Selenium	**1**	**0.74**	**0.61**	**1.04**	**0.61 J**	**0.79**	**1.03**	**0.73**
Silver	**0.16 J**	**0.09 J**	**0.04 J**	**0.13 J**	**0.04 J**	**0.14 J**	**0.09 J**	**0.09 J**
Zinc	**43.4**	**25.5**	**15.8**	**36.7**	**18.7**	**43.7**	**30.4**	**29.8**
Organometallic Compounds (µg/kg)								
Tributyltin (ion)	**5.67**	**95.5**	3.81 U	**2.8 J**	3.79 UJ	**13.4**	**0.525 J**	3.65 U
Semivolatile Organics (µg/kg)								
1,2,4-Trichlorobenzene	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	4.8 U	5 U	5 U
1,2-Dichlorobenzene	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	**6.1**	5 U	5 U
1,4-Dichlorobenzene	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	**3.7 J**	5 U	5 U
2,4-Dimethylphenol	**3.4 J**	23.8 U	24 U	**3.1 J**	23.5 UJ	**10.6 J**	**2.8 J**	24.9 U
2-Methylphenol (o-Cresol)	4.9 U	4.8 U	4.8 U	**2.2 J**	4.7 U	4.8 U	5 U	5 U
4-Methylphenol (p-Cresol)	**6.4**	**2.7 J**	4.8 U	**6.8**	4.7 U	**14.4**	**5.1**	**2.8 J**
Benzoic acid	**146**	**43.3 J**	96 U	**93.3 J**	94 UJ	**228 J**	**77 J**	**46.1 J**
Benzyl alcohol	19.7 U	19.1 U	19.2 U	**17.9 J**	18.8 U	19 U	19.8 U	19.9 U
bis(2-Ethylhexyl)phthalate	**56.7**	**32.8 J**	48 U	**30.2 J**	47 U	**106**	**32.9 J**	49.8 U
Butylbenzyl phthalate	19.7 U	19.1 U	19.2 U	19 U	18.8 U	19 U	19.8 U	19.9 U
Diethyl phthalate	19.7 U	19.1 U	24.5 U	**--**	18.8 U	19 U	38.2 U	19.9 U
Dimethyl phthalate	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	**3.1 J**	5 U	5 U
Di-n-butyl phthalate	41.4 U	20.6 U	30.4 U	**72.2**	**17.7 J**	19 U	**6 J**	19.9 U
Di-n-octyl phthalate	19.7 U	19.1 U	19.2 U	19 U	18.8 U	19 U	19.8 U	19.9 U
Hexachlorobenzene	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	4.8 U	5 U	5 U
Hexachlorobutadiene	4.9 U	4.8 U	4.8 U	4.7 U	4.7 U	4.8 U	5 U	5 U
n-Nitrosodiphenylamine	**3.4 J**	4.8 U	4.8 U	4.7 U	4.7 U	4.8 U	5 U	5 U
Pentachlorophenol	**9.3 J**	19.1 UJ	19.2 UJ	**4.1 J**	18.8 UJ	**11.2 J**	**10.1 J**	19.9 UJ
Phenol	15 U	9.7 U	4.8 U	**20.3**	4.7 U	53 U	23.1 U	17.5 U
Polycyclic Aromatic Hydrocarbons (µg/kg)								
2-Methylnaphthalene	**28.6**	**10.6 J**	19.2 U	**17.7 J**	18.8 U	**21.5**	19.8 U	19.9 U
Acenaphthene	**7.5 J**	19.1 U	19.2 U	19 U	18.8 U	**21.1**	**8.2 J**	19.9 U
Acenaphthylene	**11 J**	19.1 U	19.2 U	19 U	18.8 U	**10.9 J**	19.8 U	19.9 U
Anthracene	**28.7**	**16.1 J**	19.2 U	**18.6 J**	18.8 U	**26.6 J**	**14.4 J**	**8.5 J**
Benzo(a)anthracene	**56.2**	**33.6**	19.2 U	**42.5**	18.8 U	**25.1**	**13.1 J**	**8 J**
Benzo(a)pyrene	**67.2**	**45.7**	19.2 U	**46.1**	18.8 U	**40.3**	**18.8 J**	**9.7 J**
Benzo(b,j,k)fluoranthenes	**205**	**115**	38.4 U	**118**	37.6 U	**114**	**49.2**	**22.5 J**
Benzo(g,h,i)perylene	**48.5**	**30.3**	19.2 U	**33.1**	18.8 U	**30.8**	**17.2 J**	**9.7 J**
Chrysene	**82.7**	**53.7**	19.2 U	**61.4**	18.8 U	**51.1**	**23.4**	**11.8 J**
Dibenzo(a,h)anthracene	**18.8**	**12.4**	4.8 U	**9.2**	4.7 U	**11**	**6**	**2.7 J**
Dibenzofuran	**16.6 J**	**7.2 J**	19.2 U	**9 J**	18.8 U	**23.9**	**9.6 J**	19.9 U
Fluoranthene	**110**	**52**	19.2 U	**52.1**	18.8 U	**90.9**	**36**	**18.5 J**
Fluorene	**15.7 J**	**7.3 J**	19.2 U	**8 J**	18.8 U	**28**	**12.5 J**	19.9 U
Indeno(1,2,3-c,d)pyrene	**43.9**	**28.7**	19.2 U	**29.5**	18.8 U	**25.4**	**14.6 J**	**7.3 J**
Naphthalene	**27.7**	**15.9 J**	19.2 U	**20.1**	18.8 U	**60.2**	**27.9**	**16.9 J**
Phenanthrene	**53.3**	**43**	**7.7 J**	**39.2**	18.8 U	**78.3**	**38.5**	**24.2**
Pyrene	**174**	**79.1**	**6.6 J**	**76**	18.8 U	**215**	**71.1**	**40.1**
Total Benzofluoranthenes (b,j,k) (U = 0)	**205**	**115**	38.4 U	**118**	37.6 U	**114**	**49.2**	**22.5 J**
Total HPAH (DMMP) (U = 0)[1]	**806.3**	**450.5**	**6.6 J**	**467.9**	37.6 U	**603.6**	**249.4 J**	**130.3 J**
Total LPAH (DMMP) (U = 0)[2]	**143.9 J**	**82.3 J**	**7.7 J**	**85.9 J**	18.8 U	**225.1 J**	**101.5 J**	**49.6 J**
Total PAH (DMMP) (U = 0)	**950.2 J**	**532.8 J**	**14.3 J**	**553.8 J**	37.6 U	**828.7 J**	**350.9 J**	**179.9 J**
Pesticides (µg/kg)[3]								
4,4'-DDD (p,p'-DDD)	1.59 U	0.32 U	0.32 U	0.32 U	0.31 U	0.32 U	0.31 U	1.93 U
4,4'-DDE (p,p'-DDE)	0.67 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	1.61 U	0.32 U	0.32 U	0.32 U	0.31 U	3.96 U	3.39 U	2.42 U
Aldrin	1.83 U	0.37 U	0.36 U	0.37 U	0.35 U	0.37 U	0.36 U	0.36 U
Chlordane, alpha- (Chlordane, cis-)	0.55 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	1.62 U	0.32 U	0.32 U	14.9 U	0.31 U	0.32 U	0.32 U	0.32 U
Dieldrin	0.57 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.23 U	0.05 U	0.05 U	1.49 U	0.04 U	0.05 U	0.04 U	0.04 U
Nonachlor, cis-	1.04 U	0.21 U	0.21 U	0.21 U	0.2 U	0.21 U	0.2 U	0.2 U
Nonachlor, trans-	1.13 U	0.23 U	0.22 U	0.23 U	0.22 U	0.23 U	0.22 U	0.22 U
Oxychlordane	0.64 U	0.13 U	0.13 U	21.9 U	0.12 U	0.13 U	0.12 U	0.12 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	1.61 U	0.32 U	0.32 U	0.32 U	0.31 U	3.96 U	3.39 U	2.42 U
Total DMMP Chlordane (U = 0)[5]	1.62 U	0.32 U	0.32 U	21.9 U	0.31 U	0.32 U	0.32 U	0.32 U
PCB Aroclors (µg/kg)								
Aroclor 1016	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	3.9 U	3.8 U
Aroclor 1221	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	3.9 U	3.8 U
Aroclor 1232	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	3.9 U	3.8 U
Aroclor 1242	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	3.9 U	3.8 U
Aroclor 1248	**5.8**	**4.1**	3.9 U	4 U	3.8 U	**52.7**	**44.9**	**11**
Aroclor 1254	**9**	**5 J**	3.9 U	**3.4 J**	3.8 U	**94.3 J**	**33.5 J**	**7.8**
Aroclor 1260	**5.5 J**	**2.1 J**	3.9 U	**2.6 J**	3.8 U	**26.3 J**	**11.7 J**	**5.7 J**
Aroclor 1262	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 UJ	3.9 UJ	3.8 UJ
Aroclor 1268	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 UJ	3.9 UJ	3.8 UJ
Total DMMP PCB Aroclors (U = 0)	**20.3 J**	**11.2 J**	3.9 U	**6 J**	3.8 U	**173.3 J**	**90.1 J**	**24.5 J**
PCB Aroclors (mg/kg-OC)[6]								
Total DMMP PCB Aroclors (U = 0)	**2.01 J**	**2.49 J**	2.05 U	**0.70 J**	2.71 U	**28.41 J**	**24.35 J**	**3.27 J**

Notes:

(yellow)	Detected concentration is greater than DMMP SL screening level
(orange)	Detected concentration is greater than DMMP BT screening level
(blue)	Non-detected concentration is above one or more identified screening levels
(gray)	TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6
Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID Depth Analyte	C-13-A-190223 0 - 2 ft	C-13-B-190223 2 - 4 ft	C-13-C-190223 4 - 6 ft	C-14-A-190221 0 - 2 ft	C-14-B-190221 2 - 4 ft	C-15-A-190222 0 - 2 ft	C-15-B-190222 2 - 4 ft	C-15-C-190222 4 - 6 ft
Metals (mg/kg)								
Antimony	0.24 UJ	0.25 UJ	0.22 UJ	0.23 UJ	0.23 UJ	0.25 UJ	0.22 UJ	0.22 UJ
Arsenic	**6.08**	**6.67**	**3.88**	**4.18**	**5.08**	**6.4**	**2.74**	**4.28**
Cadmium	**0.11 J**	**0.11 J**	**0.05 J**	0.11 U	**0.06 J**	**0.05 J**	0.11 U	**0.04 J**
Chromium	**13**	**13.5**	**12**	**11.3**	**13**	**12.4**	**9.38**	**11.5**
Copper	**66.1**	**22.7**	**14.1**	**12.3**	**14.6**	**21.3**	**11.5**	**14.3**
Lead	**4.5**	**5.04**	**1.67**	**1.54**	**1.8**	**5.36**	**1.36**	**1.74**
Mercury	**0.0252**	**0.0381**	**0.011 J**	0.0216 U	0.0216 U	**0.027 J**	**0.0142 J**	**0.0148 J**
Selenium	**0.77**	**0.89**	**0.73**	**0.95**	**0.78**	**0.77**	**0.62**	**0.66**
Silver	**0.08 J**	**0.11 J**	**0.05 J**	**0.04 J**	**0.05 J**	**0.09 J**	**0.04 J**	**0.05 J**
Zinc	**43.1**	**34.2**	**22.2**	**21.7**	**22.2**	**30**	**18**	**22.5**
Organometallic Compounds (µg/kg)								
Tributyltin (ion)	**1.68 J**	**3.69**	3.81 U	3.74 U	3.82 U	**1.99 J**	3.77 U	3.84 U
Semivolatile Organics (µg/kg)								
1,2,4-Trichlorobenzene	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
1,2-Dichlorobenzene	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
1,4-Dichlorobenzene	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 UJ	5 UJ	5 UJ
2,4-Dimethylphenol	24.5 U	24.8 U	24.5 U	24.3 U	24.7 U	23.6 UJ	24.8 UJ	24.8 UJ
2-Methylphenol (o-Cresol)	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
4-Methylphenol (p-Cresol)	4.9 U	**3.1 J**	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Benzoic acid	**71.1 J**	**76.3 J**	**22.3 J**	97.1 U	98.6 U	**79.4 J**	99 U	99 UJ
Benzyl alcohol	19.6 U	**3.4 J**	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
bis(2-Ethylhexyl)phthalate	**30.4 J**	**41.7 J**	49 U	**54.7**	49.3 U	**61.8**	49.5 U	49.5 U
Butylbenzyl phthalate	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	**7.8 J**	19.8 U	19.8 U
Diethyl phthalate	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	31.9 U
Dimethyl phthalate	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Di-n-butyl phthalate	19.6 U	19.9 U	19.6 U	34.4 U	39.9 U	121 U	81.4 U	38.6 U
Di-n-octyl phthalate	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Hexachlorobenzene	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Hexachlorobutadiene	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
n-Nitrosodiphenylamine	4.9 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Pentachlorophenol	19.6 UJ	19.9 UJ	19.6 UJ	19.4 UJ	**7.7 J**	18.9 UJ	19.8 UJ	19.8 UJ
Phenol	23.7 U	31.6 U	8.2 U	4.9 U	4.9 U	13.7 U	5.9 U	7 U
Polycyclic Aromatic Hydrocarbons (µg/kg)								
2-Methylnaphthalene	**7.1 J**	**7 J**	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Acenaphthene	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Acenaphthylene	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Anthracene	**6.9 J**	**10.6 J**	19.6 UJ	19.4 U	19.7 U	**6.1 J**	19.8 UJ	19.8 UJ
Benzo(a)anthracene	**17.1 J**	**19.2 J**	19.6 U	19.4 U	19.7 U	**10.2 J**	19.8 U	19.8 U
Benzo(a)pyrene	**23.1**	**29.4**	19.6 U	19.4 U	19.7 U	**18.9**	19.8 U	19.8 U
Benzo(b,j,k)fluoranthenes	**62.9**	**85.1**	39.2 U	38.8 U	39.4 U	**54.5**	39.6 U	39.6 U
Benzo(g,h,i)perylene	**20.8**	**26.9**	19.6 U	19.4 U	19.7 U	**10.9 J**	19.8 U	19.8 U
Chrysene	**27.8**	**32.4**	19.6 U	19.4 U	19.7 U	**17 J**	19.8 U	19.8 U
Dibenzo(a,h)anthracene	**6.6**	**8.6**	4.9 U	4.9 U	4.9 U	**4.8**	5 U	5 U
Dibenzofuran	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Fluoranthene	**25.5**	**25.2**	19.6 U	19.4 U	19.7 U	**16.5 J**	19.8 U	19.8 U
Fluorene	19.6 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Indeno(1,2,3-c,d)pyrene	**15.9 J**	**21.9**	19.6 U	19.4 U	19.7 U	**10.6 J**	19.8 U	19.8 U
Naphthalene	**7.9 J**	**9 J**	19.6 U	19.4 U	19.7 U	**8.9 J**	19.8 UJ	19.8 UJ
Phenanthrene	**16.3 J**	**21.4**	**5.8 J**	19.4 U	19.7 U	**15.8 J**	**6.1 J**	19.8 U
Pyrene	**48.8**	**68.5**	19.6 U	19.4 U	19.7 U	**27.5**	19.8 U	19.8 U
Total Benzofluoranthenes (b,j,k) (U = 0)	**62.9**	**85.1**	39.2 U	38.8 U	39.4 U	**54.5**	39.6 U	39.6 U
Total HPAH (DMMP) (U = 0)[1]	**248.5 J**	**317.2 J**	39.2 U	38.8 U	39.4 U	**170.9 J**	39.6 U	39.6 U
Total LPAH (DMMP) (U = 0)[2]	**31.1 J**	**41 J**	**5.8 J**	19.4 U	19.7 U	**30.8 J**	**6.1 J**	19.8 UJ
Total PAH (DMMP) (U = 0)	**279.6 J**	**358.2 J**	**5.8 J**	38.8 U	39.4 U	**201.7 J**	**6.1 J**	39.6 UJ
Pesticides (µg/kg)[3]								
4,4'-DDD (p,p'-DDD)	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U	0.31 U	0.32 U	0.32 U
4,4'-DDE (p,p'-DDE)	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.31 U	0.32 U	0.32 U
Aldrin	0.37 U	0.36 U	0.36 U	0.37 U	0.37 U	0.35 U	0.37 U	0.37 U
Chlordane, alpha- (Chlordane, cis-)	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	0.32 U	1.94 U	0.32 U	0.32 U	0.33 U	0.31 U	0.32 U	0.32 U
Dieldrin	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.04 U	0.05 U	0.05 U
Nonachlor, cis-	0.21 U	0.2 U	0.21 U	0.21 U	0.21 U	0.2 U	0.21 U	0.21 U
Nonachlor, trans-	0.23 U	0.22 U	0.23 U	0.23 U	0.23 U	0.22 U	0.23 U	0.23 U
Oxychlordane	0.13 U	0.12 U	0.13 U	0.13 U	0.13 U	0.12 U	0.13 U	0.13 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.31 U	0.32 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	0.32 U	1.94 U	0.32 U	0.32 U	0.33 U	0.31 U	0.32 U	0.32 U
PCB Aroclors (µg/kg)								
Aroclor 1016	4 U	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Aroclor 1221	4 U	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Aroclor 1232	4 U	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Aroclor 1242	4 U	3.9 U	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Aroclor 1248	**6.5**	**8**	**3.7 J**	3.9 U	4 U	**8.2**	4 U	4 U
Aroclor 1254	**3.3 J**	**5.9**	3.9 U	3.9 U	4 U	**8.1 J**	4 U	4 U
Aroclor 1260	**1.9 J**	**9.2 J**	3.9 U	3.9 U	4 U	**3.1 J**	4 U	4 U
Aroclor 1262	4 UJ	3.9 UJ	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Aroclor 1268	4 UJ	3.9 UJ	3.9 U	3.9 U	4 U	3.8 U	4 U	4 U
Total DMMP PCB Aroclors (U = 0)	**11.7 J**	**23.1 J**	**3.7 J**	3.9 U	4 U	**19.4 J**	4 U	4 U
PCB Aroclors (mg/kg-OC)[6]								
Total DMMP PCB Aroclors (U = 0)	**1.98 J**	**5.92 J**	**2.06 J**	4.33 U	2.67 U	**7.76 J**	4 U	2.35 U

Notes:

Yellow	Detected concentration is greater than DMMP SL screening level
Orange	Detected concentration is greater than DMMP BT screening level
Blue	Non-detected concentration is above one or more identified screening levels
Grey	TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	C-16-A-190223 0 - 2 ft	C-16-B-190223 2 - 4 ft	C-17-A-190222 0 - 2 ft	C-17-B-190222 2 - 4 ft	C-17-C-190222 4 - 8 ft	C-18-A1-190220 0 - 2.3 ft	C-18-B1-190220 3.9 - 6.3 ft
Metals (mg/kg)							
Antimony	0.2 UJ	0.23 UJ	0.28 UJ	0.37 UJ	0.25 UJ	0.24 U	0.22 U
Arsenic	**3.82**	**2.21**	**3.74**	**3.44**	**2.15**	**3.2**	**3.89**
Cadmium	**0.07 J**	0.11 U	**0.05 J**	**0.21**	**0.04 J**	**0.05 J**	0.11 U
Chromium	**10.2**	**10.6**	**16.3**	**16.4**	**14.4**	**11.5**	**10.1**
Copper	**14.9**	**10.5**	**32.6**	**30.7**	**21.2**	**16.1**	**13**
Lead	**2.82**	**1.29**	**3.94**	**3.12**	**2.07**	**2.81**	**1.51**
Mercury	**0.0195 J**	**0.00813 J**	**0.0296**	**0.0373**	**0.0201 J**	0.0291 U	0.021 U
Selenium	**0.67**	**0.69**	**1.11**	**1.22**	**0.98**	**0.7**	**0.88**
Silver	**0.08 J**	**0.04 J**	**0.1 J**	**0.1 J**	**0.07 J**	**0.05 J**	**0.04 J**
Zinc	**22.5**	**19.7**	**30.4**	**25.3**	**23.9**	**25.6**	**29.6**
Organometallic Compounds (µg/kg)							
Tributyltin (ion)	**15.8**	**0.895 J**	3.61 U	3.84 U	3.69 U	**2.31 J**	3.64 UJ
Semivolatile Organics (µg/kg)							
1,2,4-Trichlorobenzene	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
1,2-Dichlorobenzene	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
1,4-Dichlorobenzene	4.8 U	4.9 U	5 UJ	4.9 UJ	4.8 UJ	4.8 U	4.7 U
2,4-Dimethylphenol	23.9 U	24.6 U	24.8 UJ	**2.6 J**	23.9 UJ	24.2 U	23.6 U
2-Methylphenol (o-Cresol)	4.8 U	4.9 U	**2.7 J**	**3.1 J**	4.8 U	4.8 U	4.7 U
4-Methylphenol (p-Cresol)	4.8 U	4.9 U	**4.7 J**	**7.6**	**2 J**	**3.1 J**	4.7 U
Benzoic acid	**68.4 J**	98.6 UJ	**310**	**164**	**32.9 J**	**214 J**	**60.2 J**
Benzyl alcohol	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
bis(2-Ethylhexyl)phthalate	47.8 U	49.3 U	49.7 U	48.7 U	**29.6 J**	48.4 U	47.2 U
Butylbenzyl phthalate	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Diethyl phthalate	23.2 U	19.7 U	19.9 U	19.5 U	24.6 U	**7.2 J**	**9.2 J**
Dimethyl phthalate	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
Di-n-butyl phthalate	19.1 U	19.7 U	97.9 U	99.9 U	91.1 U	19.4 U	18.9 U
Di-n-octyl phthalate	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Hexachlorobenzene	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
Hexachlorobutadiene	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
n-Nitrosodiphenylamine	4.8 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.7 U
Pentachlorophenol	19.1 UJ	19.7 UJ	**4.5 J**	19.5 UJ	19.2 UJ	19.4 UJ	18.9 UJ
Phenol	18.3 U	8.1 U	**41**	**34.7**	7.3 U	**38.7**	13.4 U
Polycyclic Aromatic Hydrocarbons (µg/kg)							
2-Methylnaphthalene	19.1 U	19.7 U	**11.7 J**	**7.1 J**	**6.2 J**	19.4 U	**7.5 J**
Acenaphthene	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Acenaphthylene	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Anthracene	**8.8 J**	19.7 UJ	19.9 UJ	19.5 UJ	19.2 UJ	**5.9 J**	18.9 U
Benzo(a)anthracene	**11.9 J**	19.7 U	**6.5 J**	19.5 U	19.2 U	**9 J**	18.9 U
Benzo(a)pyrene	**10.8 J**	19.7 U	19.9 U	19.5 U	19.2 U	**16.4 J**	18.9 U
Benzo(b,j,k)fluoranthenes	38.2 U	39.4 U	**22.7 J**	39 U	38.3 U	**42.2**	37.8 U
Benzo(g,h,i)perylene	**7.7 J**	19.7 U	19.9 U	19.5 U	19.2 U	**9.7 J**	18.9 U
Chrysene	**28.8**	19.7 U	**14.7 J**	**8.8 J**	**5.9 J**	**18.2 J**	18.9 U
Dibenzo(a,h)anthracene	**2.7 J**	4.9 U	**2.6 J**	4.9 U	4.8 U	**3.8 J**	4.7 U
Dibenzofuran	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Fluoranthene	**12.3 J**	19.7 U	**8 J**	19.5 U	**4.9 J**	**13.9 J**	18.9 U
Fluorene	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	19.4 U	18.9 U
Indeno(1,2,3-c,d)pyrene	19.1 U	19.7 U	19.9 U	19.5 U	19.2 U	**8.2 J**	18.9 U
Naphthalene	19.1 U	19.7 U	**6.3 J**	**6.8 J**	**8.1 J**	**7.9 J**	**5.4 J**
Phenanthrene	**15.8 J**	19.7 U	**25.2**	**13.7 J**	**14.6 J**	**11.9 J**	**6.3 J**
Pyrene	**23.5**	19.7 U	**21.3**	19.5 U	**6.2 J**	**48.3**	18.9 U
Total Benzofluoranthenes (b,j,k) (U = 0)	38.2 U	39.4 U	**22.7 J**	39 U	38.3 U	**42.2**	37.8 U
Total HPAH (DMMP) (U = 0)[1]	**97.7 J**	39.4 U	**75.8 J**	**8.8 J**	**17 J**	**169.7 J**	37.8 U
Total LPAH (DMMP) (U = 0)[2]	**24.6 J**	19.7 UJ	**31.5 J**	**20.5 J**	**22.7 J**	**25.7 J**	**11.7 J**
Total PAH (DMMP) (U = 0)	**122.3 J**	39.4 UJ	**107.3 J**	**29.3 J**	**39.7 J**	**195.4 J**	**11.7 J**
Pesticides (µg/kg)[3]							
4,4'-DDD (p,p'-DDD)	0.31 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
4,4'-DDE (p,p'-DDE)	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
Aldrin	0.36 U	0.37 U	0.37 U	0.37 U	0.36 U	0.36 U	0.37 U
Chlordane, alpha- (Chlordane, cis-)	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	0.32 U	0.33 U	0.33 U	0.33 U	0.32 U	0.99 U	0.32 U
Dieldrin	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Nonachlor, cis-	0.2 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U	0.21 U
Nonachlor, trans-	0.22 U	0.23 U	0.23 U	0.23 U	0.22 U	0.22 U	0.23 U
Oxychlordane	0.12 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	0.32 U	0.33 U	0.33 U	0.33 U	0.32 U	0.99 U	0.32 U
PCB Aroclors (µg/kg)							
Aroclor 1016	4 U	4 U	4 U	4 U	4 U	3.9 U	4 U
Aroclor 1221	4 U	4 U	4 U	4 U	4 U	3.9 U	4 U
Aroclor 1232	4 U	4 U	4 U	4 U	4 U	3.9 U	4 U
Aroclor 1242	4 U	4 U	4 U	4 U	4 U	3.9 U	4 U
Aroclor 1248	**2 J**	4 U	**2.5 J**	4 U	4 U	3.9 U	4 U
Aroclor 1254	**2.2 J**	4 U	**2.4 J**	4 U	4 U	3.9 U	4 U
Aroclor 1260	**1.1 J**	4 U	**1.1 J**	4 U	4 U	3.9 UJ	4 U
Aroclor 1262	4 U	4 U	4 U	4 U	4 U	3.9 UJ	4 U
Aroclor 1268	4 U	4 U	4 U	4 U	4 U	3.9 UJ	4 U
Total DMMP PCB Aroclors (U = 0)	**5.3 J**	4 U	**6 J**	4 U	4 U	3.9 UJ	4 U
PCB Aroclors (mg/kg-OC)[6]							
Total DMMP PCB Aroclors (U = 0)	**2.12 J**	8 U	**0.72 J**	0.12 U	1.03 U	1.34 UJ	3.08 U

Notes:

Yellow	Detected concentration is greater than DMMP SL screening level
Orange	Detected concentration is greater than DMMP BT screening level
Blue	Non-detected concentration is above one or more identified screening levels
Grey	TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID / Depth / Analyte	C-19-A-190220 0 - 2 ft	C-19-B-190220 2 - 4 ft	C-20-A-190219 0 - 2 ft	C-20-B-190219 2 - 4 ft	C-21-A-190219 0 - 2 ft	C-21-B-190219 2 - 4 ft	C-22-A-190219 0 - 2 ft	C-22-B-190219 2 - 4 ft
Metals (mg/kg)								
Antimony	0.19 UJ	0.23 UJ	0.23 UJ	0.21 UJ	0.23 UJ	0.21 UJ	0.2 UJ	0.2 UJ
Arsenic	**1.89**	**2.53**	**1.28**	**1.1**	**4.41**	**2.26**	**1.59**	**1.31**
Cadmium	0.1 U	0.12 U	**0.05 J**	**0.03 J**	0.11 U	**0.05 J**	0.1 U	0.1 U
Chromium	**9.73**	**10.3**	**9.69**	**10.4**	**7.99**	**8.59**	**11.3**	**9.53**
Copper	**12.7**	**15.2**	**13.9**	**14**	**14.9**	**14.9**	**12.7**	**10.9**
Lead	**1.54**	**1.84**	**1.41**	**1.5**	**1.43**	**1.49**	**1.36**	**1.41**
Mercury	0.0187 U	0.0204 U	**0.00698 J**	**0.00973 J**	**0.0112 J**	**0.0134 J**	**0.00859 J**	**0.00788 J**
Selenium	**0.62**	**0.77**	**0.51 J**	**0.82**	**0.82**	**0.82**	**0.72**	**0.84**
Silver	**0.04 J**	**0.05 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.03 J**	**0.03 J**	**0.03 J**
Zinc	**20.9**	**21.3**	**18.7**	**20.1**	**18**	**20.1**	**19.2**	**17.6**
Organometallic Compounds (µg/kg)								
Tributyltin (ion)	**0.417 J**	**1.07 J**	3.79 U	3.76 U	3.63 U	3.76 U	3.53 U	3.57 U
Semivolatile Organics (µg/kg)								
1,2,4-Trichlorobenzene	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
1,2-Dichlorobenzene	4.9 U	4.9 U	5 U	**0.8 J**	4.8 U	4.8 U	4.9 U	4.9 U
1,4-Dichlorobenzene	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
2,4-Dimethylphenol	24.4 UJ	24.6 UJ	24.8 UJ	24.3 UJ	23.9 UJ	24.2 UJ	24.7 UJ	24.7 UJ
2-Methylphenol (o-Cresol)	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
4-Methylphenol (p-Cresol)	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Benzoic acid	97.7 UJ	**19.6 J**	99.1 UJ	97.1 UJ	95.7 UJ	96.7 UJ	98.7 UJ	98.6 UJ
Benzyl alcohol	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
bis(2-Ethylhexyl)phthalate	48.9 U	49.2 U	49.5 U	48.6 U	47.9 U	48.3 U	49.4 U	49.3 U
Butylbenzyl phthalate	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Diethyl phthalate	19.5 U	19.7 U	35.8 U	28.9 U	19.1 U	19.3 U	19.7 U	21.9 U
Dimethyl phthalate	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Di-n-butyl phthalate	**161**	**133**	**36.8**	**22.6**	**17.2 J**	**39.8**	**18.8 J**	19.7 U
Di-n-octyl phthalate	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Hexachlorobenzene	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Hexachlorobutadiene	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
n-Nitrosodiphenylamine	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Pentachlorophenol	19.5 UJ	19.7 UJ	19.8 UJ	19.4 UJ	19.1 UJ	19.3 UJ	19.7 UJ	19.7 UJ
Phenol	4.9 U	5.3 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Polycyclic Aromatic Hydrocarbons (µg/kg)								
2-Methylnaphthalene	19.5 U	19.7 U	19.8 U	19.4 U	**7.3 J**	19.3 U	19.7 U	19.7 U
Acenaphthene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Acenaphthylene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Anthracene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Benzo(a)anthracene	19.5 U	19.7 U	19.8 U	19.4 U	**7 J**	19.3 U	19.7 U	19.7 U
Benzo(a)pyrene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Benzo(b,j,k)fluoranthenes	39.1 U	39.3 U	39.6 U	38.9 U	38.3 U	38.7 U	39.5 U	39.5 U
Benzo(g,h,i)perylene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Chrysene	19.5 U	19.7 U	19.8 U	19.4 U	**14.3 J**	19.3 U	19.7 U	19.7 U
Dibenzo(a,h)anthracene	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Dibenzofuran	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Fluoranthene	19.5 U	19.7 U	19.8 U	19.4 U	**5.8 J**	19.3 U	19.7 U	19.7 U
Fluorene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Indeno(1,2,3-c,d)pyrene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Naphthalene	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Phenanthrene	19.5 U	19.7 U	19.8 U	19.4 U	**38.1**	19.3 U	19.7 U	19.7 U
Pyrene	19.5 U	**5.5 J**	**5.9 J**	19.4 U	**8.1 J**	19.3 U	19.7 U	19.7 U
Total Benzofluoranthenes (b,j,k) (U = 0)	39.1 U	39.3 U	39.6 U	38.9 U	38.3 U	38.7 U	39.5 U	39.5 U
Total HPAH (DMMP) (U = 0)[1]	39.1 U	**5.5 J**	**5.9 J**	38.9 U	**35.2 J**	38.7 U	39.5 U	39.5 U
Total LPAH (DMMP) (U = 0)[2]	19.5 U	19.7 U	19.8 U	19.4 U	**38.1**	19.3 U	19.7 U	19.7 U
Total PAH (DMMP) (U = 0)	39.1 U	**5.5 J**	**5.9 J**	38.9 U	**73.3 J**	38.7 U	39.5 U	39.5 U
Pesticides (µg/kg)[3]								
4,4'-DDD (p,p'-DDD)	0.31 U	0.31 U	0.3 U	0.31 U	0.31 U	0.31 U	0.31 U	0.32 U
4,4'-DDE (p,p'-DDE)	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	0.31 U	0.32 U	0.31 U	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U
Aldrin	0.36 U	0.36 U	0.35 U	0.36 U	0.35 U	0.36 U	0.36 U	0.36 U
Chlordane, alpha- (Chlordane, cis-)	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	0.32 U	0.32 U	0.31 U	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U
Dieldrin	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.04 U	0.05 U	0.04 U	0.05 U	0.04 U	0.05 U	0.05 U	0.05 U
Nonachlor, cis-	0.2 U	0.21 U	0.2 U	0.21 U	0.2 U	0.2 U	0.21 U	0.21 U
Nonachlor, trans-	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U
Oxychlordane	0.12 U	0.12 U	0.12 U	0.13 U	0.12 U	0.12 U	0.13 U	0.13 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	0.31 U	0.32 U	0.31 U	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	0.32 U	0.32 U	0.31 U	0.32 U	0.31 U	0.32 U	0.32 U	0.32 U
PCB Aroclors (µg/kg)								
Aroclor 1016	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1221	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1232	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1242	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1248	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1254	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1260	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1262	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Aroclor 1268	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
Total DMMP PCB Aroclors (U = 0)	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U
PCB Aroclors (mg/kg-OC)[6]								
Total DMMP PCB Aroclors (U = 0)	4.22 U	3.9 U	4.75 U	9.75 U	0.78 U	3.55 U	5.57 U	10 U

Notes:

Detected concentration is greater than DMMP SL screening level

Detected concentration is greater than DMMP BT screening level

Non-detected concentration is above one or more identified screening levels

TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 6

Sample Results Summary - Metals, TBT, Semivolatiles, Pesticides, and PCBs

Sample ID Depth Analyte	C-23-A1-190222 0 - 2 ft	C-23-B1-190222 2 - 4 ft	C-24-A-190223 0 - 2 ft	C-24-B-190223 2 - 4 ft	C-25-A-190222 0 - 2 ft	C-25-B-190222 2 - 4 ft
Metals (mg/kg)						
Antimony	0.21 UJ	0.21 UJ	0.22 UJ	0.21 UJ	0.24 UJ	0.24 UJ
Arsenic	**2.41**	**2**	**1.99**	**1.16**	**2.79**	**2.59**
Cadmium	**0.04 J**	**0.04 J**	0.11 U	0.1 U	**0.05 J**	0.12 U
Chromium	**10.1**	**9.02**	**11.3**	**9.86**	**15.5**	**13.2**
Copper	**15.1**	**12.8**	**13.4**	**11.2**	**27.7**	**19.4**
Lead	**1.84**	**1.45**	**1.64**	**1.6**	**2.42**	**1.79**
Mercury	0.0232 U	**0.0101 J**	**0.0112 J**	**0.00818 J**	**0.0219 J**	**0.0191 J**
Selenium	**0.66**	**0.84**	**0.62**	**0.64**	**0.85**	**0.73**
Silver	**0.04 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.07 J**	**0.05 J**
Zinc	**23.8**	**21.2**	**23**	**22.4**	**73.9**	**20.1**
Organometallic Compounds (µg/kg)						
Tributyltin (ion)	3.51 U	3.46 U	3.78 U	3.53 U	3.6 U	3.77 U
Semivolatile Organics (µg/kg)						
1,2,4-Trichlorobenzene	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
1,2-Dichlorobenzene	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
1,4-Dichlorobenzene	5 UJ	4.9 UJ	4.9 U	4.9 U	4.9 UJ	4.8 UJ
2,4-Dimethylphenol	24.9 UJ	24.6 UJ	24.5 U	24.7 U	24.7 UJ	24.2 UJ
2-Methylphenol (o-Cresol)	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
4-Methylphenol (p-Cresol)	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Benzoic acid	**15.4 J**	98.6 U	**43.9 J**	**25.5 J**	**33.6 J**	**84.3 J**
Benzyl alcohol	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
bis(2-Ethylhexyl)phthalate	49.9 U	49.3 U	49.1 U	49.4 U	**30.4 J**	**31.4 J**
Butylbenzyl phthalate	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Diethyl phthalate	30.9 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Dimethyl phthalate	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Di-n-butyl phthalate	87.1 U	142 U	19.6 U	19.8 U	140 U	171 U
Di-n-octyl phthalate	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Hexachlorobenzene	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Hexachlorobutadiene	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
n-Nitrosodiphenylamine	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Pentachlorophenol	20 UJ	19.7 UJ	19.6 UJ	19.8 UJ	19.8 UJ	19.3 UJ
Phenol	6.8 U	6.5 U	10 U	7.9 U	14.8 U	19.5 U
Polycyclic Aromatic Hydrocarbons (µg/kg)						
2-Methylnaphthalene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	**17.9 J**
Acenaphthene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Acenaphthylene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Anthracene	20 UJ	19.7 UJ	19.6 UJ	19.8 UJ	19.8 UJ	19.3 UJ
Benzo(a)anthracene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Benzo(a)pyrene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Benzo(b,j,k)fluoranthenes	39.9 U	39.4 U	39.3 U	39.6 U	39.5 U	38.7 U
Benzo(g,h,i)perylene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Chrysene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Dibenzo(a,h)anthracene	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Dibenzofuran	20 U	19.7 U	19.6 U	19.8 U	19.8 U	**5.9 J**
Fluoranthene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Fluorene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Indeno(1,2,3-c,d)pyrene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Naphthalene	20 UJ	19.7 UJ	19.6 U	19.8 U	19.8 UJ	**5.8 J**
Phenanthrene	20 U	19.7 U	19.6 U	19.8 U	**6.7 J**	**15 J**
Pyrene	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Total Benzofluoranthenes (b,j,k) (U = 0)	39.9 U	39.4 U	39.3 U	39.6 U	39.5 U	38.7 U
Total HPAH (DMMP) (U = 0)[1]	39.9 U	39.4 U	39.3 U	39.6 U	39.5 U	38.7 U
Total LPAH (DMMP) (U = 0)[2]	20 UJ	19.7 UJ	19.6 UJ	19.8 UJ	**6.7 J**	**20.8 J**
Total PAH (DMMP) (U = 0)	39.9 UJ	39.4 UJ	39.3 UJ	39.6 UJ	**6.7 J**	**20.8 J**
Pesticides (µg/kg)[3]						
4,4'-DDD (p,p'-DDD)	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U	0.31 U
4,4'-DDE (p,p'-DDE)	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
4,4'-DDT (p,p'-DDT)	0.32 U	0.31 U	0.32 U	0.32 U	0.31 U	0.32 U
Aldrin	0.36 U	0.36 U	0.36 U	0.36 U	0.35 U	0.36 U
Chlordane, alpha- (Chlordane, cis-)	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Chlordane, beta- (Chlordane, trans-)	0.32 U	0.31 U	0.32 U	0.32 U	0.31 U	0.32 U
Dieldrin	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U	0.11 U
Heptachlor	0.05 U	0.04 U	0.05 U	0.05 U	0.04 U	0.05 U
Nonachlor, cis-	0.2 U	0.2 U	0.21 U	0.21 U	0.2 U	0.2 U
Nonachlor, trans-	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U	0.22 U
Oxychlordane	0.12 U	0.12 U	0.13 U	0.13 U	0.12 U	0.12 U
Sum 4,4 DDT, DDE, DDD (U = 0)[4]	0.32 U	0.31 U	0.32 U	0.32 U	0.31 U	0.32 U
Total DMMP Chlordane (U = 0)[5]	0.32 U	0.31 U	0.32 U	0.32 U	0.31 U	0.32 U
PCB Aroclors (µg/kg)						
Aroclor 1016	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1221	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1232	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1242	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1248	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1254	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1260	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1262	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Aroclor 1268	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
Total DMMP PCB Aroclors (U = 0)	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U
PCB Aroclors (mg/kg-OC)[6]						
Total DMMP PCB Aroclors (U = 0)	5.57 U	9.75 U	6.5 U	10 U	1.31 U	0.89 U

Notes:

Detected concentration is greater than DMMP SL screening level

Detected concentration is greater than DMMP BT screening level

Non-detected concentration is above one or more identified screening levels

TOC is <0.5% (see footnote 6)

Bold: Detected result

1. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
2. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
3. Pesticides are reported to the method detection limit.
4. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.
5. Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.
6. The normal range for OC-normalization is 0.5% to 3.5%. Several TOC values are <0.5%, and the dry weight result should be used for screening.

µg/kg: microgram per kilogram
BT: Bioaccumulation Trigger
DMMP: Dredged Material Management Program
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
J: Estimated value
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
mg/kg: milligram per kilogram
mg/kg-OC: milligram per kilogram total organic carbon normalized
ML: Maximum Level
PCB: polychlorinated biphenyl
pct: percent
SL: Screening Level
TOC: total organic carbon
U: Compound analyzed, but not detected above detection limit

Table 7

Summary of Dioxin/Furan Results

Analyte	C-1-A-190219	C-1-B-190219	C-1-C-190219	C-2-A-190219	C-2-B-190219	C-3-A-190218	C-3-B-190218	C-4-A-190218	C-4-B-190218	C-5-A-190221	C-5-B-190221
Depth	0 - 2 ft	2 - 4 ft	4 - 6 ft	0 - 2 ft	2 - 4 ft	0 - 2.7 ft	2.7 - 5.8 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Dioxin Furans (ng/kg)											
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**1.87 J**	**0.51 J**	**0.08 J**	**1.23 J**	**0.26 J**	**2.53 J**	**0.08 J**	0.05 UJ	0.05 UJ	**0.59 J**	**0.67 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**1.78 J**	**0.32 J**	**0.03 J**	**0.96 J**	**0.19 J**	**2.42 J**	**0.02 J**	0.05 UJ	0.05 UJ	**0.36 J**	**0.01 J**

Analyte	C-6-A-190219	C-6-B-190219	C-7-A-190221	C-7-B-190221	C-7-C-190221	C-8-A-190221	C-8-B-190221	C-9-A-190220	C-9-B-190220	C-10-A-190221	C-10-B-190221
Depth	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	4 - 6 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Dioxin Furans (ng/kg)											
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**0.74 J**	**0.05 J**	**4.38 J**	**0.53 J**	**0.68 J**	**5.00 J**	**0.60 J**	**0.06 J**	**0.06 J**	**8.79 J**	**7.42 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**0.57 J**	**5.60E-04 J**	**4.21 J**	**0.02 J**	**2.97E-05 J**	**4.88 J**	**0.07 J**	**0.01 J**	**2.88E-03 J**	**8.40 J**	**7.29 J**

Analyte	C-10-C-190221	C-11-A-190220	C-11-B-190220	C-12-A-190223	C-12-B-190223	C-12-C-190223	C-12-D-190223	C-12-E-190223	C-13-A-190223	C-13-B-190223	C-13-C-190223
Depth	4 - 6 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	4 - 6 ft	6 - 8 ft	8 - 10 ft	0 - 2 ft	2 - 4 ft	4 - 6 ft
Dioxin Furans (ng/kg)											
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**0.61 J**	**5.92 J**	**0.18 J**	**56.21 J**	**54.47 J**	**17.74 J**	**0.63 J**	**0.07 J**	**5.34 J**	**7.73 J**	**11.88 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**0.42 J**	**5.76 J**	**0.09 J**	**56.21 J**	**54.01 J**	**17.55 J**	**0.51 J**	**2.76E-03 J**	**5.06 J**	**7.55 J**	**11.73 J**

Notes:

Detected concentration is greater than DMMP SL screening level (4 ng/kg TEQ)

Detected concentration is greater than DMMP BT screening level (10 ng/kg TEQ)

Bold: Detected result

*: EMPC value reported by laboratory; treated as non-detect (U) in the TEQ calculation

BT: Bioaccumulation Trigger

D/F: dioxins/furans

DMMP: Dredged Material Management Program

J: Estimated value

ML: Maximum Level

ng/kg: nanogram per kilogram

SL: Screening Level

TEF: toxic equivalence factor

TEQ: toxic equivalent

U: Compound analyzed, but not detected above detection limit

Table 7
Summary of Dioxin/Furan Results

Sample ID / Depth / Analyte	C-13-D-190223 6 - 8 ft	C-13-E-190223 8 - 10 ft	C-14-A-190221 0 - 2 ft	C-14-B-190221 2 - 4 ft	C-15-A-190222 0 - 2 ft	C-15-B-190222 2 - 4 ft	C-15-C-190222 4 - 6 ft	C-16-A-190223 0 - 2 ft	C-16-B-190223 2 - 4 ft	C-17-A-190222 0 - 2 ft	C-17-B-190222 2 - 4 ft
Dioxin Furans (ng/kg)											
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**7.64 J**	**0.07 J**	**0.68 J**	**0.56 J**	**10.56 J**	**0.15 J**	**0.07 J**	**2.75 J**	**0.18 J**	**1.86 J**	**0.19 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**7.29 J**	**0.01 J**	**6.68E-03 J**	**0.07 J**	**9.37 J**	**0.08 J**	**0.01 J**	**2.66 J**	**0.11 J**	**1.81 J**	**0.11 J**

Sample ID / Depth / Analyte	C-17-C-190222 4 - 8 ft	C-18-A1-190220 0 - 2.3 ft	C-18-B1-190220 3.9 - 6.3 ft	C-19-A-190220 0 - 2 ft	C-19-B-190220 2 - 4 ft	C-20-A-190219 0 - 2 ft	C-20-B-190219 2 - 4 ft	C-21-A-190219 0 - 2 ft	C-21-B-190219 2 - 4 ft	C-22-A-190219 0 - 2 ft	C-22-B-190219 2 - 4 ft
Dioxin Furans (ng/kg)											
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**0.10 J**	**2.99 J**	**0.08 J**	**0.27 J**	**0.39 J**	**0.50 J**	**0.04 J**	**0.08 J**	**0.06 J**	**0.15 J**	**0.13 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**0.02 J**	**2.93 J**	**0.03 J**	**0.14 J**	**0.27 J**	**0.42 J**	**4.80E-04 J**	**0.02 J**	**0.02 J**	**0.09 J**	**0.06 J**

Sample ID / Depth / Analyte	C-23-A1-190222 0 - 2 ft	C-23-B1-190222 2 - 4 ft	C-24-A-190223 0 - 2 ft	C-24-B-190223 2 - 4 ft	C-25-A-190222 0 - 2 ft	C-25-B-190222 2 - 4 ft
Dioxin Furans (ng/kg)						
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2)	**0.35 J**	**0.08 J**	**0.63 J**	**0.05 J**	**0.07 J**	**0.07 J**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	**0.27 J**	**0.01 J**	**0.48 J**	**5.5E-03 J**	**0.02 J**	**0.01 J**

Notes:

Detected concentration is greater than DMMP SL screening level (4 ng/kg TEQ)

Detected concentration is greater than DMMP BT screening level (10 ng/kg TEQ)

Bold: Detected result

*: EMPC value reported by laboratory; treated as non-detect (U) in the TEQ calculation

BT: Bioaccumulation Trigger

D/F: dioxins/furans

DMMP: Dredged Material Management Program

J: Estimated value

ML: Maximum Level

ng/kg: nanogram per kilogram

SL: Screening Level

TEF: toxic equivalence factor

TEQ: toxic equivalent

U: Compound analyzed, but not detected above detection limit

Table 8
Suitability Probabilities for Open-Water Disposal of Non-Native Material

Area	Station	sediment category	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Analyses[1]	Detected SL/BT Exceedance	Dioxins/furans above 4/10 pptr TEQ	Suitable/Unsuitable	Suitability Probablility	Average suitability probability	Rounded Suitability Probability
Mouth	C-1	surf	A	0 to 2	-49.9 to -51.9	Full Suite	no	no	suitable	100	92.86	90
	C-1	surf	B	2 to 4	-51.9 to -53.9	Full Suite	no	no	suitable	100		
	C-2	surf	A	0 to 2	-51.4 to -53.4	Full Suite	no	no	suitable	100		
	C-3	undetermined	A	0 to 2.7	-52.5 to -55.2	Full Suite	Total Chlordane non-detect	no	possibly suitable	50		
	C-3	undetermined	B	2.7 to 5.8	-55.2 to -58.3	Full Suite	no	no	suitable	100		
	C-4	surf	A	0 to 2	-53.6 to -55.6	Full Suite	no	no	suitable	100		
	C-5	surf	A	0 to 2	-51.5 to -53.5	Full Suite	no	no	suitable	100		
Middle	C-7	surf	A	0 to 2	-50.4 to -52.4	Full Suite	no	4.38	likely suitable	75	63.63636364	60
	C-8	undetermined	A	0 to 2	-52.0 to -54.0	Full Suite	no	5.00	likely suitable	75		
	C-8	undetermined	B	2 to 4	-54.0 to -56.0	Full Suite	no	no	suitable	100		
	C-10	surf	A	0 to 2	-49.0 to -51.0	Full Suite	no	8.79	likely suitable	75		
	C-10	surf	B	2 to 4	-51.0 to -53.0	Full Suite	Tributyltin	7.42	unsuitable	0		
	C-10	surf	C	4 to 6	-53.0 to -55.0	Full Suite	no	no	suitable	100		
	C-11	surf	A	0 to 2	-51.6 to -53.6	Full Suite	Total Chlordane non-detect	5.92	possibly suitable	50		
	C-12	undetermined	A	0 to 2	-22.7 to -24.7	Full Suite	Total PCB Aroclors	56.2	unsuitable	0		
	C-12	undetermined	B	2 to 4	-24.7 to -26.7	Full Suite	no	54.5	unsuitable	0		
	C-12	undetermined	C	4 to 6	-26.7 to -28.7	Full Suite	no	17.7	unsuitable	0		
	C-12	undetermined	D	6 to 8	-28.7 to -30.7	D/F	no	no	suitable	100		
	C-12	undetermined	E	8 to 10	-30.7 to -32.7	D/F	no	no	suitable	100		
	C-13	undetermined	A	0 to 2	-39.0 to -41	Full Suite	no	5.34	likely suitable	75		
	C-13	undetermined	B	2 to 4	-41.0 to -43.0	Full Suite	no	7.73	likely suitbble	75		
	C-13	undetermined	C	4 to 6	-43.0 to -45.0	Full Suite	no	11.88	unsuitable	0		
	C-13	undetermined	D	6 to 8	-45.0 to -47.0	D/F	no	7.64	likely suitable	75		
	C-13	undetermined	E	8 to 10	-47.0 to -49.0	D/F	no	no	suitable	100		
	C-14	surf	A	0 to 2	-52.6 to -54.6	Full Suite	no	no	suitable	100		
	C-14	surf	B	2 to 4	-54.6 to -56.6	Full Suite	no	no	suitable	100		
	C-15	undetermined	A	0 to 2	-45.6 to -47.6	Full Suite	no	10.6	unsuitable	0		
	C-15	undetermined	B	2 to 4	-47.6 to -49.6	Full Suite	no	no	suitable	100		
	C-15	undetermined	C	4 to 6	-49.6 to -51.6	Full Suite	no	no	suitable	100		
Head	C-16	surf	A	0 to 2	-50.6 to -52.6	Full Suite	no	no	suitable	100	100	100
	C-17	undetermined	A	0 to 2	-19.7 to -21.7	Full Suite	no	no	suitable	100		
	C-17	undetermined	B	2 to 4	-21.7 to -23.7	Full Suite	no	no	suitable	100		
	C-17	undetermined	C	4 to 8	-23.7 to -25.7	Full Suite	no	no	suitable	100		
	C-18	surf	A	0 to 2.3	-52.2 to -54.5	Full Suite	no	no	suitable	100		
	C-24	surf	A	0 to 2	-51.1 to -53.1	Full Suite	no	no	suitable	100		
	C-25	surf	A	0 to 2	-51.4 to -53.4	Full Suite	no	no	suitable	100		
	C-25	surf	B	2 to 4	-53.4 to -55.4	Full Suite	no	no	suitable	100		

Legend

	Probability of being suitable during full characterization
suitable	100
likely suitable	75
possibly suitable	50
unsuitable	0

above SL, BT or dioxin above 4 pptr TEQ

dioxin above 10 pptr TEQ

all less than SLs/BTs

Table 9
Suitability Probabilities for Open-Water Disposal of Native Material

Station		Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Analyses[1]	Detected SL/BT Exceedance	Dioxins/furans above 4 pptr TEQ	Suitable/Unsuitable	Suitability Probablility	Average suitability probability	Rounded Suitability Probability
C-1	native	C	4 to 6	-53.9 to -55.9	Full Suite	no	no	suitable	100	98.07692308	95
C-2	native	B	2 to 4	-53.4 to -55.4	Full Suite	no	no	suitable	100		
C-2	native	C	4 to 6	-55.4 to -57.4	TBT	no	no	suitable	100		
C-2	native	D	6 to 8.6	57.4 to -60.0	TBT	no	no	suitable	100		
C-4	native	B	2 to 4	-55.6 to -57.6	Full Suite	no	no	suitable	100		
C-5	native	B	2 to 4	-53.5 to -55.5	Full Suite	no	no	suitable	100		
C-6	native	A	0 to 2	-53.9 to -55.9	Full Suite	no	no	suitable	100		
C-6	native	B	2 to 4	-55.9 to -57.9	Full Suite	no	no	suitable	100		
C-7	native	B	2 to 4	-52.4 to -54.4	Full Suite	Hexachlorobutadiene	no	possibly suitable	50		
C-7	native	C	4 to 6	-54.4 to -56.4	Full Suite	no	no	suitable	100		
C-9	native	A	0 to 2	-53.0 to -55.0	Full Suite	no	no	suitable	100		
C-9	native	B	2 to 4	-55.0 to -57.0	Full Suite	no	no	suitable	100		
C-11	native	B	2 to 4	-53.6 to -55.6	Full Suite	no	no	suitable	100		
C-16	native	B	2 to 4	-52.6 to -54.6	Full Suite	no	no	suitable	100		
C-18	native	B	3.9 to 6.3	-54.5 to -56.9	Full Suite	no	no	suitable	100		
C-19	native	A	0 to 2	-52.4 to -54.4	Full Suite	no	no	suitable	100		
C-19	native	B	2 to 4	-54.4 to -56.4	Full Suite	no	no	suitable	100		
C-20	native	A	0 to 2	-51.3 to -53.3	Full Suite	no	no	suitable	100		
C-20	native	B	2 to 4	-53.3 to -55.3	Full Suite	no	no	suitable	100		
C-21	native	A	0 to 2	-53.7 to -55.7	Full Suite	no	no	suitable	100		
C-21	native	B	2 to 4	-55.7 to -57.7	Full Suite	no	no	suitable	100		
C-22	native	A	0 to 2	-51.0 to -53.0	Full Suite	no	no	suitable	100		
C-22	native	B	2 to 4	-53.0 to -55.0	Full Suite	no	no	suitable	100		
C-23	native	A	0 to 2	-53.7 to -55.7	Full Suite	no	no	suitable	100		
C-23	native	B	2 to 4	-55.7 to -57.7	Full Suite	no	no	suitable	100		
C-24	native	B	2 to 4	-53.1 to -55.1	Full Suite	no	no	suitable	100		

Legend

	Probability of being suitable during full characterization
suitable	100
likely suitable	75
possibly suitable	50
unsuitable	0

- above SL, BT or dioxin above 4 pptr TEQ
- dioxin above 10 pptr TEQ
- all less than SLs/BTs

Table 10
SMS Comparison for Samples with TOC above 0.5%

Sample ID		C-1-A-190219	C-5-B-190221	C-6-B-190219	C-7-A-190221	C-8-A-190221	C-10-A-190221	C-11-A-190220	C-12-A-190223	C-12-C-190223	C-13-A-190223	C-17-A-190222	C-17-B-190222
Sample Date		2/19/2019	2/21/2019	2/19/2019	2/21/2019	2/21/2019	2/21/2019	2/20/2019	2/23/2019	2/23/2019	2/23/2019	2/22/2019	2/22/2019
Depth		0 - 2 ft	2 - 4 ft	2 - 4 ft	0 - 2 ft	0 - 2 ft	0 - 2 ft	0 - 2 ft	0 - 2 ft	4 - 6 ft	0 - 2 ft	0 - 2 ft	2 - 4 ft
Analyte	SQS	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ	Result Value VQ
Conventional Parameters (%)													
Total organic carbon		0.71	0.74	0.71	0.55	0.54	1.01	0.86	0.61	0.75	0.59	0.83	3.24
Metals (mg/kg)													
Arsenic	57	3.24	1.63	1.41	4.52	4.3	5.95	4.8	6.8	5.07	6.08	3.74	3.44
Cadmium	5.1	0.09 J	0.05 J	0.13 U	0.08 J	0.07 J	0.13 J	0.09 J	0.14	0.14	0.11 J	0.05 J	0.21
Chromium	260	14.7	12.7	11.1	16.3	13.6	15.6	14.3	16.3	16.7	13	16.3	16.4
Copper	390	26.7	16.9	15.6	25.2	24.4	31.8	27.3	29.2	24.7	66.1	32.6	30.7
Lead	450	6.01	1.86	1.46	6.14	5.97	8.1	6.34	14.8	5.11	4.5	3.94	3.12
Mercury	0.41	0.0423	0.0227 U	0.00982 J	0.0278 J	0.0351 J	0.0428 J	0.0352	0.0703	0.0549	0.0252	0.0296	0.0373
Silver	6.1	0.12 J	0.06 J	0.06 J	0.11 J	0.11 J	0.16 J	0.13 J	0.14 J	0.09 J	0.08 J	0.1 J	0.1 J
Zinc	410	33.3	24	18.8	37.2	34.1	43.4	36.7	43.7	29.8	43.1	30.4	25.3
Semivolatile Organics (ug/kg)													
Benzoic acid	650	84.7 J	56.2 J	37.8 J	26.5 J	37.1 J	146	93.3 J	228 J	46.1 J	71.1 J	310	164
Benzyl alcohol	57	19.9 U	19.5 U	19.7 U	19.9 U	19.5 U	19.7 U	17.9 J	19 U	19.9 U	19.6 U	19.9 U	19.5 U
2,4-Dimethylphenol	29	24.9 UJ	24.4 U	24.6 UJ	24.8 U	24.4 U	3.4 J	3.1 J	10.6 J	24.9 U	24.5 U	24.8 UJ	2.6 J
2-Methylphenol (o-Cresol)	63	3 J	4.9 U	4.9 U	5 U	4.9 U	4.9 U	2.2 J	4.8 U	5 U	4.9 U	2.7 J	3.1 J
4-Methylphenol (p-Cresol)	670	5	4.9 U	4.9 U	5 U	4.9 U	6.4	6.8	14.4	2.8 J	4.9 U	4.7 J	7.6
Pentachlorophenol	360	19.9 UJ	5.5 J	19.7 UJ	19.9 UJ	19.5 UJ	9.3 J	4.1 J	11.2 J	19.9 UJ	19.6 UJ	4.5 J	19.5 UJ
Phenol	420	13.5 U	8.1 U	6.4 U	6.2 U	4.9 U	15 U	20.3	53 U	17.5 U	23.7 U	41	34.7
Semivolatile Organics (mg/kg OC)													
1,2,4-Trichlorobenzene	0.81	0.38 U	0.35 U	0.37 U	0.49 U	0.48 U	0.26 U	0.29 U	0.41 U	0.36 U	0.44 U	0.33 U	0.08 U
1,2-Dichlorobenzene	2.3	0.70 U	0.13 J	0.69 U	0.70 U	0.69 U	0.69 U	0.66 U	0.86	0.70 U	0.69 U	0.70 U	0.69 U
1,4-Dichlorobenzene	3.1	0.70 U	0.69 U	0.69 U	0.70 U	0.69 U	0.69 U	0.66 U	0.52 J	0.70 U	0.69 U	0.70 UJ	0.69 UJ
Hexachlorobenzene	0.38	0.10 U	0.09 U	0.10 U	0.13 U	0.13 U	0.07 U	0.08 U	0.11 U	0.09 U	0.12 U	0.08 U	0.02 U
bis(2-Ethylhexyl)phthalate	47	7.01 U	6.89 U	6.93 U	4.21 J	6.87 U	7.99	4.25 J	14.93	7.01 U	4.28 J	7.00 U	6.86 U
Butylbenzyl phthalate	4.9	2.80 U	2.75 U	2.77 U	2.80 U	2.75 U	2.77 U	2.68 U	2.68 U	2.80 U	2.76 U	2.80 U	2.75 U
Diethyl phthalate	61	2.80 U	2.75 U	2.77 U	2.80 U	9.44 U	2.77 U	--	2.68 U	2.80 U	2.76 U	2.80 U	2.75 U
Dimethyl phthalate	53	0.70 U	0.69 U	0.69 U	0.70 U	0.69 U	0.69 U	0.66 U	0.44 J	0.70 U	0.69 U	0.70 U	0.69 U
Di-n-butyl phthalate	220	5.25	3.28 U	7.90	6.80 U	2.75 U	5.83 U	10.17	2.68 U	2.80 U	2.76 U	13.79 U	14.07 U
Di-n-octyl phthalate	58	2.80 U	2.75 U	2.77 U	2.80 U	2.75 U	2.77 U	2.68 U	2.68 U	2.80 U	2.76 U	2.80 U	2.75 U
Hexachlorobutadiene	3.9	0.70 U	0.66 U	0.69 U	0.91 U	0.91 U	0.49 U	0.55 U	0.79 U	0.67 U	0.83 U	0.60 U	0.15 U
Dibenzofuran	15	1.23 J	2.75 U	0.76 J	2.80 U	1.73 J	2.34 J	1.27 J	3.37	2.80 U	2.76 U	2.80 U	2.75 U
n-Nitrosodiphenylamine	11	0.70 U	0.69 U	0.69 U	0.70 U	0.69 U	0.48 J	0.66 U	0.68 U	0.70 U	0.69 U	0.70 U	0.69 U
Polycyclic Aromatic Hydrocarbons (mg/kg OC)													
2-Methylnaphthalene	38	3.48	2.42 J	3.00	2.80 U	4.94	4.03	2.49 J	3.03	2.80 U	1.00 J	1.65 J	1.00 J
Acenaphthene	16	2.80 U	2.75 U	2.77 U	2.80 U	1.08 J	1.06 J	2.68 U	2.97	2.80 U	2.76 U	2.80 U	2.75 U
Acenaphthylene	66	2.80 U	2.75 U	2.77 U	2.80 U	0.90 J	1.55 J	2.68 U	1.54 J	2.80 U	2.76 U	2.80 U	2.75 U
Anthracene	220	2.08 J	2.75 U	2.77 U	1.86 J	2.83	4.04	2.62 J	3.75 J	1.20 J	0.97 J	2.80 UJ	2.75 UJ
Benzo(a)anthracene	110	3.39	0.73 J	2.77 U	4.20	5.41	7.92	5.99	3.54	1.13 J	2.41 J	0.92 J	2.75 U
Benzo(a)pyrene	99	2.86	2.75 U	2.77 U	5.32	5.89	9.46	6.49	5.68	1.37 J	3.25	2.80 U	2.75 U
Benzo(b,j,k)fluoranthenes	230	8.13	5.51 U	5.54 U	17.04	13.90	28.87	16.62	16.06	3.17 J	8.86	3.20 J	5.49 U
Benzo(g,h,i)perylene	31	2.06 J	2.75 U	2.77 U	4.13	3.82	6.83	4.66	4.34	1.37 J	2.93	2.80 U	2.75 U
Chrysene	110	5.28	1.00 J	1.04 J	7.15	10.10	11.65	8.65	7.20	1.66 J	3.92	2.07 J	1.24 J
Dibenzo(a,h)anthracene	12	0.62 J	0.69 U	0.69 U	1.24	1.66	2.65	1.30	1.55	0.38 J	0.93	0.37 J	0.69 U
Fluoranthene	160	6.68	2.75 U	2.77 U	6.66	9.08	15.49	7.34	12.80	2.61 J	3.59	1.13 J	2.75 U
Fluorene	23	1.17 J	2.75 U	2.77 U	0.82 J	1.45 J	2.21 J	1.13 J	3.94	2.80 U	2.76 U	2.80 U	2.75 U
Indeno(1,2,3-c,d)pyrene	34	1.89 J	2.75 U	2.77 U	3.90	3.54	6.18	4.15	3.58	1.03 J	2.24 J	2.80 U	2.75 U
Naphthalene	99	3.03	1.11 J	1.56 J	2.39 J	3.66	3.90	2.83	8.48	2.38 J	1.11 J	0.89 J	0.96 J
Phenanthrene	100	6.44	2.69 J	3.34	4.76	8.44	7.51	5.52	11.03	3.41	2.30 J	3.55	1.93 J
Pyrene	1000	8.66	2.75 U	2.77 U	9.27	11.49	24.51	10.70	30.28	5.65	6.87	3.00	2.75 U
PCB Aroclors (mg/kg-OC)[6]													
Total DMMP PCB Aroclors (U = 0)	12	0.72 J	0.54 U	0.56 U	1.71 J	2.19 J	2.01 J	0.7 J	28.41 J	3.27 J	1.98 J	0.72 J	0.12 U

non-detect reported at MDL
non-detect exceedance
detected exceedance

Table 11
SMS Comparison for Samples with TOC less than 0.5%

Analyte	SQS	C-1-B-190219 2 - 4 ft	C-1-C-190219 4 - 6 ft	C-2-A-190219 0 - 2 ft	C-2-B-190219 2 - 4 ft	C-3-A-190218 0 - 2.7 ft	C-3-B-190218 2.7 - 5.8 ft	C-4-A-190218 0 - 2 ft	C-4-B-190218 2 - 4 ft	C-5-A-190221 0 - 2 ft	C-6-A-190219 0 - 2 ft	C-7-B-190221 2 - 4 ft	C-7-C-190221 4 - 6 ft	C-8-B-190221 2 - 4 ft
Conventional Parameters (%)														
Total organic carbon		**0.21**	**0.09**	**0.37**	**0.26**	**0.49**	**0.27**	**0.15**	**0.12**	**0.28**	**0.22**	**0.44**	**0.2**	**0.39**
Metals (mg/kg)														
Arsenic	57	**1.67**	**1.06**	**4.97**	**1.95**	**3.7**	**1.77**	**1.12**	**1.01**	**1.59**	**1.14**	**1.76**	**1.39**	**2.66**
Cadmium	5.1	0.11 U	0.12 U	**0.05 J**	**0.05 J**	**0.06 J**	0.12 U	0.12 U	0.12 U	**0.04 J**	**0.12**	0.12 U	0.12 U	**0.07 J**
Chromium	260	**11**	**9.49**	**12.5**	**12.7**	**12.3**	**10.9**	**11.8**	**10.8**	**11.3**	**9.11**	**8.75**	**9.6**	**16.8**
Copper	390	**13.7**	**10.3**	**18.3**	**16.6**	**25.5**	**14.9**	**11.9**	**10.8**	**14.4**	**10.3**	**10.1**	**9.06**	**28.3**
Lead	450	**2.33**	**1.33**	**3.46**	**2.15**	**6.26**	**1.55**	**1.26**	**1.21**	**2.25**	**1.42**	**1.11**	**1.06**	**3.39**
Mercury	0.41	**0.025**	**0.0114 J**	**0.0249 J**	**0.0167 J**	**0.0599 J**	0.0231 UJ	0.026 UJ	0.0254 UJ	0.0269 U	0.0241 U	0.0266 U	0.0214 U	**0.0183 J**
Silver	6.1	**0.06 J**	**0.03 J**	**0.08 J**	**0.05 J**	**0.12 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.06 J**	**0.04 J**	**0.04 J**	**0.03 J**	**0.09 J**
Zinc	410	**19.3**	**14.9**	**27**	**23.7**	**34.4**	**19.9**	**20**	**19.4**	**21.1**	**17.9**	**16.4**	**16.7**	**32.1**
Semivolatile Organics (ug/kg)														
Benzoic acid	650	95.9 UJ	96.3 UJ	97.5 UJ	97 UJ	**85.1 J**	**15.8 J**	**16.8 J**	94.3 UJ	**21.2 J**	99.1 UJ	97.1 U	98.8 U	99.5 U
Benzyl alcohol	57	19.2 U	19.3 U	19.5 U	19.4 U	**13.4 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Hexachlorobutadiene	11	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	**26.5**	4.9 U	5 U
2,4-Dimethylphenol	29	24 UJ	24.1 UJ	24.4 UJ	24.3 UJ	24.1 UJ	24.6 UJ	24.3 UJ	23.6 UJ	24.9 U	24.8 UJ	24.3 U	24.7 U	24.9 U
2-Methylphenol (o-Cresol)	63	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
4-Methylphenol (p-Cresol)	670	4.8 U	4.8 U	**2.9 J**	4.9 U	**5.4**	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
Pentachlorophenol	360	19.2 UJ	19.3 UJ	19.5 UJ	19.4 UJ	19.3 UJ	19.7 UJ	19.4 UJ	18.9 UJ	**5.4 J**	19.8 UJ	19.4 UJ	19.8 UJ	19.9 UJ
Phenol	420	4.8 U	4.8 U	7.8 U	4.9 U	**30**	6.1 U	5.6 U	4.7 U	6.4 U	5 U	5.4 U	4.9 U	5 U
Semivolatile Organics (ug/kg)														
1,2,4-Trichlorobenzene	31	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
1,2-Dichlorobenzene	35	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
1,4-Dichlorobenzene	110	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
Hexachlorobenzene	22	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	**3 J**	4.9 U	5 U
bis(2-Ethylhexyl)phthalate	1300	47.9 U	48.2 U	48.8 U	48.5 U	**29.5 J**	49.2 U	48.6 U	47.1 U	49.8 U	49.5 U	48.6 U	49.4 U	49.8 U
Butylbenzyl phthalate	63	19.2 U	19.3 U	19.5 U	19.4 U	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Diethyl phthalate	200	19.2 U	19.3 U	19.5 U	19.4 U	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	25.5 U	27.7 U
Dimethyl phthalate	71	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
Di-n-butyl phthalate	1400	**22.5**	**22.4**	**40.6**	**14.9 J**	**118**	**69.7**	**96.1**	**108**	19.9 U	**43.4**	19.4 U	30.6 U	19.9 U
Di-n-octyl phthalate	6200	19.2 U	19.3 U	19.5 U	19.4 U	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Dibenzofuran	540	19.2 U	19.3 U	19.5 U	19.4 U	**12 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
n-Nitrosodiphenylamine	28	4.8 U	4.8 U	4.9 U	4.9 U	4.8 U	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
Polycyclic Aromatic Hydrocarbons (ug/kg)														
2-Methylnaphthalene	670	**8.6 J**	19.3 U	19.5 U	**6.4 J**	**18.4 J**	**8 J**	19.4 U	18.9 U	19.9 U	19.8 U	**7.8 J**	**9.8 J**	**9.8 J**
Acenaphthene	500	19.2 U	19.3 U	19.5 U	19.4 U	**7 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Acenaphthylene	1300	19.2 U	19.3 U	19.5 U	19.4 U	19.3 U	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Anthracene	960	19.2 U	19.3 U	**7.7 J**	19.4 U	**13.9 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Benzo(a)anthracene	1300	**16.6 J**	19.3 U	**17.5 J**	**5.2 J**	**20.7**	19.7 U	19.4 U	18.9 U	**7.4 J**	19.8 U	19.4 U	19.8 U	**5.4 J**
Benzo(a)pyrene	1600	**16.7 J**	19.3 U	**16.3 J**	19.4 U	**26.8**	19.7 U	19.4 U	18.9 U	**8.5 J**	19.8 U	19.4 U	19.8 U	19.9 U
Benzo(b,j,k)fluoranthenes	3200	**35.3 J**	38.5 U	**38.8 J**	38.8 U	**75.9**	39.4 U	38.9 U	37.7 U	**26.9 J**	39.6 U	38.8 U	39.5 U	39.8 U
Benzo(g,h,i)perylene	670	**8 J**	19.3 U	**10.1 J**	19.4 U	**20.1**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Chrysene	1400	**21.2**	19.3 U	**24**	**6.7 J**	**34.4**	**5.3 J**	19.4 U	18.9 U	**11.7 J**	19.8 U	19.4 U	19.8 U	**17.6 J**
Dibenzo(a,h)anthracene	230	**3.7 J**	4.8 U	**2.7 J**	4.9 U	**7.6**	4.9 U	4.9 U	4.7 U	5 U	5 U	4.9 U	4.9 U	5 U
Fluoranthene	1700	**22**	19.3 U	**32.1**	**7.7 J**	**38.3**	19.7 U	19.4 U	18.9 U	**11.9 J**	19.8 U	19.4 U	19.8 U	19.9 U
Fluorene	540	19.2 U	19.3 U	19.5 U	19.4 U	**11 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Indeno(1,2,3-c,d)pyrene	600	**7.4 J**	19.3 U	**8.3 J**	19.4 U	**16.7 J**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	19.8 U	19.9 U
Naphthalene	2100	**8.7 J**	19.3 U	**11.7 J**	**5.3 J**	**31**	19.7 U	19.4 U	18.9 U	19.9 U	19.8 U	19.4 U	**8.5 J**	19.9 U
Phenanthrene	1500	**13.6 J**	19.3 U	**24.9**	**13 J**	**36.9**	**13 J**	**5.9 J**	18.9 U	**12.9 J**	19.8 U	**14.7 J**	19.8 U	**22.6**
Pyrene	2600	**27.1**	19.3 U	**39.5**	**9.3 J**	**63.5**	19.7 U	19.4 U	18.9 U	**15.9 J**	**6.3 J**	19.4 U	19.8 U	19.9 U
PCB Aroclors (µg/kg)														
Total DMMP PCB Aroclors (U = 0)	130	3.9 U	4 U	**2 J**	4 U	**3.8 J**	4 U	4 U	3.9 U	**0.8 J**	**1.9 J**	4 U	4 U	3.9 U

non-detect exceedance
detected exceedance
AET-based SQS different from DMMP SL

Table 11
SMS Comparison for Samples with TOC less than 0.5%

Analyte	SQS	C-9-A-190220 0 - 2 ft	C-9-B-190220 2 - 4 ft	C-10-B-190221 2 - 4 ft	C-10-C-190221 4 - 6 ft	C-11-B-190220 2 - 4 ft	C-12-B-190223 2 - 4 ft	C-13-B-190223 2 - 4 ft	C-13-C-190223 4 - 6 ft	C-14-A-190221 0 - 2 ft	C-14-B-190221 2 - 4 ft	C-15-A-190222 0 - 2 ft	C-15-B-190222 2 - 4 ft	C-15-C-190222 4 - 6 ft
Conventional Parameters (%)														
Total organic carbon		**0.11**	**0.19**	**0.45**	**0.19**	**0.14**	**0.37**	**0.39**	**0.18**	**0.09**	**0.15**	**0.25**	**0.1**	**0.17**
Metals (mg/kg)														
Arsenic	57	**2.08**	**2.58**	**3.4**	**1.88**	**1.3**	**5.07**	**6.67**	**3.88**	**4.18**	**5.08**	**6.4**	**2.74**	**4.28**
Cadmium	5.1	0.11 U	**0.09 J**	**0.12 J**	**0.1**	0.12 U	**0.13**	**0.11 J**	**0.05 J**	0.11 U	**0.06 J**	**0.05 J**	0.11 U	**0.04 J**
Chromium	260	**11.3**	**11.8**	**11.3**	**8.23**	**10.7**	**16.2**	**13.5**	**12**	**11.3**	**13**	**12.4**	**9.38**	**11.5**
Copper	390	**10.7**	**14.4**	**19.1**	**11.8**	**11.1**	**23.8**	**22.7**	**14.1**	**12.3**	**14.6**	**21.3**	**11.5**	**14.3**
Lead	450	**1.25**	**1.61**	**4.2**	**1.46**	**1.33**	**6.32**	**5.04**	**1.67**	**1.54**	**1.8**	**5.36**	**1.36**	**1.74**
Mercury	0.41	0.0217 U	**0.00517 J**	**0.0271 J**	**0.00691 J**	0.0241 U	**0.0607**	**0.0381**	**0.011 J**	0.0216 U	0.0216 U	**0.027 J**	**0.0142 J**	**0.0148 J**
Silver	6.1	**0.04 J**	**0.06 J**	**0.09 J**	**0.04 J**	**0.04 J**	**0.09 J**	**0.11 J**	**0.05 J**	**0.04 J**	**0.05 J**	**0.09 J**	**0.04 J**	**0.05 J**
Zinc	410	**18**	**19.7**	**25.5**	**15.8**	**18.7**	**30.4**	**34.2**	**22.2**	**21.7**	**22.2**	**30**	**18**	**22.5**
Semivolatile Organics (ug/kg)														
Benzoic acid	650	99.1 UJ	95.3 UJ	**43.3 J**	96 U	94 UJ	**77 J**	**76.3 J**	**22.3 J**	97.1 U	98.6 U	**79.4 J**	99 U	99 UJ
Benzyl alcohol	57	**10.1 J**	**9.7 J**	19.1 U	19.2 U	18.8 U	19.8 U	**3.4 J**	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Hexachlorobutadiene	11	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
2,4-Dimethylphenol	29	24.8 UJ	23.8 UJ	23.8 U	24 U	23.5 UJ	**2.8 J**	24.8 U	24.5 U	24.3 U	24.7 U	23.6 UJ	24.8 UJ	24.8 UJ
2-Methylphenol (o-Cresol)	63	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
4-Methylphenol (p-Cresol)	670	5 U	4.8 U	**2.7 J**	4.8 U	4.7 U	**5.1**	**3.1 J**	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Pentachlorophenol	360	19.8 UJ	19.1 UJ	19.1 UJ	19.2 UJ	18.8 UJ	**10.1 J**	19.9 UJ	19.6 UJ	19.4 UJ	**7.7 J**	18.9 UJ	19.8 UJ	19.8 UJ
Phenol	420	5 U	5.3 U	9.7 U	4.8 U	4.7 U	23.1 U	31.6 U	8.2 U	4.9 U	4.9 U	13.7 U	5.9 U	7 U
Semivolatile Organics (ug/kg)														
1,2,4-Trichlorobenzene	31	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
1,2-Dichlorobenzene	35	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
1,4-Dichlorobenzene	110	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 UJ	5 UJ	5 UJ
Hexachlorobenzene	22	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
bis(2-Ethylhexyl)phthalate	1300	49.5 U	47.7 U	**32.8 J**	48 U	47 U	**32.9 J**	**41.7 J**	49 U	**54.7**	49.3 U	**61.8**	49.5 U	49.5 U
Butylbenzyl phthalate	63	19.8 U	19.1 U	19.1 U	19.2 U	18.8 U	19.8 U	19.9 U	19.6 U	19.4 U	19.7 U	**7.8 J**	19.8 U	19.8 U
Diethyl phthalate	200	19.8 U	19.1 U	19.1 U	24.5 U	18.8 U	38.2 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	31.9 U
Dimethyl phthalate	71	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Di-n-butyl phthalate	1400	**23.4**	**40.5**	20.6 U	30.4 U	**17.7 J**	**6 J**	19.9 U	19.6 U	34.4 U	39.9 U	121 U	81.4 U	38.6 U
Di-n-octyl phthalate	6200	19.8 U	19.1 U	19.1 U	19.2 U	18.8 U	19.8 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Dibenzofuran	540	19.8 U	19.1 U	**7.2 J**	19.2 U	18.8 U	**9.6 J**	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
n-Nitrosodiphenylamine	28	5 U	4.8 U	4.8 U	4.8 U	4.7 U	5 U	5 U	4.9 U	4.9 U	4.9 U	4.7 U	5 U	5 U
Polycyclic Aromatic Hydrocarbons (ug/kg)														
2-Methylnaphthalene	670	19.8 U	19.1 U	**10.6 J**	19.2 U	18.8 U	19.8 U	**7 J**	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Acenaphthene	500	19.8 U	19.1 U	19.1 U	19.2 U	18.8 U	**8.2 J**	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Acenaphthylene	1300	19.8 U	19.1 U	19.1 U	19.2 U	18.8 U	19.8 U	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Anthracene	960	19.8 U	19.1 U	**16.1 J**	19.2 U	18.8 U	**14.4 J**	**10.6 J**	19.6 UJ	19.4 U	19.7 U	**6.1 J**	19.8 UJ	19.8 UJ
Benzo(a)anthracene	1300	19.8 U	19.1 U	**33.6**	19.2 U	18.8 U	**13.1 J**	**19.2 J**	19.6 U	19.4 U	19.7 U	**10.2 J**	19.8 U	19.8 U
Benzo(a)pyrene	1600	19.8 U	19.1 U	**45.7**	19.2 U	18.8 U	**18.8 J**	**29.4**	19.6 U	19.4 U	19.7 U	**18.9**	19.8 U	19.8 U
Benzo(b,j,k)fluoranthenes	3200	39.6 U	38.1 U	**115**	38.4 U	37.6 U	**49.2**	**85.1**	39.2 U	38.8 U	39.4 U	**54.5**	39.6 U	39.6 U
Benzo(g,h,i)perylene	670	19.8 U	19.1 U	**30.3**	19.2 U	18.8 U	**17.2 J**	**26.9**	19.6 U	19.4 U	19.7 U	**10.9 J**	19.8 U	19.8 U
Chrysene	1400	19.8 U	19.1 U	**53.7**	19.2 U	18.8 U	**23.4**	**32.4**	19.6 U	19.4 U	19.7 U	**17 J**	19.8 U	19.8 U
Dibenzo(a,h)anthracene	230	5 U	4.8 U	**12.4**	4.8 U	4.7 U	**6**	**8.6**	4.9 U	4.9 U	4.9 U	**4.8**	5 U	5 U
Fluoranthene	1700	19.8 U	19.1 U	**52**	19.2 U	18.8 U	**36**	**25.2**	19.6 U	19.4 U	19.7 U	**16.5 J**	19.8 U	19.8 U
Fluorene	540	19.8 U	19.1 U	**7.3 J**	19.2 U	18.8 U	**12.5 J**	19.9 U	19.6 U	19.4 U	19.7 U	18.9 U	19.8 U	19.8 U
Indeno(1,2,3-c,d)pyrene	600	19.8 U	19.1 U	**28.7**	19.2 U	18.8 U	**14.6 J**	**21.9**	19.6 U	19.4 U	19.7 U	**10.6 J**	19.8 U	19.8 U
Naphthalene	2100	19.8 U	19.1 U	**15.9 J**	19.2 U	18.8 U	**27.9**	**9 J**	19.6 U	19.4 U	19.7 U	**8.9 J**	19.8 UJ	19.8 UJ
Phenanthrene	1500	19.8 U	**14.7 J**	**43**	**7.7 J**	18.8 U	**38.5**	**21.4**	**5.8 J**	19.4 U	19.7 U	**15.8 J**	**6.1 J**	19.8 U
Pyrene	2600	19.8 U	19.1 U	**79.1**	**6.6 J**	18.8 U	**71.1**	**68.5**	19.6 U	19.4 U	19.7 U	**27.5**	19.8 U	19.8 U
PCB Aroclors (µg/kg)														
Total DMMP PCB Aroclors (U = 0)	130	4 U	3.9 U	**11.2 J**	3.9 U	3.8 U	**90.1 J**	**23.1 J**	**3.7 J**	3.9 U	4 U	**19.4 J**	4 U	4 U

non-detect exceedance
detected exceedance
AET-based SQS different from DMMP SL

Table 11
SMS Comparison for Samples with TOC less than 0.5%

Sample ID / Analyte	SQS	C-16-A-190223	C-16-B-190223	C-17-C-190222	C-18-A1-190220	C-18-B1-190220	C-19-A-190220	C-19-B-190220	C-20-A-190219	C-20-B-190219	C-21-A-190219	C-21-B-190219	C-22-A-190219	C-22-B-190219
Depth		0 - 2 ft	2 - 4 ft	4 - 8 ft	0 - 2.3 ft	3.9 - 6.3 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft	0 - 2 ft	2 - 4 ft
Conventional Parameters (%)														
Total organic carbon		**0.25**	**0.05**	**0.39**	**0.29**	**0.13**	**0.09**	**0.1**	**0.08**	**0.04**	**0.49**	**0.11**	**0.07**	**0.04**
Metals (mg/kg)														
Arsenic	57	**3.82**	**2.21**	**2.15**	**3.2**	**3.89**	**1.89**	**2.53**	**1.28**	**1.1**	**4.41**	**2.26**	**1.59**	**1.31**
Cadmium	5.1	**0.07 J**	0.11 U	**0.04 J**	**0.05 J**	0.11 U	0.1 U	0.12 U	**0.05 J**	**0.03 J**	0.11 U	**0.05 J**	0.1 U	0.1 U
Chromium	260	**10.2**	**10.6**	**14.4**	**11.5**	**10.1**	**9.73**	**10.3**	**9.69**	**10.4**	**7.99**	**8.59**	**11.3**	**9.53**
Copper	390	**14.9**	**10.5**	**21.2**	**16.1**	**13**	**12.7**	**15.2**	**13.9**	**14**	**14.9**	**14.9**	**12.7**	**10.9**
Lead	450	**2.82**	**1.29**	**2.07**	**2.81**	**1.51**	**1.54**	**1.84**	**1.41**	**1.5**	**1.43**	**1.49**	**1.36**	**1.41**
Mercury	0.41	**0.0195 J**	**0.00813 J**	**0.0201 J**	0.0291 U	0.021 U	0.0187 U	0.0204 U	**0.00698 J**	**0.00973 J**	**0.0112 J**	**0.0134 J**	**0.00859 J**	**0.00788 J**
Silver	6.1	**0.08 J**	**0.04 J**	**0.07 J**	**0.05 J**	**0.04 J**	**0.04 J**	**0.05 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.03 J**	**0.03 J**	**0.03 J**
Zinc	410	**22.5**	**19.7**	**23.9**	**25.6**	**29.6**	**20.9**	**21.3**	**18.7**	**20.1**	**18**	**20.1**	**19.2**	**17.6**
Semivolatile Organics (ug/kg)														
Benzoic acid	650	**68.4 J**	98.6 UJ	**32.9 J**	**214 J**	**60.2 J**	97.7 UJ	**19.6 J**	99.1 UJ	97.1 UJ	95.7 UJ	96.7 UJ	98.7 UJ	98.6 UJ
Benzyl alcohol	57	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Hexachlorobutadiene	11	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
2,4-Dimethylphenol	29	23.9 U	24.6 U	23.9 UJ	24.2 U	23.6 U	24.4 UJ	24.6 UJ	24.8 UJ	24.3 UJ	23.9 UJ	24.2 UJ	24.7 UJ	24.7 UJ
2-Methylphenol (o-Cresol)	63	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
4-Methylphenol (p-Cresol)	670	4.8 U	4.9 U	**2 J**	**3.1 J**	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Pentachlorophenol	360	19.1 UJ	19.7 UJ	19.2 UJ	19.4 UJ	18.9 UJ	19.5 UJ	19.7 UJ	19.8 UJ	19.4 UJ	19.1 UJ	19.3 UJ	19.7 UJ	19.7 UJ
Phenol	420	18.3 U	8.1 U	7.3 U	**38.7**	13.4 U	4.9 U	5.3 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Semivolatile Organics (ug/kg)														
1,2,4-Trichlorobenzene	31	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
1,2-Dichlorobenzene	35	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	**0.8 J**	4.8 U	4.8 U	4.9 U	4.9 U
1,4-Dichlorobenzene	110	4.8 U	4.9 U	4.8 UJ	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Hexachlorobenzene	22	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
bis(2-Ethylhexyl)phthalate	1300	47.8 U	49.3 U	**29.6 J**	48.4 U	47.2 U	48.9 U	49.2 U	49.5 U	48.6 U	47.9 U	48.3 U	49.4 U	49.3 U
Butylbenzyl phthalate	63	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Diethyl phthalate	200	23.2 U	19.7 U	24.6 U	**7.2 J**	**9.2 J**	19.5 U	19.7 U	35.8 U	28.9 U	19.1 U	19.3 U	19.7 U	21.9 U
Dimethyl phthalate	71	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Di-n-butyl phthalate	1400	19.1 U	19.7 U	91.1 U	19.4 U	18.9 U	**161**	**133**	**36.8**	**22.6**	**17.2 J**	**39.8**	**18.8 J**	19.7 U
Di-n-octyl phthalate	6200	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Dibenzofuran	540	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
n-Nitrosodiphenylamine	28	4.8 U	4.9 U	4.8 U	4.8 U	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Polycyclic Aromatic Hydrocarbons (ug/kg)														
2-Methylnaphthalene	670	19.1 U	19.7 U	**6.2 J**	19.4 U	**7.5 J**	19.5 U	19.7 U	19.8 U	19.4 U	**7.3 J**	19.3 U	19.7 U	19.7 U
Acenaphthene	500	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Acenaphthylene	1300	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Anthracene	960	**8.8 J**	19.7 UJ	19.2 UJ	**5.9 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Benzo(a)anthracene	1300	**11.9 J**	19.7 U	19.2 U	**9 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	**7 J**	19.3 U	19.7 U	19.7 U
Benzo(a)pyrene	1600	**10.8 J**	19.7 U	19.2 U	**16.4 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Benzo(b,j,k)fluoranthenes	3200	38.2 U	39.4 U	38.3 U	**42.2**	37.8 U	39.1 U	39.3 U	39.6 U	38.9 U	38.3 U	38.7 U	39.5 U	39.5 U
Benzo(g,h,i)perylene	670	**7.7 J**	19.7 U	19.2 U	**9.7 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Chrysene	1400	**28.8**	19.7 U	**5.9 J**	**18.2 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	**14.3 J**	19.3 U	19.7 U	19.7 U
Dibenzo(a,h)anthracene	230	**2.7 J**	4.9 U	4.8 U	**3.8 J**	4.7 U	4.9 U	4.9 U	5 U	4.9 U	4.8 U	4.8 U	4.9 U	4.9 U
Fluoranthene	1700	**12.3 J**	19.7 U	**4.9 J**	**13.9 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	**5.8 J**	19.3 U	19.7 U	19.7 U
Fluorene	540	19.1 U	19.7 U	19.2 U	19.4 U	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Indeno(1,2,3-c,d)pyrene	600	19.1 U	19.7 U	19.2 U	**8.2 J**	18.9 U	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Naphthalene	2100	19.1 U	19.7 U	**8.1 J**	**7.9 J**	**5.4 J**	19.5 U	19.7 U	19.8 U	19.4 U	19.1 U	19.3 U	19.7 U	19.7 U
Phenanthrene	1500	**15.8 J**	19.7 U	**14.6 J**	**11.9 J**	**6.3 J**	19.5 U	19.7 U	19.8 U	19.4 U	**38.1**	19.3 U	19.7 U	19.7 U
Pyrene	2600	**23.5**	19.7 U	**6.2 J**	**48.3**	18.9 U	19.5 U	**5.5 J**	**5.9 J**	19.4 U	**8.1 J**	19.3 U	19.7 U	19.7 U
PCB Aroclors (µg/kg)														
Total DMMP PCB Aroclors (U = 0)	130	**5.3 J**	4 U	4 U	3.9 UJ	4 U	3.8 U	3.9 U	3.8 U	3.9 U	3.8 U	3.9 U	3.9 U	4 U

non-detect exceedance
detected exceedance
AET-based SQS different from DMMP SL

Table 11
SMS Comparison for Samples with TOC less than 0.5%

Analyte	SQS	C-23-A1-190222 0 - 2 ft	C-23-B1-190222 2 - 4 ft	C-24-A-190223 0 - 2 ft	C-24-B-190223 2 - 4 ft	C-25-A-190222 0 - 2 ft	C-25-B-190222 2 - 4 ft
Conventional Parameters (%)							
Total organic carbon		**0.07**	**0.04**	**0.06**	**0.04**	**0.29**	**0.44**
Metals (mg/kg)							
Arsenic	57	**2.41**	**2**	**1.99**	**1.16**	**2.79**	**2.59**
Cadmium	5.1	**0.04 J**	**0.04 J**	0.11 U	0.1 U	**0.05 J**	0.12 U
Chromium	260	**10.1**	**9.02**	**11.3**	**9.86**	**15.5**	**13.2**
Copper	390	**15.1**	**12.8**	**13.4**	**11.2**	**27.7**	**19.4**
Lead	450	**1.84**	**1.45**	**1.64**	**1.6**	**2.42**	**1.79**
Mercury	0.41	0.0232 U	**0.0101 J**	**0.0112 J**	**0.00818 J**	**0.0219 J**	**0.0191 J**
Silver	6.1	**0.04 J**	**0.04 J**	**0.04 J**	**0.04 J**	**0.07 J**	**0.05 J**
Zinc	410	**23.8**	**21.2**	**23**	**22.4**	**73.9**	**20.1**
Semivolatile Organics (ug/kg)							
Benzoic acid	650	**15.4 J**	98.6 U	**43.9 J**	**25.5 J**	**33.6 J**	**84.3 J**
Benzyl alcohol	57	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Hexachlorobutadiene	11	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
2,4-Dimethylphenol	29	24.9 UJ	24.6 UJ	24.5 U	24.7 U	24.7 UJ	24.2 UJ
2-Methylphenol (o-Cresol)	63	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
4-Methylphenol (p-Cresol)	670	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Pentachlorophenol	360	20 UJ	19.7 UJ	19.6 UJ	19.8 UJ	19.8 UJ	19.3 UJ
Phenol	420	6.8 U	6.5 U	10 U	7.9 U	14.8 U	19.5 U
Semivolatile Organics (ug/kg)							
1,2,4-Trichlorobenzene	31	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
1,2-Dichlorobenzene	35	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
1,4-Dichlorobenzene	110	5 UJ	4.9 UJ	4.9 U	4.9 U	4.9 UJ	4.8 UJ
Hexachlorobenzene	22	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
bis(2-Ethylhexyl)phthalate	1300	49.9 U	49.3 U	49.1 U	49.4 U	**30.4 J**	**31.4 J**
Butylbenzyl phthalate	63	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Diethyl phthalate	200	30.9 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Dimethyl phthalate	71	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Di-n-butyl phthalate	1400	87.1 U	142 U	19.6 U	19.8 U	140 U	171 U
Di-n-octyl phthalate	6200	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Dibenzofuran	540	20 U	19.7 U	19.6 U	19.8 U	19.8 U	**5.9 J**
n-Nitrosodiphenylamine	28	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Polycyclic Aromatic Hydrocarbons (ug/kg)							
2-Methylnaphthalene	670	20 U	19.7 U	19.6 U	19.8 U	19.8 U	**17.9 J**
Acenaphthene	500	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Acenaphthylene	1300	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Anthracene	960	20 UJ	19.7 UJ	19.6 UJ	19.8 UJ	19.8 UJ	19.3 UJ
Benzo(a)anthracene	1300	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Benzo(a)pyrene	1600	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Benzo(b,j,k)fluoranthenes	3200	39.9 U	39.4 U	39.3 U	39.6 U	39.5 U	38.7 U
Benzo(g,h,i)perylene	670	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Chrysene	1400	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Dibenzo(a,h)anthracene	230	5 U	4.9 U	4.9 U	4.9 U	4.9 U	4.8 U
Fluoranthene	1700	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Fluorene	540	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Indeno(1,2,3-c,d)pyrene	600	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
Naphthalene	2100	20 UJ	19.7 UJ	19.6 U	19.8 U	19.8 UJ	**5.8 J**
Phenanthrene	1500	20 U	19.7 U	19.6 U	19.8 U	**6.7 J**	**15 J**
Pyrene	2600	20 U	19.7 U	19.6 U	19.8 U	19.8 U	19.3 U
PCB Aroclors (µg/kg)							
Total DMMP PCB Aroclors (U = 0)	130	3.9 U	3.9 U	3.9 U	4 U	3.8 U	3.9 U

non-detect exceedance
detected exceedance
AET-based SQS different from DMMP SL

Table 12
Probability of Suitability for Beneficial Use of Non-Native Material

Section	Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Detected SL/BT Exceedance	Dioxins/furans above 4/10 pptr TEQ	PAH above 2000 ug/kg	Beneficial Use Suitable/Unsuitable	Suitability Probablility	Average suitability probability	Rounded Suitability Probability
Mouth	C-1	A	0 to 2	-49.9 to -51.9	no	no	no	suitable	100	85.71	**85**
		B	2 to 4	-51.9 to -53.9	no	no	no	suitable	100		
	C-2	A	0 to 2	-51.4 to -53.4	no	no	no	suitable	100		
	C-3	A	0 to 2.7	-52.5 to -55.2	Total Chlordane non-detect	no	no	unsuitable	0		
		B	2.7 to 5.8	-55.2 to -58.3	no	no	no	suitable	100		
	C-4	A	0 to 2	-53.6 to -55.6	no	no	no	suitable	100		
	C-5	A	0 to 2	-51.5 to -53.5	no	no	no	suitable	100		
Middle	C-7	A	0 to 2	-50.4 to -52.4	no	4.38	no	unsuitable	0	40.91	**40**
	C-8	A	0 to 2	-52.0 to -54.0	no	5.00	no	unsuitable	0		
		B	2 to 4	-54.0 to -56.0	no	no	no	suitable	100		
	C-10	A	0 to 2	-49.0 to -51.0	no	8.79	no	unsuitable	0		
		B	2 to 4	-51.0 to -53.0	Tributyltin	7.42	no	unsuitable	0		
		C	4 to 6	-53.0 to -55.0	no	no	no	suitable	100		
	C-11	A	0 to 2	-51.6 to -53.6	Total Chlordane non-detect	5.92	no	unsuitable	0		
	C-12	A	0 to 2	-22.7 to -24.7	Total PCB Aroclors	56.2	no	unsuitable	0		
		B	2 to 4	-24.7 to -26.7	no	54.5	no	unsuitable	0		
		C	4 to 6	-26.7 to -28.7	no	17.7	no	unsuitable	0		
		D	6 to 8	-28.7 to -30.7	no	no	no	suitable	100		
		E	8 to 10	-30.7 to -32.7	no	no	no	suitable	100		
	C-13	A	0 to 2	-39.0 to -41	no	5.34	no	unsuitable	0		
		B	2 to 4	-41.0 to -43.0	no	7.73	no	unsuitable	0		
		C	4 to 6	-43.0 to -45.0	no	11.88	no	unsuitable	0		
		D	6 to 8	-45.0 to -47.0	no	7.64	no	unsuitable	0		
		E	8 to 10	-47.0 to -49.0	no	no	no	suitable	100		
	C-14	A	0 to 2	-52.6 to -54.6	no	no	no	suitable	100		
		B	2 to 4	-54.6 to -56.6	no	no	no	suitable	100		
	C-15	A	0 to 2	-45.6 to -47.6	no	10.6	no	unsuitable	0		
		B	2 to 4	-47.6 to -49.6	no	no	no	suitable	100		
		C	4 to 6	-49.6 to -51.6	no	no	no	suitable	100		
Head	C-16	A	0 to 2	-50.6 to -52.6	no	no	no	suitable	100	100	**100**
	C-17	A	0 to 2	-19.7 to -21.7	no	no	no	suitable	100		
		B	2 to 4	-21.7 to -23.7	no	no	no	suitable	100		
		C	4 to 8	-23.7 to -25.7	no	no	no	suitable	100		
	C-18	A	0 to 2.3	-52.2 to -54.5	no	no	no	suitable	100		
	C-24	A	0 to 2	-51.1 to -53.1	no	no	no	suitable	100		
	C-25	A	0 to 2	-51.4 to -53.4	no	no	no	suitable	100		
		B	2 to 4	-53.4 to -55.4	no	no	no	suitable	100		

above SL, BT or dioxin above 4 pptr TEQ
dioxin above 10 pptr TEQ
all less than SLs/BTs

Table 13
Native Material - Probability of Suitability for Beneficial Use

Station	Sample ID	Sample Depth (feet)	Sample Elevation (feet MLLW)	Detected SL/BT Exceedance	Dioxins/furans above 4 pptr TEQ	PAH above 2000 ug/kg	Beneficial Use Suitable/Unsuitable	Suitability Probablility	Average suitability probability	Rounded Suitability Probability
C-1	C	4 to 6	-53.9 to -55.9	no	no	no	suitable	100	96.15	95
C-2	B	2 to 4	-53.4 to -55.4	no	no	no	suitable	100		
	C	4 to 6	-55.4 to -57.4	no	no	no	suitable	100		
	D	6 to 8.6	57.4 to -60.0	no	no	no	suitable	100		
C-4	B	2 to 4	-55.6 to -57.6	no	no	no	suitable	100		
C-5	B	2 to 4	-53.5 to -55.5	no	no	no	suitable	100		
C-6	A	0 to 2	-53.9 to -55.9	no	no	no	suitable	100		
	B	2 to 4	-55.9 to -57.9	no	no	no	suitable	100		
C-7	B	2 to 4	-52.4 to -54.4	Hexachlorobutadiene	no	no	unsuitable	0		
	C	4 to 6	-54.4 to -56.4	no	no	no	suitable	100		
C-9	A	0 to 2	-53.0 to -55.0	no	no	no	suitable	100		
	B	2 to 4	-55.0 to -57.0	no	no	no	suitable	100		
C-11	B	2 to 4	-53.6 to -55.6	no	no	no	suitable	100		
C-16	B	2 to 4	-52.6 to -54.6	no	no	no	suitable	100		
C-18	B	3.9 to 6.3	-54.5 to -56.9	no	no	no	suitable	100		
C-19	A	0 to 2	-52.4 to -54.4	no	no	no	suitable	100		
	B	2 to 4	-54.4 to -56.4	no	no	no	suitable	100		
C-20	A	0 to 2	-51.3 to -53.3	no	no	no	suitable	100		
	B	2 to 4	-53.3 to -55.3	no	no	no	suitable	100		
C-21	A	0 to 2	-53.7 to -55.7	no	no	no	suitable	100		
	B	2 to 4	-55.7 to -57.7	no	no	no	suitable	100		
C-22	A	0 to 2	-51.0 to -53.0	no	no	no	suitable	100		
	B	2 to 4	-53.0 to -55.0	no	no	no	suitable	100		
C-23	A	0 to 2	-53.7 to -55.7	no	no	no	suitable	100		
	B	2 to 4	-55.7 to -57.7	no	no	no	suitable	100		
C-24	B	2 to 4	-53.1 to -55.1	no	no	no	suitable	100		

above SL, BT or dioxin above 4 pptr TEQ
dioxin above 10 pptr TEQ
all less than SLs/BTs

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232-1274

September 5, 2019

Laura A. Boerner
Chief, Planning, Environmental, & Cultural Resources Branch
P.O. Box 3755
Seattle, WA 98124-3755
ATTN: CENWS-PMP

Re: Fish and Wildlife Coordination Act Planning Aid Letter on the Corps of Engineers' National Environmental Policy Act environmental assessment (EA) for the Tacoma Harbor, WA Navigation Improvement Project, Pierce, County, Washington.

Dear Chief Boerner;

The National Marine Fisheries Service (NMFS) has reviewed the December 21, 2019 Public Notice for the proposed Tacoma Harbor deepening in the Blair Waterway of Commencement Bay in Pierce County, Washington. This Planning Aid Letter is written in response to the public notice, under the authority given to NMFS through the Fish and Wildlife Coordination Act (16 USC 661-667e; 48 Stat. 401), because trust resources within NMFS' jurisdiction will be affected by the proposed project.

These trust resources include Endangered Species Act (ESA) listed Puget Sound (PS) Chinook salmon *(Oncorhynchus tshawytscha)*, PS steelhead (*O. mykiss*), Southern Resident (SR) Killer Whale (*Orcinus orca*), and designated essential fish habitat (EFH) for various life stages of Pacific Coast salmon, Pacific Coast groundfish, and coastal pelagic species. Other species that fall within the fiduciary responsibility of the Federal government are the variety of fishes and shellfishes traditionally harvested by treaty tribes.

Purpose and Need for Proposed Action

The proposal involves the deepening of the Blair Waterway in Commencement Bay, Tacoma, Washington (Figure 1). The Tacoma Harbor currently measures approximately 51 feet MLLW (mean lower low water), a measurement that is equal to the average height of the lowest tide recorded every day during a 19-year period. Initial alternatives include deepening the Blair Waterway from minus 51 feet to up to minus 58 feet Mean Lower Low Water (MLLW) and widening the existing authorized channel (330 to 520 feet wide) to better accommodate larger vessels already calling at Tacoma Harbor, such as the post-Panamax Generation 4.

The Corps and the Port recognize that channel deepening is essential to maintaining the Port's competitive position as a premier international trade gateway, particularly relative to Canadian ports. A deeper harbor would eliminate transit delays due to tidal changes and allow larger, fully-loaded ships to more efficiently and cost-effectively visit the Port of Tacoma. The Tacoma

Harbor is a major gateway for containerized traffic and the channels must have sufficient depth for partially loaded vessels to call, take on additional cargo, and leave fully loaded. Tide restrictions, light loading, or other operational inefficiencies created by inadequate channel depth currently limits the Port's competitiveness, especially when competing with nearby and naturally deep harbors in British Columbia and the outer coast.

Figure 1. Aerial Image of Blair Waterway

Sediment that is determined to be suitable for beneficial reuse will either go to open water disposal or may be used at the potential Saltchuck marine site. Saltchuck is a deeper water site located adjacent to other restoration actions. The material placed would be intended to raise the elevation to create nearshore juvenile Chinook rearing habitat (Figure 2).

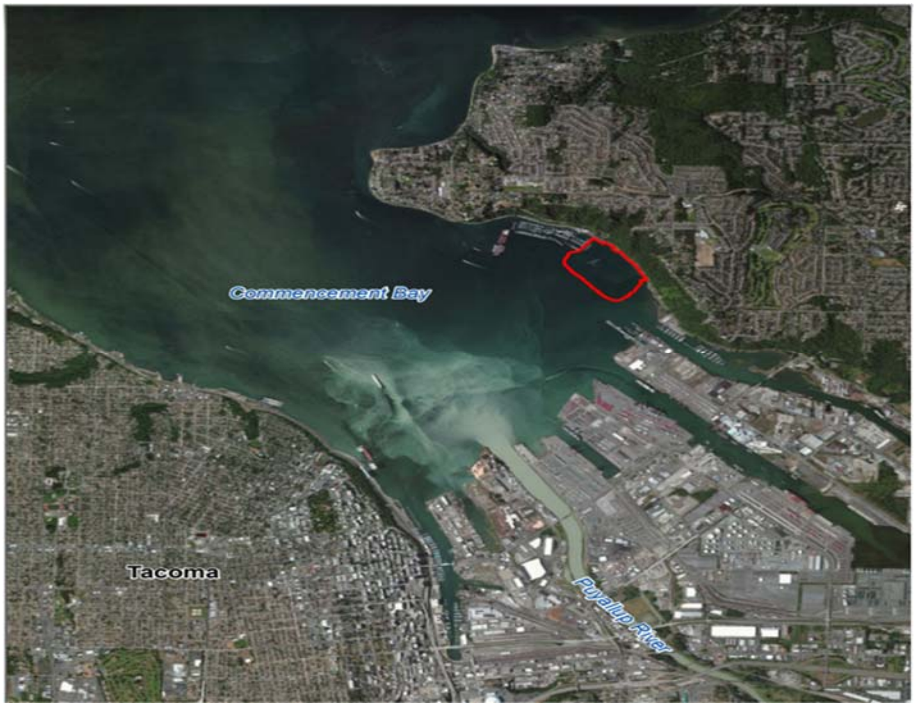


Figure 2. Location of the potential Saltchuck mitigation site

Existing Conditions
Lingering effects of more than a century of human development combined with numerous ongoing activities in the industrial waterways have contributed to the currently degraded environmental baseline conditions in Commencement Bay, including the Blair Waterway. In 1981, the U.S. Environmental Protection Agency (EPA) listed Commencement Bay as a Federal Superfund site. As a result of this, the cleanup of contaminants has been a high priority. After the completion of the dredging, the EPA deleted the Blair Waterway and all lands that drain to the Blair Waterway from the National Priorities List.

The shorelines of Commencement Bay have been highly altered using riprap and other materials to provide bank protection. Blair Waterway comprises seven percent of the total of armored shoreline that cover 71 percent of the length of the Commencement Bay shoreline. Based on shoreline surveys and aerial photo interpretation of the area, approximately five miles, or 20 percent of the Commencement Bay shoreline, is covered by wide over-water structures (Kerwin 1999). The existing project area is presently altered using riprap that provides low to medium quality feeding and refuge habitat for juvenile salmon (Spence et al. 1996).

At present, the small amount of functional salmonid habitat within Commencement Bay shorelines is gradually increasing in acreage because of habitat restoration projects and natural processes. The importance of nearshore marine habitat, as part of a restoration strategy for habitat function within the estuary, has been emphasized by the Chinook salmon habitat protection and restoration strategy for the Puyallup Watershed and is an important step toward improving the overall ecological functionality of the area.

Proposed Action and Potential Effects

The proposed project as described above involves deepening the navigational channel by dredging the Blair Waterway in Commencement Bay to accommodate loading and unloading of larger container ships. The Corps has indicated that deepening the navigational shipping channel to accommodate larger container ships is a viable alternative to meet the business needs of the Port of Tacoma. Other alternatives or measures are available or are currently being used, but these measures over the long-term do not solve the Port's issues on cost savings and reducing navigation challenges for larger ships entering the Port.

The Corps' in-water work window for Commencement Bay July 15 to February 15 which can reduce, but not avoid, effects on ESA listed species or designated critical habitat.

Potential construction-related impacts associated with dredging the Blair Waterway would include water quality impacts due to increased turbidity, suspended sediments, and contaminants. The variety of effects of increased turbidity and suspended sediment may be characterized as lethal, sublethal or behavioral (Bash et al. 2001; Newcombe and MacDonald 1991; Waters 1995). Lethal effects include gill trauma (physical damage to the respiratory structures), severely reduced respiratory function and performance, and smothering and other effects that can reduce egg-to-fry survival (Bash et al. 2001). Sublethal effects include physiological stress reducing the ability of a fish to perform vital functions (Cederholm and Reid 1987), increased metabolic oxygen demand and susceptibility to disease and other stressors (Bash et al. 2001), and reduced feeding efficiency (Bash et al. 2001; Berg and Northcote 1985; Waters 1995). Sublethal effects can act separately or cumulatively to reduce growth rates and increase fish mortality over time. Behavioral effects include avoidance, loss of territoriality, and related secondary effects to feeding rates and efficiency (Bash et al. 2001).

Do to the industrial nature of the area, dredging of the Blair Waterway has the potential to cause the release or resuspension of contaminants. The effects to aquatic life differ depending upon the type of contaminant. Metal, polyaromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs), as groupings of related contaminants, present a risk of additive or synergistic effects. Potential effects of bioaccumulation include inhibited reproduction, delayed fry emergence, liver disease or malfunction, morphological abnormalities, immune system impairment, and mortality.

Dredging will cause benthic habitat disturbance for EFH species that may forage in deep water. Juvenile salmon would not be affected as they forage almost exclusively in nearshore areas. The recovery of disturbed habitats following dredging ultimately depends upon the nature of the sediment at the dredge or disposal site, sources and types of re-colonizing animals, and the extent of the disturbance.

The dredging of the navigation channel will result in larger vessels (container ships) utilizing the Blair Waterway to load and unload at Port facilities and privately-owned industrial docks. Vessel traffic is one area that has been identified as having a potential effect on the feeding behavior of the whales. SR killer whales come into the Puget Sound on an irregular basis and for a limited amount of time usually during the winter. The amount of effect from vessel traffic on killer whales during the time they are present in Washington waters is unknown.

Coordination with Federal and State Agencies and Tribal Governments
The NMFS participated in meetings with the COE, had numerous discussions with agencies related to the Tacoma Harbor General Investigation, and coordinated with relevant resource agencies, and the Puyallup Tribe. The information provided in this letter is based on conversations with the Puyallup Tribe, WDFW, and the EPA. Many of the same concerns, conclusions, and recommendations are shared by the NMFS, the Tribe, WDFW, and the EPA. This Planning Aid Letter highlights concerns regarding potential risks and damages to fish, wildlife, and tribal trust resources associated with the Tacoma Harbor deepening project.

In addition to the coordination described above, in order to provide recommendations that benefit the fish and wildlife resources, NMFS reviewed the status of ESA-listed Species and Critical Habitats (See Appendix A for summary), and the Chinook salmon habitat protection and restoration strategy for the Puyallup Watershed. Specific recovery actions identified for Commencement Bay include restoring estuarine and nearshore habitat.

Recommendations
At the outset, in the context of this proposed action, and other federal water resource development proposals, we emphasize the necessity of upholding treaty fishing rights and other/related tribal trust responsibilities.

NMFS further recommends that the U.S. Army Corps of Engineers (COE), prior to issuing its 404 Clean Water Act permit: (1) work with NMFS, US Fish and Wildlife Service, Pierce County, Washington State Department of Fish and Wildlife (WDFW), Environmental Protection Agency (EPA), and the Puyallup Tribe to determine restoration actions to mitigate for project impacts; (2) coordinate with the NMFS throughout the development of the alternatives and design of the project to expedite the ESA section 7 consultation; (3) develop a contingency plan for possible contaminants; (4) provide a full characterization of sediment quality that will be used in nearshore placement; (5) include an analysis of vessel effects to marine mammals; and (6) maximize habitat restoration in the nearshore.

These recommendations are provided in greater detail here:

1. The Corps should work with NMFS, USFWS, Pierce County, WDFW, EPA, and the Puyallup Tribe to determine restoration actions to mitigate for project impacts, as well as impacts associated with interrelated and interdependent action such as long-term habitat loss, increased shade, changes in vessel sizes. Mitigation should meet the objectives of the current Recovery Plans for Puget Sound Chinook salmon.

2. Coordinate with the NMFS throughout the development of the alternatives and design of the project to expedite the ESA section 7 consultation.

    Early coordination can (1) provide an opportunity for the Service(s) to suggest conservation measures that can be incorporated into the project to avoid, reduce, or minimize potential adverse effects to listed species; (2) identify design alternatives or mitigation opportunities that can benefit the recovery of listed species; and (3) provide technical assistance on specific species habitat

requirements that could be incorporated into the project.

3. Develop a contingency plan to minimize water quality effects should contaminants be discovered during sediment sampling prior to dredging.

4. Because of the possibility of contaminants, sediment used in nearshore placement of dredged material at the Saltchuck marine site needs to be fully characterized to ensure fish or their prey resources will not be adversely affected. The Corps should provide a full characterization of sediment quality that will be used in nearshore placement to confirm fish or their prey resources will not be adversely affected.

5. Include an analysis of effects to marine mammals from larger vessels that will be transiting through Puget Sound to the Blair Waterway.

6. Maximize nearshore habitat restoration. Restored habitat function to areas will benefit ESA listed juvenile salmon and their prey resources, which in turn is beneficial to SRKW. Restored nearshore habitat also benefits designated EFH, and provides beneficial stewardship of treaty trust resources.

7. Perform monitoring of habitat restoration site to confirm that fish use established at baseline or improved levels, and at what time frame.

Summary and Service Position

Dredging of the Blair Waterway will retain the degraded condition of habitat in Commencement Bay that has been impacted for over 100 years, and which, despite its designation as critical habitat, does not have sufficient habitat conditions to improve conservation outcomes for ESA listed resources, and which currently fails to meet treaty obligations because consumption of fishes and shellfishes harvested from the area must be restricted to avoid human health impacts. Detrimental effects of the Blair Waterway dredging include water quality degradation, benthic effects, exposure of protected and trust species, and habitat and species disruptions associated with increased vessel size. Multiple beneficial effects would result from restored nearshore marine habitat.

Thank you for the opportunity to comment on the proposed project. If you have any questions, please contact Bonnie Shorin, of the Oregon/Washington Coastal Area Office at (360) 753-9578, or by email at Bonnie.Shorin@noaa.gov.

Sincerely,

for

Kim W. Kratz, Ph.D
Assistant Regional Administrator
Oregon Washington Coastal Office

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APPENDIX

Status of the Species

PS Chinook

This Evolutionary Significant Unit (ESU) comprises 22 populations distributed over five geographic areas. Most populations within the ESU have declined in abundance over the past 7 to 10 years, with widespread negative trends in natural-origin spawner abundance, and hatchery-origin spawners present in high fractions in most populations outside of the Skagit watershed. Escapement levels for all populations remain well below the Technical Review Team (TRT) planning ranges for recovery, and most populations are consistently below the spawner-recruit levels identified by the TRT as consistent with recovery.

Limiting factors include:

- Degraded floodplain and in-river channel structure
- Degraded estuarine conditions and loss of estuarine habitat
- Degraded riparian areas and loss of in-river large woody debris
- Excessive fine-grained sediment in spawning gravel
- Degraded water quality and temperature
- Degraded nearshore conditions
- Impaired passage for migrating fish
- Severely altered flow regime

PS Steelhead

This DPS comprises 32 populations. The DPS is currently at very low viability, with most of the 32 populations and all three population groups at low viability. Information considered during the most recent status review indicates that the biological risks faced by the Puget Sound Steelhead DPS have not substantively changed since the listing in 2007, or since the 2011 status review. Furthermore, the Puget Sound Steelhead TRT recently concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 populations. In the near term, the outlook for environmental conditions affecting Puget Sound steelhead is not optimistic. While harvest and hatchery production of steelhead in Puget Sound are currently at low levels and are not likely to increase substantially in the foreseeable future, some recent environmental trends not favorable to Puget Sound steelhead survival and production are expected to continue.

Limiting factors include:

- Continued destruction and modification of habitat
- Widespread declines in adult abundance despite significant reductions in harvest
- Threats to diversity posed by use of two hatchery steelhead stocks
- Declining diversity in the DPS, including the uncertain but weak status of summer-run fish
- A reduction in spatial structure
- Reduced habitat quality
- Urbanization
- Dikes, hardening of banks with riprap, and channelization

SR Killer Whale
The Southern Resident killer whale DPS is composed of a single population that ranges as far south as central California and as far north as southeast Alaska. The estimated effective size of the population (based on the number of breeding individuals under ideal genetic conditions) is very small — <30 whales, or about 1/3 of the current population size. The small effective population size, the absence of gene flow from other populations, and documented breeding within pods may elevate the risk from inbreeding and other issues associated with genetic deterioration. As of July 1, 2013, there were 26 whales in J pod, 19 whales in K pod and 37 whales in L pod, for a total of 82 whales. Estimates for the historical abundance of Southern Resident killer whales range from 140 whales (based on public display removals to 400 whales, as used in population viability analysis scenarios.

Limiting factors include:
- Quantity and quality of prey
- Exposure to toxic chemicals
- Disturbance from sound and vessels
- Risk from oil spills

Chinook Salmon and SR Killer Whale Critical Habitat

There is no designated PS steelhead critical habitat in the project area.

PS Chinook salmon
The NMFS designated critical habitat for the Puget Sound Chinook salmon on September 2, 2005 (70 FR 52630). One of the six PBFs of Puget Sound Chinook salmon critical habitat are in the action area:

The action area is located within the marine physical or biological features (PBF) of PS Chinook critical habitat. The PBFs for PS Chinook salmon marine critical habitat are:

(1) Water quality and quantity conditions and (2) Forage, including aquatic invertebrates and fish, supporting growth and maturation; and (3) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

Dredging activities will result in temporary degradation of water quality due to increased turbidity, suspended sediments, and possible contaminants.

SR Killer Whale
The final rule listing Southern Resident killer whales (SRKW) as endangered identified several potential factors that may have caused their decline or may be limiting recovery. These are: quantity and quality of prey, toxic chemicals which accumulate in top predators, and disturbance from sound and vessel traffic. The rule also identified oil spills as a potential risk factor for this species (73 FR 4176).

SR Killer Whales are not known to frequent the Blair Waterway. Vessel traffic transiting the Puget Sound may affect the feeding behavior of SR killer whales.

Essential Fish Habitat

The project area includes habitats that have been designated as EFH for various life-history stages of 17 species of groundfish, four coastal pelagic species, and three species of Pacific salmon.

Appendix E

Example of Noise Propagation from Pile Installation in the Blair Waterway

The Corps has proposed potential slope stabilization along four areas of the Blair Waterway. Sideslope stability requirements will be further analyzed and addressed in the preconstruction and engineering development (PED) phase, when ship simulation is conducted, and confirms the final channel alignment and width. Stabilization measures may include, but are not limited to, secant wall, sheet pile wall, and/or 1.5:1 slopes with rock toe stabilization. The actual stabilization method employed for each area will depend on whether or not the top of the slope in each area extends into the upland facilities and, if it does not, the available clearance (i.e., distance) between the top of the slope to upland facilities. Upland is land elevated above shore land, in an area above where water flows. Upland facilities include parking lots, buildings, utilities, or other infrastructure.

Exact information about the means and methods of the actual potential slope stabilization measures to be used are not available to complete a detailed noise analysis, at this time. However, previous work in the Blair Waterway found that noise levels were unlikely to exceed 160 dB_{RMS} during vibratory installation of 12-24-inch concrete piles (BergerABAM 2012). The distance at which 160 dB_{RMS} was expected to attenuate to 120 dB_{RMS} was approximately 2.8 miles (BergerABAM 2012), which is approximately the distance between Area 1 (Area 1: STA 44+00.00 to STA 48+00.0) and the mouth of Commencement Bay. The Blair Waterway and shape of Commencement Bay are expected to contain a substantial portion of noise generated. Appendix E (Berger ABAM 2012) is an example of estimated noise propagation during pile installation, and how noise is likely to propagate during slope stabilization. Based on final designs of slope stabilization measures, materials, and installation details developed in PED, a more refined noise analysis of the particular slope stabilization methods will be performed, if warranted, such as if actual proposed slope stabilization at a particular area uses noise-generating construction methods such as vibratory hammer installation.

Please see Section 5.1.3 (Fish, Wildlife, and Invertebrates) and 5.2.5 (Southern Resident Killer Whale [SRKW]) for additional information about anticipated noise generation during construction based on the level of project detail during the feasibility study.

Figure 5 - Site 4

Programmatic Piling Repair Project - Biological Evaluation
Appendix C: Marine Mammal Monitoring Plan
Temporary Effect and Monitoring Areas

Source: Pierce County GIS (2011)

Q:\Vancouver\2012\VAVAN-12-024\Planning\Graphics\Marine Monitoring Plan\Revised 040512\Site 4.mxd

Vibratory Temp. Effect Area (Removal/Installation)

Vibratory Monitoring Area (Removal/Installation)

Impact Temp. Effect Area (Installation)

Impact Monitoring Area (Installation)

Site

1 APM TERMINALS	7 TRIDENT
2 TERMINAL 7	8 BRAC PROPERTY
3 OCT	9 PARCEL 86
4 HUSKY TERMINAL	10 PARCEL 99
5 BLAIR DOCK	11 PARCEL 105
6 PARCEL 115	12 WUT

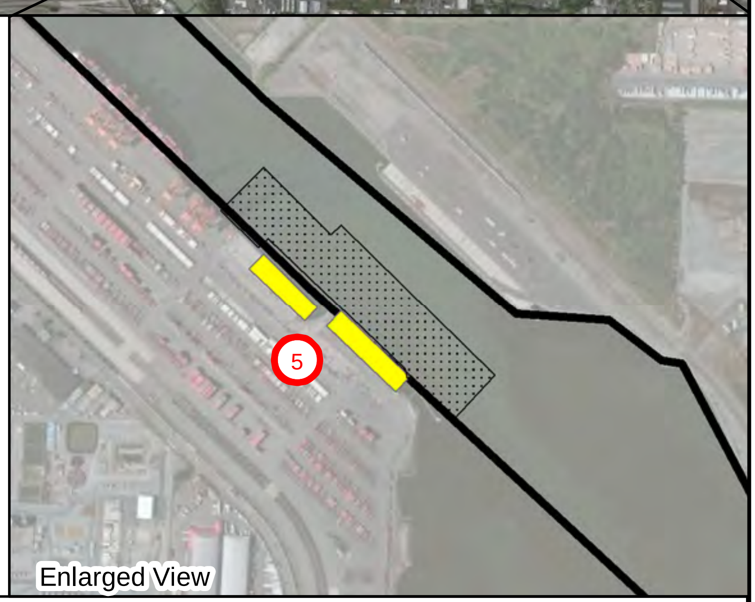

Figure 6 - Site 5

Programmatic Piling Repair Project - Biological Evaluation
Appendix C: Marine Mammal Monitoring Plan
Temporary Effect and Monitoring Areas

N
S

0 0.25 0.5 1 1.5 Miles

Source: Pierce County GIS (2011)

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Figure 7 - Site 6

Programmatic Piling Repair Project - Biological Evaluation
Appendix C: Marine Mammal Monitoring Plan
Temporary Effect and Monitoring Areas

N
S

0 0.25 0.5 1 1.5 Miles

Source: Pierce County GIS (2011)

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OR 97232-1274

Refer to NMFS No:
WCRO-2020-00645

February 16, 2022

Laura Boerner
Planning Chief
Environmental and Cultural Resources Branch
Corps of Engineers, Seattle District
Post Office Box 3755
Seattle, Washington 98124-3755

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the U.S. Army Corps of Engineers' Proposed Port of Tacoma's Harbor Navigation Improvement Project in the Blair Waterway of Tacoma Harbor, Pierce County, Washington (HUC 171100190204).

Dear Ms. Boerner:

Thank you for your letter of March 20, 2020, requesting initiation of consultation with the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Port of Tacoma's Harbor Navigation Improvement Project. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).[1]

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)) for this action.

The enclosed document contains a biological opinion prepared by NMFS pursuant to section 7 of the ESA on the effects of the proposed action. In this opinion, NMFS concludes that the proposed action would adversely affect but is not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon, PS steelhead, Puget Sound Georgia Basin (PS/GB) bocaccio, and PS/GB yelloweye rockfish. NMFS also concludes that the proposed action is likely to adversely affect designated critical habitat for PS Chinook salmon but is not likely to result in the destruction or adverse modification of that designated critical habitat. This opinion also documents our rationale and conclusion that the proposed action is not likely to adversely affect green sturgeon, eulachon, and Southern Resident killer whales (SRKW) or designated critical habitat for SRKW.

[1] For purposes of this consultation, we also considered whether the substantive analysis and its conclusions regarding the effects of the proposed actions articulated in the Biological Opinion and its Incidental Take Statement would be any different under the 50 CFR part 402 regulations as they existed prior to the 2019 Rule. We have determined that they would not be any different.

This opinion includes an incidental take statement (ITS) that describes reasonable and prudent measures (RPMs) NMFS considers necessary or appropriate to minimize the incidental take associated with this action, and sets forth terms and conditions that the COE must comply with in order to be exempt from the prohibitions of section 9 of the ESA.

This document also includes the results of our analysis of the action's likely effects on essential fish habitat (EFH) pursuant to Section 305(b) of the MSA. NMFS reviewed the likely effects of the proposed action on EFH, and concluded that the action would adversely affect designated EFH for Pacific Coast salmon and Pacific Coast groundfish. Therefore, we have included the results of that review in Section 3 of this document. NMFS also provides Conservation Recommendations to minimize adverse effects to EFH. Section 305(b)(4)(B) of the MSA requires that an action agency provide a detailed response in writing to the NMFS within 30 days after receiving an EFH Conservation Recommendation.

Please contact David Price in the Central Puget Sound Branch of the Oregon/Washington Coastal Office by email at David.Price@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Kim W. Kratz. Ph.D.
Assistant Regional Administrator
Oregon Washington Coastal Office

cc: Kaitlin Whitlock, USACE
Fred Goetz, USACE
Kristine Ceragioli, USACE

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the

Port of Tacoma Navigation Improvements

NMFS Consultation Number: WCRO-2020-00645

Action Agency: U.S. Army Corps of Engineers, Seattle District

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Puget Sound Chinook Salmon (*Oncorhynchus tshawytscha)*	Threatened	Yes	No	Yes	No
Puget Sound Steelhead (*O. mykiss*)	Threatened	Yes	No	NA	NA
Puget Sound/Georgia Basin boccacio rockfish (*Sebastes paucispinis*)	Endangered	Yes	No	No	NA
Puget Sound/Georgia Basin yelloweye rockfish (*S. ruberrimus*)	Threatened	Yes	No	NA	NA
Southern Resident Killer Whale (*Orcinus orca*)	Endangered	No	No	No	No
Green Sturgeon (*Acipenser medirostris*)	Threatened	No	No	NA	NA
Eulachon (*Thaleichthys pacificus*)	Threatened	No	No	NA	NA
Humpback whale, Central America DPS (*Megaptera novaeangliae*)	Endangered	No	No	NA	NA
Humpback whale, Mexico DPS (*Megaptera novaeangliae*)	Threatened	No	No	NA	NA

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes
Pacific Coast Groundfish	Yes	Yes
Coastal Pelagic	No	No

Issued By:

Kim W. Kratz, Ph.D
Assistant Regional Administrator
Oregon Washington Coastal Office

Date: February 16, 2022

TABLE OF CONTENTS

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3, below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared this biological opinion (Opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.), and implementing regulations at 50 CFR 402, as amended.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the Oregon Washington Coastal Office in Lacey, Washington.

1.2 Consultation History

On March 20, 2020, the U.S. Army Corps of Engineers Seattle District (Corps) requested formal ESA section 7 consultation on the effects of authorizing proposed deepening and widening of the Blair Waterway in the Port of Tacoma. The Corps proposes this authorization under Section 209 of the Rivers and Harbors Act of 1962, Public Law 87-874 which allows for the evaluation of alternatives for navigation improvement and consideration of ecosystem restoration in the form of beneficial use of dredge material at Tacoma Harbor. In addition, evaluation of beneficial use of dredged material as part of this study is authorized by Section 204 of the Water Resources Development Act of 1992, as amended by Section 1038(2) of the Water Resources Reform and Development Act of 2014 and Section 1122(i)(2) of the Water Resources Development Act of 2016 – Regional Sediment Management. Section 204(d), as amended, provides that, in developing and carrying out a federal water resources development project involving the disposal of dredged material, the Assistant Secretary of the Army for Civil Works (ASA(CW)) may select, with the consent of the non-federal interest, a disposal method that is not the least cost option, if the ASA(CW) determines that the incremental costs of the disposal method are reasonable in relation to the environmental benefits. The action also triggers MSA consultation because EFH for Pacific Coast salmon, Pacific Coast groundfish, and coastal pelagic species in the Puget Sound (a Habitat Area of Particular Concern (HAPC)) may be affected. The request for consultation included a biological assessment (BA) and multiple supplemental documents.

Since March 2020, correspondence regarding the proposed action subject to the ESA Section 7 consultation occurred between staff at NMFS and the Corps. This includes, but is not limited to clarification on the scope of potential side-slope stabilization methods via email on May 12, 2020; June 24, 2020; and December 9, 2021.

On September 11, 2020, NMFS requested additional information regarding the analysis and effects described in the BA. On December 8, 2020, the Corps responded to the technical questions in a memorandum to NMFS. Within that memorandum, the Corps revised its effects determination for Puget Sound Georgia Basin (PS/GB) rockfish from may affect, but is not likely to adversely affect (NLAA) to may affect, likely to adversely affect (LAA). As indicated in Table 1, NMFS was unable to concur with the Corps determination that the proposed action may affect, but is not likely to adversely affect PS steelhead. This species is included in formal consultation on the proposed action.

On February 22 2021, NMFS asked the Corps to specify the discretion it has in maintaining the currently authorized federal navigation channel at Blair Waterway, as well as what discretion it will have if an improved navigation channel is authorized by Congress at that location. The Corps provided that information on March 29, 2021, in a letter to NMFS. The information provided in the March 29, 2021, letter has been used to help define the environmental baseline and effects of the action considered in this consultation. NMFS acknowledges and accepts the following rationale to define the environmental baseline for this consultation:

> "Congress authorized the Blair Waterway in its current configuration, in a maintained state, and it is not within the Corps' discretion to alter its current configuration without seeking further congressional authorization. The ongoing consequences to the environment of the existing operation and configuration of the federal navigation channel, in a maintained state, as well as the effects of placing dredged material in the open-water disposal site at Commencement Bay (as addressed as part of a previous consultation), are therefore, within the "environmental baseline" considered." [2]

On January 3, 2022, the Corps confirmed with NMFS that side slope stabilization measures would be necessary at four locations to accommodate the proposed widening. On January 4, 2022, via phone, NMFS requested additional information regarding the slope stabilization measures currently in place at each of the four locations. The Corps provide pictures and a written description of current shoreline conditions via email on January 4, 2022. On January 5, 2022, NMFS asked the Corps to clarify the extent of shoreline armoring existing throughout the entire Blair Waterway. The Corps responded on January 6, indicating that, with the exception of mitigation/restoration sites, the entire Blair Waterway was armored. On January 12, 2022, NMFS requested clarification of the resulting channel slopes following installation of stabilization measures. The Corps responded informing NMFS that the channel slope waterward of the proposed secant walls at areas 2 and 3 would be maintained at 2H:1V and riprap at areas 1 and 4 would be 1.5H:1V. Based on these conversation regarding the design of the shoreline stabilization components of the proposed action NMFS analyzed the effects of secant walls with waterward 2H:1V slopes at areas 2 and 3 and riprap on a 1.5H:1V slope at areas 1 and 4.

[2] Page 3 of the March 29, 2021, letter from Alexander "Xander" L. Bullock, Colonel, Corps of Engineers, District Commander to Barry Thom, Regional Administrator, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, West Coast Region.

NMFS initiated formal ESA and MSA consultation with the Corps on August 18, 2021.

Table 1. Effects determinations made by the Corps and NMFS for the ESA-listed species and critical habitat in the project area.

Species	Status	Corps Species Determination	Corps Critical Habitat Determination	NMFS Species Determination	NMFS Critical Habitat Determination	Species Listing	Critical Habitat Listing
Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*)	T	LAA	LAA	LAA	LAA	06/28/05 (70 FR 37160)	09/02/05 (70 FR 52630)
Puget Sound steelhead (*O. mykiss*)	T	NLAA	NLAA	LAA	N/A	05/11/07 (72 FR 26722)	02/24/16 (81 FR 9252)
Puget Sound/Georgia Basin yelloweye rockfish (*Sebastes ruberrimus*)	T	LAA	N/A	LAA	N/A	04/28/10 (75 FR 22276)	02/11/15 (79 FR 68041)
Puget Sound/Georgia Basin bocaccio (*Sebastes paucispinis*)	E	LAA	N/A	LAA	N/A	04/28/10 (75 FR 22276)	02/11/15 (709 FR 68041)
Southern Resident Killer Whales (*Orcinus orca*)	E	NLAA	NLAA	NLAA	NLAA	11/18/05 (70 FR 57565)	11/29/06 (71 FR 69054)
Green Sturgeon (*Acipenser medirostris*)	T	NLAA	N/A	NLAA	N/A	04/07/06 (71 FR 17757)	11/09/09 (74 FR 52299)
Eulachon (*Thaleichthys pacificus*)	T	NLAA	N/A	NLAA	N/A	3/18/10 (75 FR 13012)	10/20/11 (76 FR 65323)
Humpback whale, Central America DPS (*Megaptera novaeangliae*)	E	Did not address	Did not address	NLAA	N/A	10/11/16 (81 FR 62259)	04/21/21 (86 FR 21082)
Humpback whale, Mexico DPS (*Megaptera novaeangliae*)	T	Did not address	Did not address	NLAA	N/A	10/11/16 (81 FR 62259)	04/21/21 (86 FR 21082)

T = Threatened E = Endangered LAA = likely to adversely affect NLAA = not likely to adversely affect
N/A = not applicable. The action area is outside designated critical habitat, or critical habitat has not been designated.

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies (50 CFR 402.02).

The U.S. Army Corps of Engineers (Corps) has developed a General Investigations study (GI), and integrated feasibility report and environmental assessment (IFR/EA), which provides the results of a deep draft navigation feasibility study undertaken to identify and evaluate alternatives to improve the navigation system's efficiency in Tacoma Harbor, Washington. This study is authorized by Section 209 of the Rivers and Harbors Act of 1962, as amended (Public Law 87-874). The Corps has undertaken this study in partnership with the Port of Tacoma (Port) as the non-federal sponsor. A recommended plan has been selected (described below) from four alternatives. Because the recommended plan forms the basis of a Chief's Report to Congress and is not a final design, NMFS is required to make assumptions in components of the action in order to complete an effects analysis. Where necessary, we identify our assumptions throughout this Opinion.

The Corps and the Port are proposing to deepen and widen the Blair Waterway to improve shipping capability and efficiency (Figure 1). The work is anticipated to take approximately four years. The Corps has determined the deepest channel that is economically justified is 57 feet below Mean Lower Low Water (MLLW). A deeper harbor would eliminate transit delays due to tidal changes and allow larger, fully loaded ships to more efficiently and cost-effectively visit the Port. Tide restrictions, light loading, or other operational inefficiencies created by inadequate channel depth currently limits the Port's capacity to accommodate increased vessel shipping loads. The proposed action would improve navigation in the Blair Waterway by deepening and widening the existing federal channel. Specific components of the proposed action include:

- Deepening the existing Blair Waterway from a depth of -51 MLLW to -57 MLLW along its entire length (approximately 2.75 miles).
- Widening the channel from 450 feet to 865 feet at specific locations (Table 2). Armoring the waterway is not proposed.
- Install slope stabilization structures to accommodate channel widening along four sections of the waterway.
    - Areas 1 and 4 would be stabilized using riprap on a 1.5H:1V slope.
    - Areas 2 and 3 would be stabilized using secant walls with a 2H:1V waterward slope.
- Expanding the existing turning basin boundary at the end of the Blair Waterway to a diameter of 1,935 feet from 1,682 and deepening the turning basin to -57 feet MLLW.

Dredging of the Blair waterway would result in approximately 2.8 million cubic yards of sediment material. 1.85 million cubic yards of suitable[3] dredged material would be placed at the Saltchuk beneficial use site; 550,000 cubic yards of material would be placed at the Commencement Bay open water disposal site; and approximately 400,000 cubic yards of material deemed unsuitable for open water disposal or beneficial use would be transported to an upland disposal site.

[3] See https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll11/id/5397 for more information on suitable vs. unsuitable dredged materials.

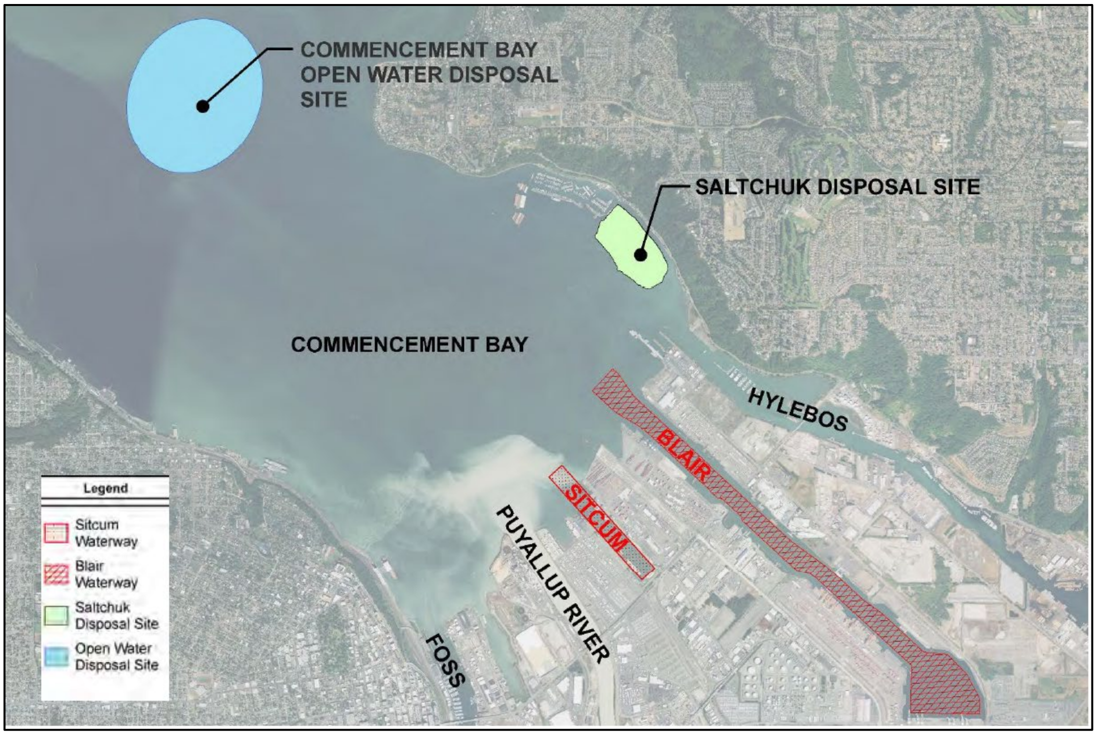

Table 2. Federally authorized and proposed widths by channel station (STA) at Blair Waterway.

Stations along the channel	Currently Authorized widths (feet)	Proposed width (feet)
STA -5 to STA 0	NA	865
STA 0 to STA 12	520	800
STA 12 to STA 44	520, narrowing to 343	520
STA 44 to STA 52	520	520
STA 52 to STA 79	520, narrowing to 330	520
STA 79 to STA 100	330	450
STA 100 to STA 116	330, widening to 1,682	525
STA 116 to STA 140 (turning basin)	1,682	1,935

1.3.1 Channel Deepening and Material Disposal

Under the recommended plan, disposal of dredged sediments would occur in three locations, including the Saltchuk beneficial use site, the Dredged Material Management Program (DMMP) open-water non-dispersive disposal site in Commencement Bay, and an upland disposal site. A mechanical clamshell bucket dredge would be used to remove suitable materials from the Blair Waterway and place approximately 1.8 million cubic yards (cy) of beneficial use sediment at the Saltchuk site and approximately 562,000 cubic yards (cy) of dredged material would be placed at the Dredged Material Management Program (DMMP) Commencement Bay open water disposal site (Figure 1). A Feasibility-level advisory suitability determination by the DMMP Agencies (U.S. Army Corps of Engineers, Washington State Department of Ecology, Washington State

Department of Natural Resource, and the Environmental Protection Agency) evaluated the potential in-water placement of 2.5 million cubic yards of dredged material from the Blair waterway at the Commencement Bay disposal site or potential beneficial use. This analysis involved the characterization of sediment core testing and indicates that approximately 392,000 cy of sediment dredged from the Blair Waterway may be unsuitable for in-water disposal, and would be transported to an upland disposal site. These quantities assume that the dredging contractor would remove the two-foot allowable over-depth during dredging. To ensure unsuitable material remains isolated during dredging, a vertical and horizontal buffer would be used in the final dredging prism design. The DMMP agencies also indicated that to ensure that unsuitable material would be separated from unsuitable material during dredging, a minimum one-foot vertical buffer and an appropriate horizontal buffer would be added to the unsuitable portions of the final dredge prism. Material deemed unsuitable for placement at Saltchuk or the Commencement Bay in-water disposal site would be removed from the channel using an environmental clamshell bucket to limit the amount of suspended and potentially unsuitable sediments.

During construction, several pieces of in-water equipment would be operating up to 24 hours per day including the dredge tugboat, barge, skiff, and survey boat. Only one dredge would be operating at a time, but would be running nearly continuously. Equipment would primarily be operating within the Blair Waterway, but the barge would travel to the open-water disposal site and the Saltchuk site to dispose of dredged materials. One or two tugboats would be used to transport barges between construction and disposal sites. Dredged materials would be placed on a barge adjacent to the site where material is actively being removed. The estimated amount of time required to complete dredging work is approximately four years, which results in roughly one-fourth to one-third of the waterway being dredged each year. A survey vessel would slowly transit the area to monitor dredging progress.

Washington Administrative Code (WAC 220-660-330) requires in-water work in commencement bay to occur between July 15 and February 15. However, to be more protective, the Corps proposed an in-water work window of August 16 to February 15, which also adheres to the in-water work window for material disposal at the Commencement Bay open-water disposal site (NMFS 2015a).

Consultations with NMFS and the U.S. Fish and Wildlife Service (USFWS) on disposal of dredged material at the DMMP open-water disposal sites in Puget Sound, including the Commencement Bay site, were conducted separately (USACE 2015; NMFS 2015a). The effects of sediment disposal at DMMP open-water disposal sites have already been considered in the programmatic formal consultation for their continued use through 2040 (NMFS 2015a), and as such, the use of the DMMP open-water disposal site for disposal of sediments are considered part of the environmental baseline for this consultation. The environmental baseline includes the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

Future maintenance dredging is not part of the proposed action, and is not considered in this Opinion. Therefore, future operation and maintenance dredging, including manner and timing, would be subject to separate, future, ESA Section 7 consultation(s).

1.3.2 Waterway Width Expansion and Slope Stabilization Measures

As proposed, the Corps will install additional side slope stabilization measures at select areas (Areas 1-4). Additional evaluation of slope stabilization measures, including no additional stabilization measures, will be considered in the Pre-construction Engineering and Design (PED) phase along the following stationing (Figure 2):

- Area 1: STA 44+00.00 to STA 48+00.00
- Area 2: STA 74+50.00 to STA 82+00.00
- Area 3: STA 94+50.00 to STA 97+50.00
- Area 4: STA 118+00.00 to STA 125+50.00

Stabilization measures include a secant wall at sites 2 and 3, which includes the existing 2:1 slope waterward of the wall, and replacement riprap at 1.5:1 slopes at sites 1 and 4[4]. The greatest extent of slope stabilization would be riprap from +10 MLLW to -57 MLLW (about 7.52 acres among four possible locations) with a secant wall (1,130 feet in length at two locations; about 4% of the total Blair Waterway shoreline: 28,566 linear feet). Where used, the proposed method for secant pile installation is augering and vibratory pile driving. Vibratory pile driving may be used to install steel casings prior to drilling. Vibratory driving may also be used to install temporary sheetpile cofferdams prior to pouring concrete. Impact pile driving would not be used at any point in the secant wall installation process. Dredging may occur before or after shoreline stabilization measures are installed. Because shoreline stabilization designs are not finalized the Corps estimates that installation of secant walls may take between 44 and 157 days depending on the diameter and height of the finalized structures. The Corps expects piles to range between 2-4 feet in diameter and 20-50 feet tall. Existing riprap would be removed prior to beginning construction.

NMFS evaluated both stabilization methods (riprap and secant stabilization) and assumed that each would be used as described in the January 12 and 20, 2022, emails from the Corps. Changes to those designs, described in detail below, would require reinitiating consultation with NMFS, except that if no armoring were determined to be necessary, reinitiation of consultation would not be necessary for that element of the proposed action.

Area 1 (STA 44+00.00 to STA 48+00.00) is about a third of the way into the channel on the southwestern side (Figure 2). Slopes extend to the edge of the adjacent upland facilities, which consist of an asphalt-paved parking lot. NMFS assumes that replacement stabilization measures in the form of 1.5H:1V slope-rock toe combination would be required at this location after conferring with the Corps. Once the design is further refined with additional analysis in PED, the

[4] Corps email on January 12, 2022 from Kaitlin Whitlock.

final engineering solution at this location may change to include a secant wall or an alternative slope stabilization measure. A change in stabilization methods from a 1.5 H:1 V slope-rock toe combination will require re-initiation, except that if no armoring were determined to be necessary, reinitiation of consultation would not be necessary for that element of the proposed action.

Area 2 (STA 74+50.00 to STA 82+00.00) is about midway into the channel on the north side. A 2H:1V slope reaches well into the uplands in Area 2, prompting the need for proposed stabilization measures. A secant wall is proposed to protect this location (January 12, 2022 email from the Corps). Once the design is further refined with additional analysis in PED, the final engineering solution at this location may change to include an alternative slope stabilization measure, which would require re-initiation of this Opinion, except that if no armoring were determined to be necessary, reinitiation of consultation would not be necessary for that element of the proposed action.

Area 3 (STA 94+50.00 to STA 97+50.00) is on the north side of the channel and is Puyallup Tribe property (Figure 2). As with Area 2, a 2H:1V slope extends into the uplands. A secant wall is proposed to protect this location (January 12, 2022 email from Kaitlin Whitlock, COE). Once the design is further refined with additional analysis in PED, the final engineering solution at this location may change to include an alternative slope stabilization measure, which would require re-initiation of this Opinion., except that if no armoring were determined to be necessary, reinitiation of consultation would not be necessary for that element of the proposed action..

Area 4 (STA 118+00.00 to STA 125+50.00) is on the north side of the channel within the entrance to the turning basin (Figure 2). It is similar to Area 1, where a 2H:1V slope marginally extends into the uplands. This area does not include upland facilities or major infrastructure, the land here is owned by the Port, and it is used for storage. The Corps proposes that replacement stabilization measures in the form of a 1.5 H:1V slope-rock toe revetment would be required at this location. Once the design is further refined with additional analysis in PED, the final engineering solution at this location may change to include a secant wall or an alternative slope stabilization measure. A change in stabilization methods from a 1.5 H:1 V slope-rock toe combination will require re-initiation, except that if no armoring were determined to be necessary, reinitiation of consultation would not be necessary for that element of the proposed action.

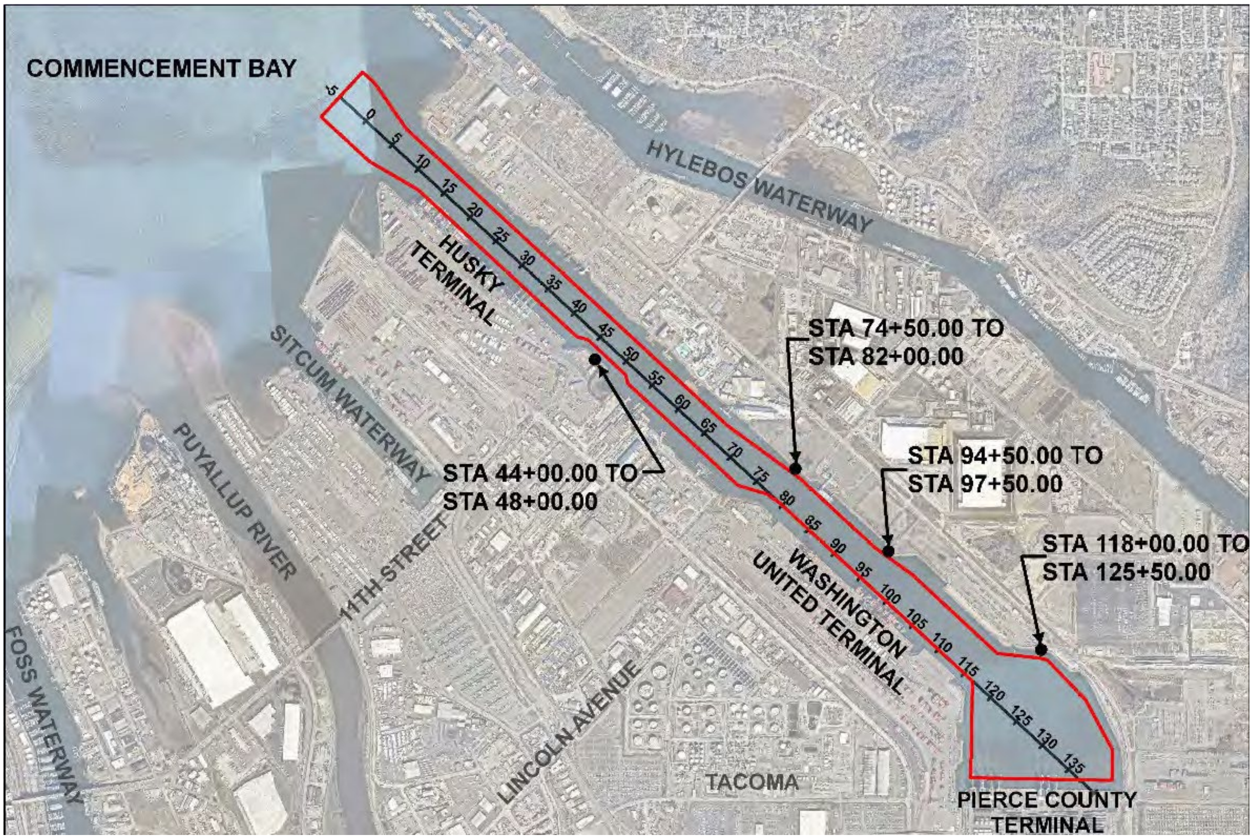

Figure 2. Potential side slope stabilization areas, Blair Waterway. Map from COE, 2020.

1.3.3 Material Placement at Saltchuk

The Saltchuk site, located north of the Blair Waterway (Figure 1), is where dredged material would be placed to restore nearshore intertidal and subtidal habitat substrate for juvenile and adult Chinook salmon, steelhead, bull trout, larval and juvenile rockfish, forage fish, and epibenthic and benthic invertebrates. The final design of the Saltchuk beneficial use site would be developed in the pre-construction engineering design (PED) phase. A full sediment characterization by DMMP agencies in PED would provide additional information to verify assumptions about in-water disposal. In addition, once further design and information is developed in PED, coordination would occur with NMFS, other natural resource agencies, and tribes to specify the criteria used to determine suitability of in-water disposal for restoration of intertidal and subtidal habitat at this location. NMFS assumes that a fully developed Saltchuk site plan is reasonably likely to occur; however, insofar as the project details are unavailable for analysis, we assume that the deposit of beneficial use sediment will occur at Saltchuk, but we do not assume that the site will develop into a fully restored site without future efforts. This is conservative assumption. The actions at Saltchuk may yield greater beneficial effects than are considered here, but a precautionary approach gives any benefit of doubt to listed species and critical habitat.

During Saltchuk disposal of dredged material, a bottom-dump barge would be used for the first bench for material deeper than -20 MLLW. A flat deck barge with a mounted excavator would be needed to place material at shallower depths. The Corps assumes a 1,200 to 3,000 cubic yard barge would be used to transport material from the Blair Waterway to the disposal sites. Based on the estimated amount of dredged material going to the disposal sites between 600 and 1,500 trips would be made over about four years depending on the size of barge.

1.3.4 Conservation Measures and Best Management Practices

Conservation measures and best management practices (BMP) described in the biological assessment that are part of the proposed action and intended to minimize adverse effects to ESA-listed species and their designated critical habitats include the following:

1. Comply with all applicable water quality standards and enforceable conditions issued in the water quality certification and adhere to monitoring protocols in the water quality monitoring plan.
2. Dredge and place material at Saltchuk only within the designated in-water work window of August 16 through February 15.
3. Prior to dredging, the entire footprint of the Blair waterway project area would undergo additional sediment testing to determine suitability for aquatic disposal, and all material determined unsuitable for in-water disposal would be transported for upland disposal at an appropriate facility.
4. An environmental clamshell bucket would be used in all areas in which sediment has been determined unsuitable for aquatic disposal to minimize resuspension of contaminated sediment.
5. The side slopes of the navigation channel would be graded to ensure that no sloughing would occur.
6. All equipment would be inspected daily to ensure that it is in proper working condition and has no leaks of fuel or hydraulic fluids. Each vessel would have a spill kit on board at all times.

NMFS also considered whether or not the proposed action would cause any other activities. We determined that the proposed action would alter the future shipping in Puget Sound. The deeper depth would allow for Post-Panamax vessels currently calling on the port to transport more cargo more efficiently. The Draft Integrated Feasibility Report/Environmental Assessment (IFR/EA; COE, 2021) prepared for this project reports that channel deepening does not increase the Port's landside capacity or decrease transportation costs by enough to increase the Port's container market share. As a result, the analysis assumes channel deepening does not induce additional cargo volume or vessel calls. Instead, deepening to -57 MLLW allows vessels to load to their full draft and carry more cargo in each transit. The greater efficiency provided at the terminals results in shipping services requiring fewer total trips to transport the same cargo volume (thereby reducing transportation costs). The analysis in the IFR/EA (COE, 2021) shows a channel deepening in the Blair Waterway to -57 MLLW would lead to a reduction of 150 and 163 vessel calls in 2030 and 2035, respectively (Table 3). This represents a 27 percent reduction in total vessel calls as a result of the proposed action. Additionally, channel deepening can reduce or eliminate the practice of ships sitting idle in Commencement Bay waiting for appropriate tide conditions to transit the waterway. By lowering and eliminating wait times at the Port the total time each vessel is emitting underwater noise in central Puget Sound would be reduced.

For the purposes of the analysis in this Opinion, a reduction in vessel traffic in the navigation channel is considered a consequence of the proposed action. Current levels of vessel traffic are not considered a consequence of the proposed action because that traffic would likely continue to occur even without the proposed action. In other words, the proposed action is considered to reduce impacts, such as noise and risk of marine mammal strike, caused by vessels calling on the Port of Tacoma Blair Waterway.

Table 3. Vessel calls to the Port of Tacoma Blair Waterway by year (2030 and 2035), class, and channel depth (current vs. proposed). Vessel draft to and from the Port is indicated for each vessel class. Table adapted from the 2020 Corps Biological Assessment.

Vessel Class	Draft Depth, To (ft.)	Draft Depth, From (ft.)	Current Depth (-51 ft. MLLW)	Proposed Depth (-57 ft. MLLW)
2030				
Panamax – PX	30.8	44.8	0	0
Post Panamax – PPX1	35.4	47.6	49	0
Super Post-Panamax – PPX2	39.4	49.2	155	54
Ultra Post-Panamax – PPX3	40	53	229	229
New Post-Panamax – PPX4	45	54	116	116
		Total Calls	**549**	**399**
2035				
Panamax – PX	30.8	44.8	0	0
Post Panamax – PPX1	35.4	47.6	81	0
Super Post-Panamax – PPX2	39.4	49.2	132	50
Ultra Post-Panamax – PPX3	40	53	189	189
New Post-Panamax – PPX4	45	54	189	189
		Total Calls	**591**	**428**

1.4 Action Area

"Action area" means all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area is determined by the greatest extent of physical, chemical, and biological effects stemming from the project. The proposed action would cause a range of effects including temporary effects related to construction, intermittent effects caused by reduced marine vessels, and enduring effects related to deepening and widening of Blair Waterway and the placement of dredged sediment at Saltchuk.

The Corps defines the action area as a 3-mile radius surrounding the Blair Waterway to fully capture the effects within Commencement Bay and the lower Puyallup River, including potential noise and turbidity effects from dredging operations. We expect the low current velocity in the Blair Waterway would limit the distance fine particles would travel from dredging site based on available aerial imagery from the Puyallup River (see Figure 1). Likewise, we anticipate that sound effects (noise) would attenuate within 3 miles of dredging operations due to the use of a clamshell bucket. We expanded the action area to include the shipping lanes of Puget Sound leading to Blair Waterway (Figure 3). The proposed action is expected to reduce the number of vessels utilizing the Port because the deeper depth would allow vessels currently using the Port to be loaded to full capacity per trip (as described above in Section 1.3).

The greater efficiency for each vessel would lead to a reduction in vessel calls on the Port for the foreseeable future. While the reduction in vessel use at the Port would be most concentrated around the Port itself, each vessel travels through Puget Sound via shipping lanes to reach Commencement Bay; meaning impacts from reduced vessel trips extend beyond the Blair Waterway in Commencement Bay, to include transit through Puget Sound. Only a portion of effects are expected to extend into the shipping lanes of the Puget Sound (described more thoroughly in Section 2.4) and these effects are expected to be entirely positive on listed species and critical habitat. The action area overlaps with the geographic ranges of the ESA-listed species and the boundaries of some designated critical habitats identified in Table 1. The action area also overlaps with areas that have been designated, under the MSA, as EFH for Pacific Coast salmon, Pacific Coast groundfish, and coastal pelagic species.


US-Canada
Pacific Coast
Puget Sound
Shipping Lanes
Puget Sound
Commencement Bay
Open Water Disposal
Site
Commencement Bay
Dash Point
State
Park
Saltchuk
Site
King
Pierce
Approximation
of Action Area
3-mile radius
Hylebos
Waterway
Blair
Waterway
Blair Waterway
Sitcum
Waterway
Puyallup River
Port of Tacoma
Manufacturing/Industrial
Center
Middle
Waterway
Tacoma
Wheeler
Osgood

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

The Corps determined that the proposed action is likely to adversely affect PS Chinook salmon, PS/GB yelloweye rockfish, and PS/GB bocaccio, and is likely to adversely affect designated critical habitat for PS Chinook salmon (Table 1). The Corps determined that the proposed action is not likely to adversely affect PS steelhead, SRKW, green sturgeon, or Eulachon or SRKW and PS steelhead critical habitat (Corps 2020a, 2020b).

NMFS considered effects of the proposed action on the species listed in Table 1. NMFS included humpback whales, Central America and Mexico DPSs, in this Opinion given the action area includes large portions of the Puget Sound including areas where humpback whales have been observed and are periodically known to occur.

2.1 Analytical Approach

This Opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This Opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this Opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The 2019 regulations define effects of the action using the term “consequences” (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision does not change the scope of our analysis, and in this Opinion we use the terms “effects” and “consequences” interchangeably.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

The following analysis evaluates a 50-year period to determine project effects on ESA-listed species and critical habitat. The 50-year period was derived from the economic analysis completed by the Corps as part of the Integrated Feasibility Report and Environmental Assessment (IFR/EA), which examines the economic impacts of widening and deepening the channel over a 50-year period. We utilized the same 50-year time period to evaluate project effects because it is difficult to anticipate how baseline conditions may change beyond 50-years. Moreover, given the dynamic economic and industrial nature of the Port of Tacoma, uncertainty associated with the response of species and habitats to climate change, and expected population growth and industrial and residential development in the Puget Sound (discussed in more detail in Section 2.5), it would be impossible to analyze effects of the proposed action past 50-years.

The following effects analysis of the proposed action on ESA-listed species and critical habitats was limited due to the feasibility phase-level design information provided by the Corps. As part of the Corps’ planning process, further work would occur should Congress authorize the recommended plan and provide appropriations to conduct further engineering and final designs. Therefore assumptions were made in order to complete the effects analysis included in this Opinion. Specifically, we assume that placement of dredged material at the Saltchuk beneficial use site is reasonably likely to occur, but would not result in a fully restored site without future efforts. Additionally, we assume that slope stabilization measures as described in Section 1.3.2 are reasonably likely to occur as part of the proposed channel widening; if slope stabilization methods or locations change as a result of final engineering analysis in PED, future reinitiation of consultation with NMFS would likely be required. Vessel traffic is anticipated to decrease as a result of the proposed action, but, as discussed in the effects section, we lack sufficient information to evaluate changes from the environmental baseline from some aspects of the larger vessels. Finally, we assume that all conservation measures and BMPs would be implemented as described in the Proposed Action section above (Section 1.3.3) and the BA.

2.2 Rangewide Status of the Species and Critical Habitat

This Opinion examines the status of each species that is likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The Opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species.

One factor affecting the status of ESA-listed species considered in this Opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of designated critical habitats in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snowpack, increases winter flows, and advances the timing of spring melt (Mote et al. 2014; Mote et al 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013; Mote et al. 2014).

During the last century, average regional air temperatures in the Pacific Northwest increased by 1-1.4°F as an annual average, and up to 2°F in some seasons (based on average linear increase per decade; Abatzoglou et al. 2014; Kunkel et al. 2013). Recent temperatures in all but two years since 1998 ranked above the 20th century average (Mote et al. 2014). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014).

Decreases in summer precipitation of as much as 30 percent by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote et al. 2013). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

The combined effects of increasing air temperatures and decreasing spring through fall flows are expected to cause increasing stream temperatures; in 2015 this resulted in 3.5-5.3°C increases in Columbia Basin streams and a peak temperature of 26°C in the Willamette (NWFSC 2015).

Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009).

The Northwest Fishery Science Center (NWFSC 2015) reported that model projections of climate conditions affecting Puget Sound salmonids were not optimistic, and recent and unfavorable environmental trends are expected to continue. A negative pattern in the Pacific Decadal Oscillation[5] has recently emerged, which adds uncertainty to the short-term duration of warming trends. However, the long-term trends of climate change and other environmental indicators suggest the continuation of warming ocean temperatures; fragmented or degraded freshwater spawning and rearing habitat; reduced snowpack; altered hydrographs producing reduced summer river flows and warmer water; and low marine survival for salmonids in the Salish Sea (NWFSC 2015). Overall, the marine heat wave in 2014-2016 had the most drastic impact on marine ecosystems in 2015, with lingering effects into 2016 and 2017. Conditions had somewhat returned to "normal" in 2018, but another marine heat wave in 2019 again set off a series of marine ecosystem changes across the North Pacific (Ford, in press). One reason for lingering effects of ecosystem response is due to biological lags. These lags result from species impacts at larval or juvenile stages, which are typically most sensitive to extreme temperatures or changes in food supply. It is only once these species grow to adult size or recruit into fisheries that the impact of the heat wave is apparent.

Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen (DO) and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999; Winder and Schindler 2004; Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright & Weitkamp 2013; Raymondi et al. 2013).

As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode et al. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (McMahon and Hartman 1989; Lawson et al. 2004).

In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0-3.7°C by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and

[5] https://www.ncdc.noaa.gov/teleconnections/pdo/.

abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011; Reeder et al. 2013).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. A 38 percent to 109 percent increase in acidity is projected by the end of this century in all but the most stringent CO_2 mitigation scenarios, and is essentially irreversible over a time scale of centuries (IPCC 2014). Regional factors appear to be amplifying acidification in the Northeast Pacific Ocean, which is occurring earlier and more acutely than in other regions and is already impacting important local marine species (Barton et al. 2012; Feely et al. 2012). Acidification also affects sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012; Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011; Reeder et al. 2013). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Tillmann and Siemann 2011; Reeder et al. 2013).

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these evolutionarily significant units ESUs (Ford, in press). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney et al. 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of ESA-listed species in the future.

2.2.1 Status of ESA-Listed Fish Species

For Pacific salmon, steelhead, and certain other listed fish species, we commonly use the four “viable salmonid population” (VSP) criteria (McElhany et al. 2000) to assess the viability of the populations that, together, constitute the species. These four criteria (spatial structure, diversity, abundance, and productivity) encompass the species’ “reproduction, numbers, or distribution” as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, populations can adapt to various environmental conditions and sustain in the natural environment.

“Spatial structure” refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population’s spatial structure depends on quality and spatial configuration critical habitat, and the dispersal characteristics and dynamics of individuals in the population.

“Diversity” refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation in single genes to complex life history traits (McElhany et al. 2000).

“Abundance” generally refers to the number adults in the naturally produced (i.e., the progeny of naturally spawning parents) in the environment (e.g., on spawning grounds).
“Productivity,” as applied to viability factors, refers to the entire life cycle (i.e., the number of naturally-spawning adults produced per parent). When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhany et al. (2000) use the terms “population growth rate” and “productivity” interchangeably when referring to production over the entire life cycle. They also refer to “trend in abundance,” which is the manifestation of long-term population growth rate.

For species with multiple populations, once the biological status of a species’ populations has been determined, we assess the status of the entire species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany et al. 2000).

The summaries that follow describe the status of ESA-listed PS Chinook salmon, PS steelhead, and PS/GB yelloweye and bocaccio rockfish that occur within the geographic area of the proposed action analyzed in this Opinion. More detailed information on the status and trends of these listed resources, and their biology and ecology, are in the listing regulations and critical habitat designations published in the Federal Register (Table 1).

Status of Puget Sound Chinook Salmon

The PS Chinook salmon evolutionarily significant unit (ESU) was listed as threatened on June 28, 2005 (70 FR 37160) (Table 1). NMFS adopted a recovery plan for this ESU in January 2007. The recovery plan consists of two documents: the Puget Sound salmon recovery plan (Shared Strategy for Puget Sound 2007) and a supplement by NMFS (2006). The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus et al. 2002). The PSTRT’s biological recovery criteria will be met when all of the following conditions are achieved:

- The viability status of all populations in the ESU is improved from current conditions, and when considered in the aggregate, persistence of the ESU is assured;
- Two to four Chinook salmon populations in each of the five biogeographical regions of the ESU achieve viability, depending on the historical biological characteristics and acceptable risk levels for populations within each region;
- At least one population from each major genetic and life history group historically present within each of the five biogeographical regions is viable;
- Tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations are functioning in a manner that is sufficient to support an ESU-wide recovery scenario; Production of Chinook salmon from tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations occurs in a manner consistent with ESU recovery; and
- Populations that do not meet the viability criteria for all VSP parameters are sustained to provide ecological functions and preserve options for ESU recovery.

On October 4, 2019, NMFS published notice of NMFS' intent to initiate a new 5-year status review for 28 listed species of Pacific salmon and steelhead and requesting updated information from the public to inform the status review (84 FR 53117). On March 24, 2020, NMFS extended the public comment period, from the original March 27, 2020, through May 26, 2020 (85 FR 16619). The Northwest Fishery Science Center (NWFSC), and NMFS' West coast Regional Office (WCRO) are currently preparing the final status review documents. In this section, we utilize some of the information in the draft viability risk assessment (Ford, in press), in order to provide the most recent information for our evaluation in this Opinion.

Where possible, particularly as new material becomes available, the latest final status review information (NMFS 2016) is supplemented with more recent information and other population specific data that may not have been available during the status review, so that NMFS is assured of using the best available information for this Opinion.

Spatial Structure and Diversity: The Puget Sound Chinook salmon ESU includes all naturally spawning populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington. The ESU also includes the progeny of numerous artificial propagation programs (NWFSC 2015). The PSTRT identified 22 extant populations, grouped into five major geographic regions, based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity. The PSTRT distributed the 22 populations among five major biogeographical regions, or major population groups (MPG), that are based on similarities in hydrographic, biogeographic, and geologic characteristics.

Three of the five MPGs (Strait of Juan de Fuca, Georgia Basin, and Hood Canal) contain only two populations, both of which must be recovered to viability to recover the ESU (NMFS 2006b). Under the Puget Sound Salmon Recovery Plan, the Suiattle and one each of the early, moderately early, and late run-timing populations in the Whidbey Basin Region, as well as the

White and Nisqually (or other late-timed) populations in the Central/South Sound Region must also achieve viability (NMFS 2006b).

The Technical Recovery Team (TRT) did not define the relative roles of the remaining populations in the Whidbey and Central/South Sound Basins for ESU viability. Therefore, NMFS developed additional guidance which considers distinctions in genetic legacy and watershed condition, among other factors, in assessing the risks to survival and recovery of the listed species by the proposed actions across all populations within the PS Chinook ESU. In doing so, it is important to take into account whether the genetic legacy of the population is intact or if it is no longer distinct within the ESU. Populations are defined by their relative isolation from each other and by the unique genetic characteristics that evolve, as a result of that isolation, and adaption to their specific habitats. If these populations still retain their historic genetic legacy, then the appropriate course, to ensure their survival and recovery, is to preserve that genetic legacy and rebuild those populations. Preserving that legacy requires both a sense of urgency and the actions necessary and appropriate to preserve the legacy that remains. However, if the genetic legacy is gone, then the appropriate course is to recover the populations using the individuals that best approximate the genetic legacy of the original population, reduce the effects of the factors that have limited their production, and provide the opportunity for them to readapt to the existing conditions.

In keeping with this approach, NMFS further classified PS Chinook populations into three tiers based on a systematic framework that considers the population's life history and production and watershed characteristics (NMFS 2010) (Figure 4). This framework, termed the Population Recovery Approach, carries forward the biological viability and delisting criteria described in the Supplement to the Puget Sound Salmon Recovery Plan (Ruckelshaus et al. 2002; NMFS 2006b). The assigned tier indicates the relative role of each of the 22 populations comprising the ESU to the viability of the ESU and its recovery. Tier 1 populations are most important for preservation, restoration, and ESU recovery. Tier 2 populations play a less important role in recovery of the ESU. Tier 3 populations play the least important role. When we analyze proposed actions, we evaluate impacts at the individual population scale for their effects on the viability of the ESU. We expect that impacts to Tier 1 populations would be more likely to affect the viability of the ESU, as a whole, than similar impacts to Tier 2 or 3 populations, because of the relatively greater importance of Tier 1 populations to overall ESU viability and recovery. NMFS has incorporated this and similar approaches in previous ESA section 4(d) determinations and Opinions on Puget Sound salmon fisheries and regional recovery planning (NMFS 2005b; 2005d; 2008f; 2008e; 2010a; 2011a; 2013b; 2014b; 2015c; 2016f; 2017b; 2018c; 2019b; 2021e).

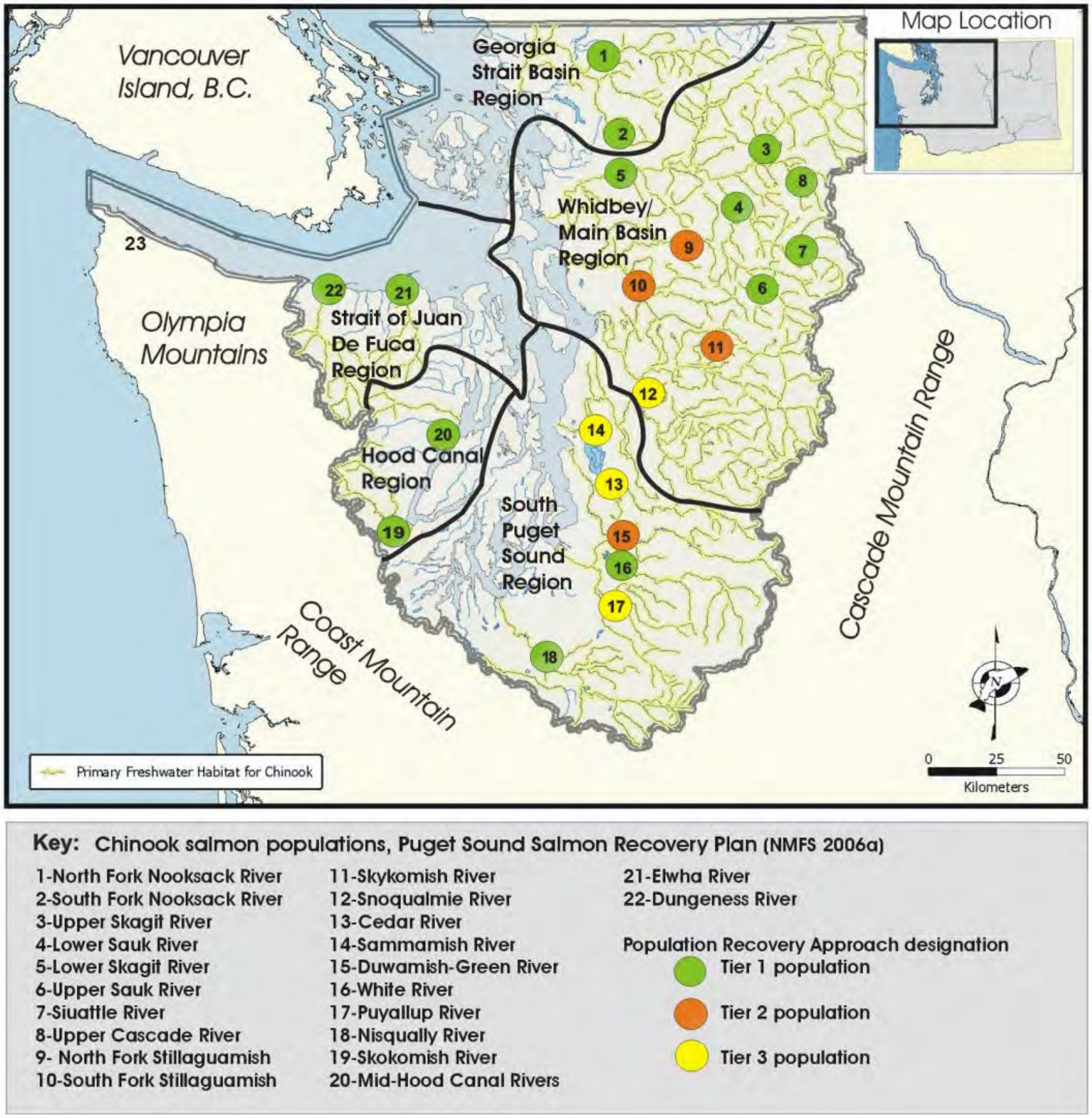

Figure 4. Puget Sound Chinook populations with tiered recovery designations.

The ESU also includes Chinook salmon from certain artificial propagation programs. Artificial propagation (hatchery) programs (26) were added to the listed Chinook salmon ESU in 2005, as part of the final listing determinations for 16 ESUs of West Coast Salmon and Final 4(d) Protective Regulations for Threatened Salmonid ESUs (70 FR 37160). In October of 2016, NMFS proposed revisions to the hatchery programs included as part of some Pacific salmon ESUs and steelhead DPSs listed under the ESA (81 FR 72759). NMFS issued its final rule in December of 2020, which includes 25 hatchery programs as part of the listed Puget Sound Chinook salmon ESU (85 FR 81822).

Since 1999, most PS Chinook populations have mean natural-origin spawner escapement levels well below levels identified as required for recovery to low extinction risk. Long-term, natural-origin mean escapements for eight populations are at or below their critical thresholds.[6] Both populations in three of the five biogeographical regions are below or near their critical threshold: Georgia Strait, Hood Canal and Strait of Juan de Fuca. When hatchery spawners are included, aggregate average escapement is over 1,000 for one of the two populations in each of these three regions, reducing the demographic risk to the populations in these regions. Additionally, hatchery spawners help two of the remaining three of these populations achieve total spawner abundances above their critical threshold, reducing demographic risk. Nine populations are above their rebuilding thresholds,[7] seven of them in the Whidbey/Main Basin Region. In 2018 NMFS and the NWFSC updated the rebuilding thresholds for several key Puget Sound populations. These thresholds represent the Maximum Sustained Yield estimate of spawners based on available habitat. The new spawner-recruit analyses for several populations indicated a significant reduction in the number of spawners that can be supported by the available habitat when compared to analyses conducted 10 to 15 years ago. This may be due to further habitat degradation or improved productivity assessment or, more likely, a combination of the two. For example, the updated rebuilding escapement threshold for the Green River is 1,700 spawners compared to the previous rebuilding escapement threshold of 5,523 spawners[8]. So, although several populations are above the updated rebuilding thresholds, indicating that escapement is sufficient for the available habitat in many cases, the overall abundance has declined.

Measures of spatial structure and diversity can give some indication of the resilience of a population to sustain itself. Spatial structure can be measured in various ways, but here we assess the proportion of natural-origin spawners (wild fish) vs. hatchery-origin spawners on the spawning grounds (Ford, in press).

Since 1990, there is a general declining population trend in the proportion of natural-origin spawners across the ESU (Table 4). While there are several populations that have maintained high levels of natural-origin spawner proportions, mostly in the Skagit and Snohomish basins, many others maintain high proportions of hatchery-origin spawners (Table 4). It should be noted that the pre-2005-2009 estimates of mean natural-origin fractions occurred prior to the widespread adoption of mass marking of hatchery produced fish. Estimates of hatchery and natural-origin proportions of fish since the implementation of mass marking are considered more robust. Several of these populations have long-standing or more recent conservation hatchery programs associated with them—North Fork (NF) and South Fork (SF) Nooksack, NF and SF

[6] After taking into account uncertainty, the critical threshold is defined as a point below which: (1) depensatory processes are likely to reduce the population below replacement; (2) the population is at risk from inbreeding depression or fixation of deleterious mutations; or (3) productivity variation due to demographic stochasticity becomes a substantial source of risk (NMFS 2000).

[7] The rebuilding threshold is defined as the escapement that will achieve Maximum Sustainable Yield (MSY) under current environmental and habitat conditions (NMFS 2000), and is based on an updated spawner-recruit assessment in the Puget Sound Chinook Harvest Management Plan, December 1, 2018. Thresholds were based on population-specific data, where available.

[8] The historic Green River escapement goal was established in 1977 as the average of estimated natural spawning escapements from 1965-1974. This goal does not reflect the lower productivity associated with the current condition of habitat. Reference the source for the historical objective from MUP (PSIT and WDFW 2017)(Green River MUP).

Stillaguamish, White River, Mid-Hood Canal, Dungeness, and the Elwha. These conservation programs are in place to maintain or increase the overall abundance of these populations, helping to conserve the diversity and increase the spatial distribution of these populations in the absence of properly functioning habitat. With the exception of the Mid-Hood Canal program, these conservation hatchery programs culture the extant, native Chinook salmon stock in these basins. With the exception of the NF and SF Stillaguamish, the remainder of the populations included in these conservation programs are identified in NMFS (2006b) as essential for the recovery of the Puget Sound Chinook salmon ESU (Table 4).

Table 4. Five-year mean of fraction of natural-origin spawners[9] (sum of all estimates divided by the number of estimates) (Ford, in press).

Population	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019
NF Nooksack R. spring	0.28	0.11	0.19	0.14	0.13
SF Nooksack R. spring	0.26	0.55	0.57	0.42	0.45
Low. Skagit R. fall	0.94	0.91	0.86	0.92	0.84
Up. Skagit R. summer	0.91	0.87	0.84	0.95	0.91
Cascade R. spring	0.98	0.92	0.89	0.94	0.86
Low. Sauk R. summer	0.94	0.97	0.95	0.91	0.98
Up. Sauk R. spring	0.99	1.00	0.98	0.97	0.99
Suiattle R. spring	0.99	0.97	0.99	0.99	0.97
NF Stillaguamish R. summer/fall	0.59	0.70	0.40	0.43	0.45
SF Stillaguamish R. summer/fall	0.59	0.70	0.40	0.54	0.46
Skykomish R. summer	0.49	0.52	0.76	0.69	0.62
Snoqualmie R. fall	0.81	0.89	0.81	0.78	0.75
Sammamish R. fall	0.29	0.36	0.16	0.07	0.16
Cedar R. fall	0.61	0.59	0.82	0.78	0.71
Green R. fall	0.55	0.47	0.43	0.39	0.30
White R. spring	0.54	0.79	0.43	0.32	0.15
Puyallup R. fall	0.88	0.79	0.52	0.41	0.32
Nisqually R. fall	0.80	0.61	0.30	0.30	0.47
Skokomish R. fall	0.40	0.46	0.45	0.10	0.16
Mid-Hood Canal fall	0.76	0.79	0.61	0.33	0.89
Dungeness R. summer	1.00	0.32	0.43	0.25	0.25
Elwha R. fall	0.41	0.53	0.35	0.06	0.05

In addition, spatial structure, or geographic distribution, of the White, Skagit, Elwha,[10] and Skokomish populations has been substantially reduced or impeded by the loss of access to the upper portions of those tributary basins due to flood control activities and hydropower development. Habitat conditions conducive to salmon survival in most other watersheds have been reduced significantly by the effects of land use, including urbanization, forestry, agriculture, and development (NMFS 2005a; SSPS 2005; NMFS 2008c; 2008d; 2008b). It is

[9] Estimates of hatchery and natural-origin spawning abundances, prior to the 2005-2009 period are based on pre-mass marking of hatchery-origin fish and, as such, may not be directly comparable to the 2005-2009 forward estimates.
[10] Removal of the two Elwha River dams and restoration of the natural habitat in the watershed began in 2011.

likely that genetic and life history diversity has been significantly adversely affected by this habitat loss.

Between 1990 and 2021, the proportion of natural-origin spawners has trended downward across the ESU, with the Whidbey Basin the only MPG with consistently high fractions of natural-origin spawner abundance. All other MPG have either variable or declining spawning populations with high proportions of hatchery-origin spawners (NWFSC 2015, Ford, in press). Overall, the new information on abundance, productivity, spatial structure and diversity since the 2015 status review supports no change in the biological risk category (NWFSC 2015; Ford, in press).

Abundance and Productivity: The abundance of the PS Chinook salmon over time shows that individual populations have varied with increasing or decreasing abundance. Generally, many populations experienced increases in total abundance during the years 2000-2008, and more recently in 2015-2017, but general declines during 2009-2014, and a downturn again in the two most recent years available for the current status review, 2017-2018. Abundance across the Puget Sound ESU has generally increased since the last status review, with only 2 of the 22 populations (Cascade and North Fork and South Fork Stillaguamish) showing a negative percent change in the 5-year geometric mean natural- origin spawner abundances since the prior status review (Table 5). However, 15 of 20 populations with positive percent change in the 5-year geometric mean natural-origin spawner abundances since the prior status review have relatively low population abundances of <1000 fish, so some of these increases represent small changes in total abundance (Ford, in press). Also, given lack of high confidence in survey techniques, particularly with small populations, there is substantial uncertainty in quantifying fish and detecting trends in small populations (Gallagher et al. 2010).

Table 5. Extant PS Chinook salmon populations in each biogeographic region and percent change between the most recent two 5-year periods (2010-2014 and 2015-2019). Five-year geometric mean of raw natural-origin spawner counts. This is the raw total spawner estimate times the fraction natural-origin estimate, if available. In parentheses, 5-year geometric mean of raw total spawner estimates (i.e., hatchery and natural) are shown. A value only in parentheses means that a total spawner estimate was available but no (or only one) estimate of natural-origin spawners was available. The geometric mean was computed as the product of estimates raised to the power 1 over the number of counts available (2 to 5). A minimum of 2 values were used to compute the geometric mean. Percent change between the most recent two 5-year periods is shown on the far right (Ford, in press).

Biogeographic Region	Population (Watershed)	2010-2014	2015-2019	Population trend (% change)
Strait of Georgia	**North Fork Nooksack River**	136 (1205)	137 (1553)	Positive 1% (29)
	South Fork Nooksack River	13 (35)	42 (106)	Positive 223% (203)
Strait of Juan de Fuca	**Elwha River**	71 (1349)	134 (2810)	Positive 89% (108)
	Dungeness River	66 (279)	114 (476)	Positive 73% (71)
Hood Canal	**Skokomish River**	136 (1485)	265 (2074)	Positive 95% (40)
	Mid Hood Canal River	80 (295)	196 (222)	Positive 145% (-25)
Whidbey Basin	Skykomish River	1698 (2462)	1736 (2806)	Positive 3% (14)
	Snoqualmie River	839 (1082)	856 (1146)	Positive 2% (6)
	North Fork Stillaguamish River	417 (996)	302 (762)	Negative 28% (-23)
	South Fork Stillaguamish River	34 (68)	37 (96)	Positive 9% (41)
	Lower Skagit River	1416 (1541)	2130 (2640)	Positive 50% (71)
	Upper Sauk River	854 (880)	1318 (1330)	Positive 54% (51)
	Lower Sauk River	376 (416)	635 (649)	Positive 69% (56)
	Suiattle River	376 (378)	640 (657)	Positive 70% (74)
	Upper Cascade River	298 (317)	185 (223)	Negative 38% (-30)
Central/South Puget Sound Basin	North Lake Washington/ Sammamish River	82 (1289)	126 (879)	Positive 54% (-32)
	Green/Duwamish River	785 (2109)	1822 (6373)	Positive 132% (202)
	Puyallup River	450 (1134)	577 (1942)	Positive 28% (71)
	White River	652 (2161)	895 (6244)	Positive 37% (189)
	Cedar River	699 (914)	889 (1253)	Positive 27% (37)
	Nisqually River	481 (1823)	766 (1841)	Positive 59% (1)

Trends in abundance over longer time periods are generally slightly negative. Fifteen-year trends in log natural-origin spawner abundance were computed over two time periods (1990-2005 and 2004- 2019) for each Puget Sound Chinook salmon population. Trends were negative in the latter period for 16 of the 22 populations and for four of the 22 populations (SF Nooksack, SF Stillaguamish, Green and Puyallup) in the earlier period. Thus, there is a general decline in natural-origin spawner abundance across all MPGs in the recent fifteen years. Upper Sauk and Suiattle (Whidbey Basin MPG), Nisqually (Central/South MPG) and Mid-Hood Canal (Hood Canal MPG) are the only populations with positive trends, though Mid-Hood Canal has an extremely low population size. Further, no change in trend between the two time periods was detected in SF Nooksack (Strait of Georgia MPG), Green and Nisqually (Central/South MPG). The average trend across the ESU for the 1990-2005 15-year time period was 0.03 (Figure 5). The average trend across the ESU for the later 15-year time period (2004-2019) was -0.02. The previous status review in 2015 (NWFSC 2015) concluded there were widespread negative trends for the total ESU despite that escapements and trends for individual populations were variable. The addition of the data to 2018 now also shows even more substantially either flat or negative trends for the entire ESU in natural-origin Chinook salmon spawner population abundances (Ford, in press).

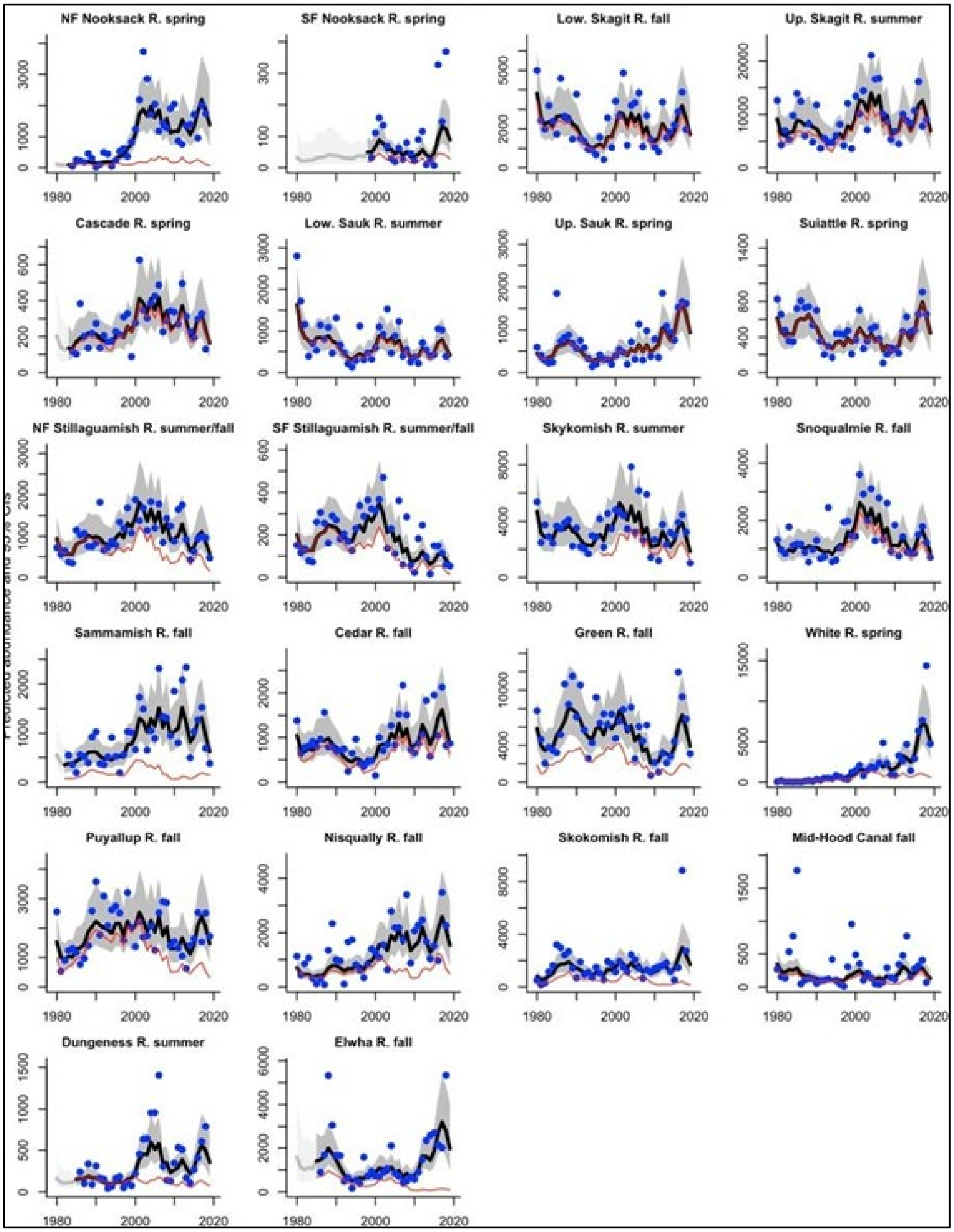

Figure 5. Smoothed trend in estimated total (thick black line, with 95 percent confidence internal in gray) and natural (thin red line) PS Chinook salmon population spawning abundance. In portions of a time series where a population has no annual estimate but smoothed spawning abundance is estimated from correlations with other populations the smoothed estimate is shown in light gray. Points show the annual raw spawning abundance estimates. For some trends the smoothed estimate may be influenced by earlier data points not included in the plot (Ford, in press).

Across the Puget Sound ESU, 10 of 22 Puget Sound populations show natural productivity below replacement in nearly all years since the mid-1980's (Figure 5). These include the North and South Forks Nooksack in the Strait of Georgia MPG, North and South Forks Stillaguamish and Skykomish in Whidbey Basin MPG, Sammamish, Green and Puyallup in the Central/South MPG, the Skokomish in the Hood Canal MPG, and Elwha in the Strait of Juan de Fuca MPG. Productivity in the Whidbey Basin MPG populations was above zero the mid-late 1990's, with the exception of Skykomish and North and South Forks Stillaguamish populations. White River population in the Central/South MPG was above replacement from the early 1980's to 2001, but has dropped in productivity consistently since the late 1980's. In recent years, only 5 populations have had productivities above zero. These are Lower Skagit, Upper Skagit, Lower Sauk, Upper Sauk, and Suiattle, all Skagit River populations in the Whidbey Basin MPG. This is consistent with, and continues the decline reported in the 2015 Status Review (NWFSC 2015).

All Puget Sound Chinook salmon populations continue to remain well below recovery levels (Ford, in press). Most populations also remain consistently below the spawner-recruit levels identified by the TRT as necessary for recovery. Across the ESU, most native-origin populations have slightly increased in abundance since the last status review in 2016, but have small negative trends over the past 15 years (Figure 6). Productivity remains low in most populations. Hatchery-origin spawners are present in high fractions in most populations outside the Skagit watershed, and in many watersheds the fraction of spawner abundances that are natural-origin have declined over time. Habitat protection, restoration and rebuilding programs in all watersheds have improved stream and estuary conditions despite record numbers of humans moving into the Puget Sound region in the past two decades. Bi-annual four-year work plans document the many completed habitat actions that were initially identified in the Puget Sound Chinook salmon recovery plan. However, the expected benefits from restoration actions is likely to take years or decades to produce significant improvement in natural population viability parameters (see Roni et al. 2010).

Development of a monitoring and adaptive management program was required by NMFS in the 2007 Supplement to the Shared Strategy Recovery Plan (NMFS 2006b), and since the last review the Puget Sound Partnership has completed this, but this program is still not fully functional for providing an assessment of watershed habitat restoration/recovery programs, nor does it fully integrate the essentially discrete habitat, harvest and hatchery programs. A recent white paper produced by the Salmon Science Advisory Group, of the Puget Sound Partnership concludes there has been "a general inability of monitoring to link restoration, changes in habitat conditions, and fish response at large-scales" (PSP 2021). A number of watershed groups are in the process of updating their Recovery Plan Chapters and this includes prioritizing and updating recovery strategies and actions, as well as assessing prior accomplishments. Overall, recent information on PS Chinook salmon abundance and productivity since the 2016 status review indicates a slight increase in abundance but does not indicate a change in biological risk to the ESU despite moderate inter-annual variability among populations and a general decline in abundance over the last 15 years (Ford, in press).

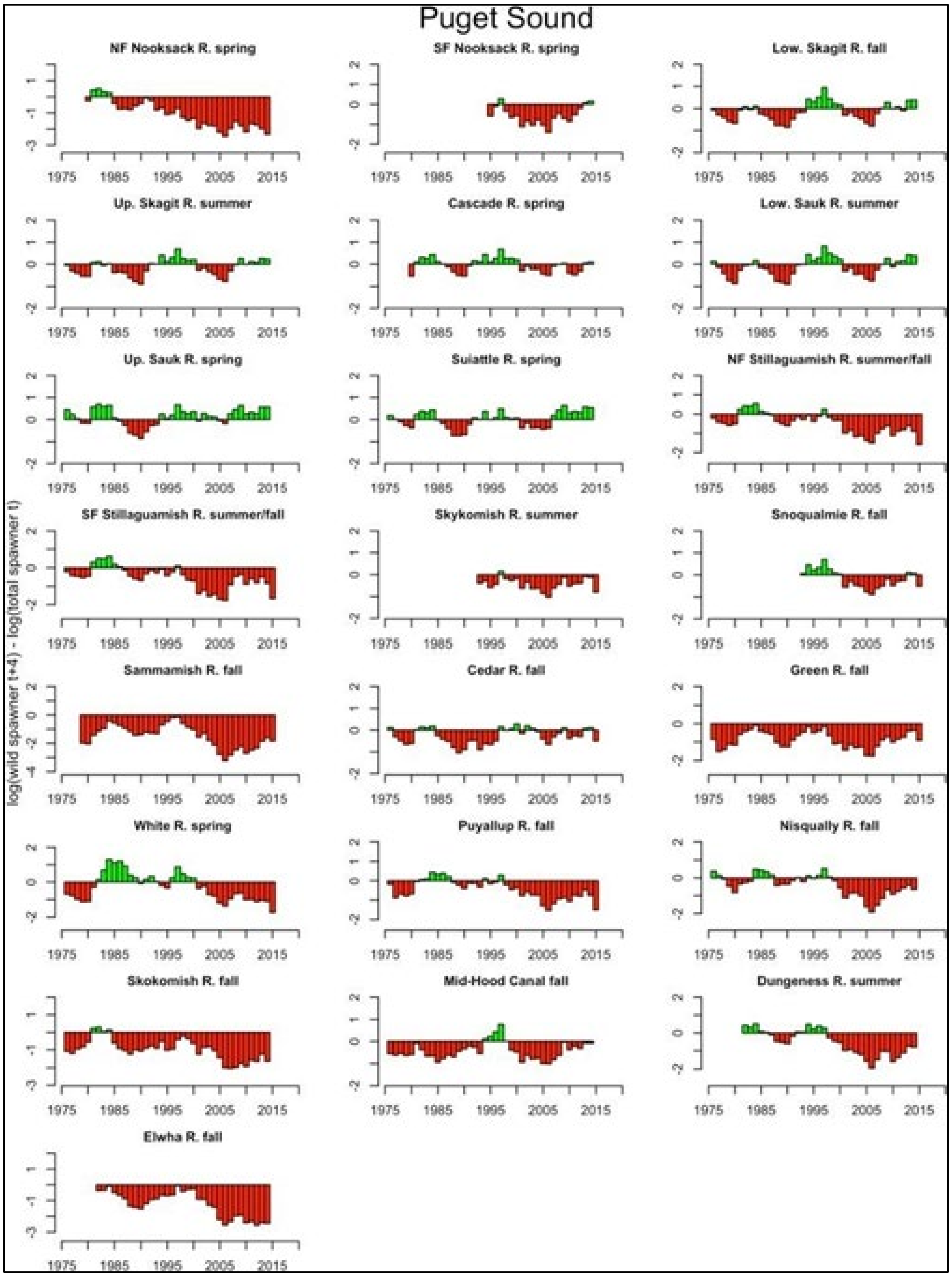

Figure 6. Trends in Chinook salmon population productivity, estimated as the log of the smoothed natural-origin spawning abundance in year t – smoothed natural-origin spawning abundance in year (t – 4) (Ford, in press).

Limiting Factors: Limiting factors for this species include:

- Degraded floodplain and in-river channel structure
- Degraded estuarine conditions and loss of estuarine habitat
- Riparian area degradation and loss of in-river large woody debris

- Excessive fine-grained sediment in spawning gravel
- Degraded water quality and temperature
- Degraded nearshore conditions
- Impaired passage for migrating fish
- Altered flow regime

PS Chinook Salmon Recovery Plan: Nearshore areas serve as the nursery for juvenile PS Chinook salmon. Riparian vegetation, shade and insect production, and forage fish eggs along marine shorelines and river deltas help to provide food, cover and thermoregulation in shallow water habitats. Forage fish spawn in large aggregations along shorelines with suitable habitat, which produce prey for juvenile PS Chinook salmon. Juvenile salmon commonly occupy "pocket estuaries" where freshwater inputs provide salinity gradients that make adjusting to the marine environment less physiologically demanding. Pocket estuaries also provide refugia from predators. As the juvenile salmon grow and adjust, they move out to more exposed shorelines such as eelgrass, kelp beds and rocky shorelines where they continue to grow and migrate into the ocean environment. Productive shoreline habitats of Puget Sound are necessary for the recovery of Puget Sound salmon (SSPS 2007).

The Puget Sound Recovery Plan (Volumes 1 and 2) includes specific recovery actions for each of the 22 extant populations of PS Chinook salmon. General protection and restoration actions summarized from the plan include:

- Aggressively protect functioning drift cells and feeder bluffs that support eelgrass bands and depositional features;
- Counties should pass strong regulations and policies limiting increased armoring of these shorelines and offering incentives for protection;
- Aggressively protect areas, especially shallow water/low gradient habitats and pocket estuaries, within 5 miles of river deltas;
- Protect the forage fish spawning areas;
- Conduct limited beach nourishment on a periodic basis to mimic the natural sediment transport processes in select sections where corridor functions may be impaired by extensive armoring;
- Maintain the functioning of shallow, fine substrate features in and near 11 natal estuaries for Chinook salmon (to support rearing of fry);
- Maintain migratory corridors along the shores of Puget Sound;
- Maintain the production of food resources for salmon;
- Maintain functioning nearshore ecosystem processes (i.e., sediment delivery and transport; tidal circulation) that create and support the above habitat features and functions;
- Increase the function and capacity of nearshore and marine habitats to support key needs of salmon;
- Protect and restore shallow, low velocity, fine substrate habitats along marine shorelines, including eelgrass beds and pocket estuaries, especially adjacent to major river deltas;
- Protect and restore riparian areas;
- Protect and restore estuarine habitats of major river mouths;

- Protect and restore spawning areas and critical rearing and migration habitats for forage fish;
- Protect and restore drift cell processes (including sediment supply, e.g., from feeder bluffs, transport, and deposition) that create and maintain nearshore habitat features such as spits, lagoons, bays, beaches.

Development of shoreline and estuary areas of Puget Sound is expected to continue to adversely impact the quality of marine habitat for PS Chinook salmon. Projected changes in nearshore and estuary development based on documented rates of developed land cover change in Bartz et al. (2015) show that between 2008 and 2060, an additional 14.7 hectares of development of shoreline areas and 204 hectares of estuary development can be expected.

Status of Puget Sound Steelhead

The PS steelhead DPS was listed as a threatened species under the ESA on May 11, 2007 (72 FR 26722). Subsequent status assessments of the DPS after the ESA-listing decision have found that the status of PS steelhead regarding risk of extinction has not changed substantially (Ford et al. 2011a; NMFS 2016a) (81 FR 33468, May 26, 2016) (Ford, in press). On October 4, 2019 NMFS published a Federal Register notice (84 FR 53117), announcing NMFS' intent to initiate a new 5-year status review for 28 listed species of Pacific salmon and steelhead and requesting updated information from the public to inform the most recent five-year status review. On March 24, 2020, NMFS extended the public comment period, from the original March 27, 2020, through May 26, 2020 (85 FR 16619). The NWFSC and the NMFS' WCR are currently preparing the final five-year status review documents.

The PS Steelhead TRT produced viability criteria, including population viability analyses (PVAs), for 20 of 32 demographically independent populations (DIPs) and three major population groups (MPGs) in the DPS (Hard et al. 2015). It also completed a report identifying historical populations of the DPS (Myers et al. 2015). The DIPs are based on genetic, environmental, and life history characteristics. Populations display winter, summer, or summer/winter run timing (Myers et al. 2015). The TRT concludes that the DPS is currently at "very low" viability, with most of the 32 DIPs and all three MPGs at "low" viability.
The designation of the DPS as "threatened" is based upon the extinction risk of the component populations. For a DIP to be considered viable, it must have at least an 85 percent probability of meeting the viability criteria, as calculated by Hard et al. (2015).

At the time of listing the Puget Sound steelhead Biological Review Team (BRT) considered the major risk factors associated with spatial structure and diversity of PS steelhead to be: (1) the low abundance of several summer run populations; (2) the sharply diminishing abundance of some winter steelhead populations, especially in south Puget Sound, Hood Canal, and the Strait of Juan de Fuca; and (3) continued releases of out-of-ESU hatchery fish from Skamania-derived summer run and Chambers Creek-derived winter run stocks (Hard et al. 2007; Hard et al. 2015). Loss of diversity and spatial structure were judged to be "moderate" risk factors (Hard et al. 2007). In 2011 the BRT identified degradation and fragmentation of freshwater habitat, with consequential effects on connectivity, as the primary limiting factors and threats facing the PS steelhead DPS (Ford et al. 2011a). The BRT also determined that most of the steelhead populations within the DPS continued to show downward trends in estimated abundance, with a few sharp declines (Ford et al. 2011a). The 2015 status review concurred that harvest and hatchery production of steelhead in Puget Sound were at low levels and not likely to increase substantially in the foreseeable future, thus these risks have been reduced since the time of listing. However, unfavorable environmental trends previously identified (Ford et al. 2011a) were expected to continue (Hard et al. 2015).

In this Opinion, where possible, the 2015 status review information is supplemented with information and other population specific data available considered during the drafting of the 2020 five-year status review for PS steelhead.

On December 27, 2019, we published a recovery plan for PS steelhead (84 FR 71379) (NMFS 2019a). The Puget Sound steelhead Recovery Plan (Plan) (NMFS 2019a) provides guidance to recover the species to the point that it can be naturally self-sustaining over the long term. To achieve full recovery, steelhead populations in Puget Sound need to be robust enough to withstand natural environmental variation and some catastrophic events, and they should be resilient enough to support harvest and habitat loss due to human population growth. The Plan aims to improve steelhead viability by addressing the pressures that contribute to the current condition: habitat loss/degradation, water withdrawals, declining water quality, fish passage barriers, dam operations, harvest, hatcheries, climate change effects, and reduced early marine survival. NMFS is using the recovery plan to organize and coordinate recovery of the species in partnership with state, local, tribal, and federal resource managers, and the many watershed restoration partners in the Puget Sound. Consultations, including this one, will incorporate information from the Plan (NMFS 2019a).

In the Plan, NMFS and the PSSTRT modified the 2013 and 2015 PSSTRT viability criteria to produce the viability criteria for PS steelhead, as described below:

- All three MPGs (North Cascade, Central-South Puget Sound, and Hood Canal-Strait of Juan de Fuca) (Figure 6) must be viable (Hard et al. 2015). The three MPGs differ substantially in key biological and habitat characteristics that contribute in distinct ways to the overall viability, diversity, and spatial structure of the DPS.
- There must be sufficient data available for NMFS to determine that each MPG is viable.

The Plan (NMFS 2019h) also established MPG-level viability criteria. The following are specific criteria are required for MPG viability:

- At least 50 percent of steelhead populations in the MPG achieve viability.
- Natural production of steelhead from tributaries to Puget Sound that are not identified in any of the 32 identified populations provides sufficient ecological diversity and productivity to support DPS-wide recovery.
- In addition to the minimum number of viable DIPs (50 percent) required above, all DIPs in the MPG must achieve an average MPG-level viability that is equivalent to or greater than the geometric mean (averaged over all the DIPs in the MPG) viability score of at least 2.2 using the 1–3 scale for individual DIPs described under the DIP viability discussion in the PSSTRT Viability Criteria document (Hard et al. 2015). This criterion is intended to ensure that MPG viability is not measured (and achieved) solely by the strongest DIPs, but also by other populations that are sufficiently healthy to achieve

MPG-wide resilience. The Plan allows for an alternative evaluation method to that in Hard et al. (2015) may be developed and used to assess MPG viability.

The Plan (NMFS 2019h) also identified specific DIPs in each of the three MPGs which must attain viability. These DIPs, by MPG, are described as follows:

For the **North Cascades MPG** eight of the sixteen DIPs in the North Cascades MPG must be viable. The eight (five winter-run and three summer-run) DIPs described below must be viable to meet this criterion:

- Of the eleven DIPs with winter or winter/summer runs, five must be viable:
- Nooksack River Winter-Run;
- Stillaguamish River Winter-Run;
- One from the Skagit River (either the Skagit River Summer-Run and Winter-Run or the Sauk River Summer-Run and Winter-Run);
- One from the Snohomish River watershed (Pilchuck, Snoqualmie, or Snohomish/Skykomish River Winter-Run); and
- One other winter or summer/winter run from the MPG at large.

The rationale for this is that there are four major watersheds in this MPG, and one viable population from each will help attain geographic spread and habitat diversity within core extant steelhead habitat (NMFS 2019h). Of the five summer-run DIPs in this MPG, three must be viable, representing each of the three major watersheds containing summer-run populations (Nooksack, Stillaguamish, Snohomish rivers). Therefore, the priority summer-run populations are as follows:

- South Fork Nooksack River Summer-Run;
- One DIP from the Stillaguamish River (Deer Creek Summer-Run or Canyon Creek Summer-Run); and
- One DIP from the Snohomish River (Tolt River Summer-Run or North Fork Skykomish River Summer-Run).

As described, these priority populations in the North Cascades MPG include specific, winter or winter/summer-run populations from the Nooksack, Stillaguamish, Skagit or Sauk, and Snohomish River basins and three summer-run populations from the Nooksack, Stillaguamish, and Snohomish basins. These populations are targeted to achieve viable status to support MPG viability. Having viable populations in these basins assures geographic spread, provides habitat diversity, reduces catastrophic risk, and increases life-history diversity (NMFS 2019h).

For the **Central and South Puget Sound MPG** four of the eight DIPs in the Central and South Puget Sound MPG must be viable. The four DIPs described below must be viable to meet this criterion:

- Green River Winter-Run;
- Nisqually River Winter-Run;
- Puyallup/Carbon rivers Winter-Run, or the White River Winter-Run; and
- At least one additional DIP from this MPG: Cedar River, North Lake Washington/Sammamish Tributaries, South Puget Sound Tributaries, or East Kitsap Peninsula Tributaries.

The rationale for this prioritization is that steelhead inhabiting the Green, Puyallup, and Nisqually River watersheds currently represent the core extant steelhead populations and these watersheds contain important diversity of stream habitats in the MPG.

For the **Hood Canal and Strait of Juan de Fuca MPG** four of the eight DIPs in the Hood Canal and Strait of Juan de Fuca MPG must be viable. The four DIPs described below must be viable to meet this criterion:

- Elwha River Winter/Summer-Run (see rationale below);
- Skokomish River Winter-Run;
- One from the remaining Hood Canal populations: West Hood Canal Tributaries Winter-Run, East Hood Canal Tributaries Winter-Run, or South Hood Canal Tributaries Winter-Run; and
- One from the remaining Strait of Juan de Fuca populations: Dungeness Winter-Run, Strait of Juan de Fuca Tributaries Winter-Run, or Sequim/Discovery Bay Tributaries Winter-Run.

The rationale for this prioritization is that the Elwha and Skokomish rivers are the two largest single watersheds in the MPG and bracket the geographic extent of the MPG. Furthermore, both Elwha and Skokomish populations have recently exhibited summer-run life histories, although the Dungeness River population was the only summer/winter run in this MPG recognized by the PSSTRT in Hard et al. (2015). Two additional populations, one population from the Strait of Juan de Fuca area and one population from the Hood Canal area, are needed for a viable MPG to maximize geographic spread and habitat diversity.

Lastly, the Plan (NMFS 2019h) also identified additional attributes, or characteristics which should be associated with a viable MPG.

- All major diversity and spatial structure conditions are represented, based on the following considerations:
- Populations are distributed geographically throughout each MPG to reduce risk of catastrophic extirpation; and
- Diverse habitat types are present within each MPG (one example is lower elevation/gradient watersheds characterized by a rain-dominated hydrograph and higher elevation/gradient watersheds characterized by a snow-influenced hydrograph).

Federal and state steelhead recovery and management efforts will provide new tools and data and technical analyses to further refine PS steelhead population structure and viability, if needed, and better define the role of individual populations at the watershed level and in the DPS. Future consultations will incorporate information from the Plan (NMFS 2019h).

<u>Spatial Structure and Diversity:</u> The PS steelhead DPS is the anadromous form of *O. mykiss* that occur in rivers, below natural barriers to migration, in northwestern Washington State that drain to Puget Sound, Hood Canal, and the Strait of Juan de Fuca between the U.S./Canada border and the Elwha River, inclusive. Non-anadromous ‘‘resident’’ *O. mykiss* occur within the range of PS steelhead but are not part of the DPS due to marked differences in physical, physiological, ecological, and behavioral characteristics (Hard et al. 2007). In October of 2016, NMFS proposed revisions to the hatchery programs included as part of Pacific salmon ESUs and

steelhead DPSs listed under the ESA (81 FR 72759). NMFS issued its final rule in December of 2020 (85 FR 81822). This final rule includes steelhead from five artificial propagation programs in the PS steelhead DPS: the Green River Natural Program; White River Winter Steelhead Supplementation Program; Hood Canal Steelhead Supplementation Program; the Lower Elwha Fish Hatchery Wild Steelhead Recovery Program; and the Fish Restoration Facility Program. (85 FR 81822, December 17, 2020).

In 2013, the PSSTRT completed its evaluation of factors that influence the diversity and spatial structure VSP criteria for steelhead in the DPS. For spatial structure, this included the fraction of available intrinsic potential rearing and spawning habitat that is occupied compared to what is needed for viability[11]. For diversity, these factors included hatchery fish production, contribution of resident fish to anadromous fish production, and run timing of adult steelhead. Quantitative information on spatial structure and connectivity was not available for most PS steelhead populations, so a Bayesian Network framework was used to assess the influence of these factors on steelhead viability at the population, MPG, and DPS scales. The PSSTRT concluded that low population viability was widespread throughout the DPS and populations showed evidence of diminished spatial structure and diversity. Specifically, population viability associated with spatial structure and diversity was highest in the Northern Cascades MPG and lowest in the Central and South Puget Sound MPG (Puget Sound Steelhead Technical Recovery Team 2011). Diversity was generally higher for populations within the Northern Cascades MPG, where more variability in viability was expressed and diversity generally higher, compared to populations in both the Central and South Puget Sound and Hood Canal and Strait of Juan de Fuca MPG, where diversity was depressed and viabilities were generally lower (NWFSC 2015). Most PS steelhead populations were given intermediate scores for spatial structure and low scores for diversity because of extensive hatchery influence, low breeding population sizes, and freshwater habitat fragmentation or loss (NWFSC 2015). The PSSTRT concluded that the Puget Sound DPS was at very low viability, considering the status of all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). For spatial structure there were a number of events that occurred in Puget Sound during the last review period (2015-2019) that are anticipated to improve status populations within several of the MPGs within the DPS.

Since the PSSTRT completed its 2013 review, the only additional spatial structure and diversity data that have become available have been estimates of the fraction of hatchery fish on the spawning grounds (NWFSC 2015). Since publication of the NWFSC report in 2015, reductions in hatchery programs founded from non-listed and out of DPS stocks (i.e., Skamania) have occurred. In addition, the fraction of out of DPS hatchery steelhead spawning naturally are low for many rivers (NWFSC 2015; NMFS 2016i; 2016h). The fraction of natural-origin steelhead spawners was 0.9 or greater for the 2005-2009 and 2010-2014 time periods for all populations where data were available, but the Snoqualmie and Stillaguamish Rivers. For 17 of 22 DIPs across the DPS, the five-year average for the fraction of natural-origin steelhead spawners exceeded 0.75 from 2005 to 2009; this average was near 1.0 for 8 populations, where data were available, from 2010 to 2014 (NWFSC 2015). However, the fraction of natural-origin steelhead spawners could not be estimated for a substantial number of DIPs during the 2010 to 2014 period, or for the most recent 2015 – 2019 timeframe (NWFSC 2015; 2020). In some river

[11] Where intrinsic potential is the area of habitat suitable for steelhead rearing and spawning, at least under historical conditions (Puget Sound Steelhead Technical Recovery Team 2011; PSSTRT 2013).

systems, such as the Green River, Snohomish/Skykomish Rivers, and the Stillaguamish Rivers these estimates were higher than some guidelines recommend (e.g., no more than 5percent hatchery-origin spawners on spawning grounds for isolated hatchery programs (HSRG 2009) over the 2005-2009 and 2010-2014 timeframes. The draft NWFSC viability risk assessment (Ford, in press) states that a third of the 32 PS steelhead populations continue to lack monitoring and abundance data, and in most cases, it is likely that abundances are very low.

Early winter-run fish produced in isolated hatchery programs are derived from Chambers Creek stock in southern Puget Sound, which has been selected for early spawn timing, a trait known to be inheritable in salmonids.[12] Summer-run fish produced in isolated hatchery programs were historically derived from the Skamania River summer stock in the lower Columbia River Basin (i.e., from outside the DPS). The production and release of hatchery fish of both run types (winter and summer) may continue to pose risk to diversity in natural-origin steelhead in the DPS, as described in Hard et al. (2007) and Hard et al. (2015). However, the draft NWFSC viability risk assessment (Ford, in press) states that risks to natural-origin PS steelhead that may be attributable to hatchery-related effects has decreased since the 2015 status review due to reductions in production of non-listed stocks, and the replacement with localized stocks. The three summer steelhead programs continuing to propagate Skamania derived stocks from outside of Puget Sound should be phased out completely by 2031 (NMFS 2019c; Ford, in press). Lastly, annual reporting from the operators and current science suggest that risks remain at the same low to negligible levels as evaluated in 2016 and 2019 (NMFS 2016b; 2019c; 2019g; 2019h).

More information on PS steelhead spatial structure and diversity can be found in NMFS's PSSTRT viability report and NMFS's status review update on salmon and steelhead (NWFSC 2015) and recent viability risk assessment (Ford, in press).

Abundance and Productivity: The viability of the PS steelhead DPS has improved somewhat since the Puget Sound Steelhead TRT concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). Increases in spawner abundance have been observed in a number of populations over the last five years; however, these improvements were disproportionately found within the South and Central Puget Sound and Strait of Juan de Fuca and Hood Canal MPGs, and primarily among smaller populations. The recent positive trends among winter-run populations in the White, Nisqually, and Skokomish rivers improve the demographic risks facing those populations. The abundance, productivity, spatial structure, and diversity of Elwha River steelhead winter and summer-runs has dramatically improved following the removal of the Elwha River dams improved. Improvements in abundance have not been as widely observed in the Northern Puget Sound MPG. The declines of summer and winter-run populations in the Snohomish Basin are especially concerning. These populations figure prominently as sources of abundance for the MPG and DPS (NMFS 2019a). Additionally, the decline in the Tolt River summer-run steelhead population was especially alarming given that it is the only summer-run population for which we have abundance estimates. The demographic and diversity risks to the Tolt River summer-run DIP are very high. In fact, all summer-run steelhead populations in the North Cascades MPG are likely at a very high demographic risk. In spite of improvements in some areas, most populations

[12] The native-origin Chambers Creek steelhead stock is now extinct.

are still at relatively low abundance levels, with about a third of the DIPs unmonitored and presumably at very low levels (Ford, in press).

As described in the recovery plan, recovery targets were calculated using a two-tiered approach adjusting for years of low and high productivity (NMFS 2019a). Abundance information is unavailable for approximately one-third of the DIPs, disproportionately so for summer-run populations. In most cases where no information is available it is assumed that abundances are very low. Some population abundance estimates are only representative of part of the population (index reaches, etc.). Where recent five-year abundance information is available, 30 percent (6 of 20 populations) are less than 10 percent of their high productivity recovery targets (lower abundance target), 65 percent (13 of 20) are between 10 and 50 percent, and 5 percent (1 of 20) are greater than 50 percent of their low abundance targets (Table 6). A key element to achieving recovery is recovering a representative number of both winter- and summer-run steelhead populations, and the restoration of viable summer-run DIPs is a long-term endeavor (NMFS 2019a). Fortunately, the relatively rapid reestablishment of summer-run steelhead in the Elwha River does provide a model for potentially re-anadromizing summer-run steelhead sequestered behind impassable dams.

Table 6. Recent (2015-2019) 5-year geometric mean of raw wild spawner counts for Puget Sound steelhead populations and population groups compared with Puget Sound Steelhead Recovery Plan high and low productivity recovery targets (NMFS 2019). (SR) – Summer-run. Abundance is compared to the high productivity individual DIP targets. Colors indicate the relative proportion of the recovery target currently obtained: red (<10%), orange (10%>x<50%), yellow (50%>x<100%), green (>100%). "*" denotes an interim recovery target.

Major Population Group	Demographically Independent Population	Abundance (2015-2019)	Recovery Target	
			High Productivity	Low Productivity
Northern Cascades	Drayton Harbor Tributaries	N/A	1,100	3,700
	Nooksack River	1,906	6,500	21,700
	South Fork Nooksack River (SR)	N/A	400	1,300
	Samish River & Independent Tributaries	1,305	1,800	6,100
	Skagit River	7,181	15,000 *	
	Sauk River	N/A		
	Nookachamps River	N/A		
	Baker River	N/A		
	Stillaguamish River	487	7,000	23,400
	Canyon Creek (SR)	N/A	100	400
	Deer Creek (SR)	N/A	700	2,300
	Snohomish/Skykomish River	690	6,100	20,600
	Pilchuck River	638	2,500	8,200
	Snoqualmie River	500	3,400	11,400
	Tolt River (SR)	40	300	1,200
	North Fork Skykomish River (SR)	N/A	200	500
Central and South Sound	Cedar River	N/A	1,200	4,000
	North Lake Washington Tributaries	N/A	4,800	16,000
	Green River	1,282	5,600	18,700
	Puyallup/Carbon River	136	4,500	15,100
	White River	130	3,600	12,000
	Nisqually River	1,368	6,100	20,500
	East Kitsap Tributaries	N/A	2,600	8,700
	South Sound Tributaries	N/A	6,300	21,200
Strait of Juan de Fuca	Elwha River	1,241	2,619	
	Dungeness River	408	1,200	4,100
	Strait of Juan de Fuca Independent Tributaries	95	1,000	3,300
	Sequim and Discovery Bay Tributaries	N/A	500	1,700
	Skokomish River	958	2,200	7,300
	West Hood Canal Tributaries	150	2,500	8,400
	East Hood Canal Tributaries	93	1,800	6,200
	South Hook Canal Tributaries	91	2,100	7,100

There are a number of planned, ongoing, and completed actions that will likely benefit steelhead populations in the near term, but have not yet influenced adult abundance. Among these, the removal of the diversion dam on the Middle Fork Nooksack River, the Pilchuck Dam removal, passage improvements at Mud Mountain Dam, the ongoing passage program in the North Fork

Skokomish River, and the planned passage program at Howard Hanson Dam. Dam removal in the Elwha River, and the resurgence of the endemic winter and summer-run steelhead populations have underscored the benefits of restoring fish passage. The Elwha River scenario is somewhat unique in that upstream habitat is in pristine condition and smolts emigrate into the Strait of Juan de Fuca and not Puget Sound or Hood Canal.

Improvements in spatial structure can only be effective if done in concert with necessary improvements in habitat. Habitat restoration efforts are ongoing, but land development and habitat degradation concurrent with increasing human population in the Puget Sound corridor may results in a continuing net loss of habitat. Recovery efforts in conjunction with improved ocean and climatic conditions have resulted in improved viability status for the majority of populations in this DPS; however, absolute abundances are still low, especially summer-run populations, and the DPS remains at high to moderate risk of extinction. However, since 2015, fifteen of the 21 populations indicate small to substantive increases in abundance.[13] Nevertheless, most steelhead populations remain small. From 2015 to 2019, nine of the 21 steelhead populations had fewer than 250 natural spawners annually, and 12 of the 21 steelhead populations had 500 or fewer natural spawners (Table 7).

[13] Nooksack River, Samish River/Bellingham Bays Tributaries, Skagit River, Stillaguamish River, Pilchuck River, Cedar River, Green River, Puyallup River, Nisqually River, White River, S. Hood Canal, Eastside Hood Canal Tributaries, Westside Hood Canal Tributaries, Skokomish River and Elwha River winter-run populations. The Skagit River and Elwha River summer-run steelhead are also showing increasing trends (Ford, in press).

Table 7. Five-year geometric mean of raw natural spawner counts for Puget Sound steelhead. This is the raw total spawner count times the fraction natural estimate, if available. Percent change between the most recent two 5-year periods is shown on the far right. (W=winter run; S=summer run).

Biogeographic Region	Population	2010-2014	2015-2019	Population trend (% Change)
North Cascades	Samish R./ Bellingham Bay Tribs. (W)	748	1305	Positive (74)
	Nooksack R. (W)	1745	1906	Positive (9)
	Skagit R. (S and W)	6391	7181	Positive (12)
	Stillaguamish R. (W)	386	487	Positive (26)
	Snohomish/ Skykomish R. (W)	975	690	Negative (-29)
	Pilchuck R. (W)	626	638	Positive (2)
	Snoqualmie R. (W)	706	500	Negative (-29)
	Tolt R. (S)	108	40	Negative (-63)
Central/South Puget Sound Basin	N. Lake WA Tribs. (W)	-	-	-
	Cedar R. (W)	4	6	Positive (50)
	Green R. (W)	662	1289	Positive (95)
	White R. (W)	514	451	Negative (-12)
	Puyallup R. (W)	85	201	Positive (136)
	Carbon R. (W)	(290)	(735)	Positive (153)
	Nisqually R. (W)	477	1368	Positive (187)
Hood Canal/Strait of Juan de Fuca	S. Hood Canal (W)	69	91	Positive (32)
	Eastside Hood Canal Tribs (W)	60	93	Positive (55)
	Skokomish R. (W)	533	958	Positive (80)
	Westside Hood Canal Tribs (W)	138	150	Positive (9)
	Dungeness R. (S and W)	517	448	Negative (-13)
	Strait of Juan de Fuca Independents (W)	151	95	Negative (-37)
	Elwha R. (W)	680	1241	Positive (82)

Limiting factors. In our 2013 proposed rule designating critical habitat for this species (USDC 2013), we noted that the following factors for decline for PS steelhead persist as limiting factors:

- The continued destruction and modification of steelhead habitat
- Widespread declines in adult abundance (total run size), despite significant reductions in harvest in recent years
- Threats to diversity posed by use of two hatchery steelhead stocks (Chambers Creek and Skamania)

- Declining diversity in the DPS, including the uncertain but weak status of summer run fish
- A reduction in spatial structure
- Reduced habitat quality through changes in river hydrology, temperature profile, downstream gravel recruitment, and reduced movement of large woody debris
- In the lower reaches of many rivers and their tributaries in Puget Sound where urban development has occurred, increased flood frequency and peak flows during storms and reduced groundwater-driven summer flows, with resultant gravel scour, bank erosion, and sediment deposition
- Dikes, hardening of banks with riprap, and channelization, which have reduced river braiding and sinuosity, increasing the likelihood of gravel scour and dislocation of rearing juveniles

PS steelhead Recovery Plan: Juvenile Puget Sound steelhead are less dependent on nearshore habitats for early marine rearing than Chinook or Chum salmon; nevertheless, nearshore, estuarine, and shoreline habitats provide important features necessary for the recovery of steelhead. Puget Sound steelhead spend only a few days to a few weeks migrating through the large fjord, but mortality rates during this life stage are critically high (Moore et al. 2010; Moore and Berejikian 2017). Early marine mortality of Puget Sound steelhead is recognized as a primary limitation to the species' survival and recovery (NMFS 2019a). Factors in the marine environment influencing steelhead survival include predation, access to prey (primarily forage fish), contaminants (toxics), disease and parasites, migration obstructions (e.g., the Hood Canal bridge), and degraded habitat conditions which exacerbate these factors.

The PS steelhead recovery plan identifies ten ecological concerns that directly impact salmon and steelhead:

- Habitat quantity (anthropogenic barriers, natural barriers, competition);
- Injury and mortality (predation, pathogens, mechanical injury, contaminated food);
- Food (altered primary productivity, food-competition, altered prey species composition and diversity);
- Riparian condition (riparian condition, large wood recruitment);
- Peripheral and transitional habitats (side channel and wetland condition, estuary conditions, nearshore conditions);
- Channel structure and form (bed and channel form, instream structural complexity);
- Sediment conditions (decreased sediment quantity, increased sediment quantity);
- Water quality (temperature, oxygen, gas saturation, turbidity, pH, salinity, toxic contaminants);
- Water quantity (increased water quantity, decreased water quantity, altered flow timing); and
- Population-level effects (reduced genetic adaptiveness, small population effects, demographic changes, life history changes).

The Puget Sound steelhead recovery plan and its associated appendix 3 includes specific recovery actions for the marine environment. General protection and restoration actions summarized from the plan include:

- Continue to improve the assessments of harbor seal predation rates on juvenile steelhead;
- Remove docks and floats which act as artificial haul-out sites for seals and sea lions;
- Consistent with the MMPA, test acoustic deterrents and other hazing techniques to reduce steelhead predation from harbor seals;
- Develop non-lethal actions for "problem animals and locations" to deter predation;
- Increase forage fish habitat to increase abundance of steelhead prey;
- Remove bulkheads and other shoreline armoring to increase forage fish;
- Acquire important forage fish habitat to protect high forage fish production areas;
- Add beach wrack to increase forage fish egg survival;
- Protect and restore aquatic vegetation (e.g., eelgrass and kelp);
- Remove creosote pilings to reduce mortality of herring eggs;
- Increase the assessment of migratory blockages, especially the Hood Canal bridge, where differential mortality has been documented;
- Identify and remedy sources of watershed chemical contaminants (e.g., PBDEs and PCBs).

Status of Puget Sound Georgia Basin Rockfish

NMFS adopted a recovery plan for both PS/GB bocaccio and yelloweye rockfish in 2017. There are no estimates of historic or present-day abundance of yelloweye rockfish, or PS/GB bocaccio across the full DPSs area. In 2013, the WDFW published abundance estimates from a remotely operated vehicle survey conducted in 2008 in the San Juan Island area (Pacunski et al. 2013). This survey was conducted exclusively within rocky habitats and represents the best available abundance estimates to date for one basin of the DPS. The survey produced estimates of 47,407 (25 percent variance) yelloweye rockfish, and 4,606 (100 percent variance) PS/GB bocaccio in the San Juan area (Tonnes et al. 2016). Though the WDFW has produced other ROV-based estimates of rockfish biomass in Washington waters of the DPSs, none have both covered the entirety of the DPSs and had sufficient sample size to accurately estimate population size for rare species, such as yelloweye rockfish and bocaccio.

Using several available, but spatiotemporally patchy, data series on rockfish occurrence and abundance in Puget Sound, Tolimieri et al. (2017) determined that total rockfish declined at a rate of 3.1 to 3.8 percent per year from 1977 to 2014 or a 69 to 76 percent total decline over that period. The two listed DPSs declined over-proportional compared to the total rockfish assemblage. Therefore, long-term population growth rate for the listed species was likely even lower (more negative) than that for total rockfish. While there is little to no evidence of recent recovery of total groundfish abundance in response to protective measures enacted over the last 25 years (Essington et al. 2013; 2021; van Duivenbode 2018), increases in the prevalence of several life stages of the more common rockfish species have been observed (Pacunski et al. 2020; LeClair et al. 2018). Given the slow maturation rate, episodic recruitment success, and rarity of yelloweye rockfish and bocaccio, combined with targeted fisheries being closed for over a decade, insufficient data exist to assess the recent recovery trajectory of these species.

Mature females of each listed species produce from several thousand to over a million eggs annually (Love et al. 2002). In rockfish the number of embryos produced by the female increases with size. For example, female copper rockfish that are 20 cm in length produce 5,000 eggs while a female 50 cm in length may produce 700,000 eggs (Palsson et al. 2009). These specific observations come from other rockfish, not the two listed species. However, the generality of maternal effects in *Sebastes spp*. suggests that some level of age or size influence on reproduction is likely for all species (Haldorson and Love 1991).

Larval rockfish rely on nearshore habitat. The nearshore is generally defined as habitats contiguous with the shoreline from extreme high water out to a depth no greater than 98 feet (30 m) relative to mean lower low water. This area generally coincides with the maximum depth of the photic zone and can contain physical or biological features essential to the conservation of many fish and invertebrate species, including PS/GB bocaccio. Approximately 27 percent of Puget Sound's shoreline has been modified by armoring (Simenstad et al. 2011). Nearshore habitats throughout the greater Puget Sound region have been affected by a variety of human activities, including agriculture, heavy industry, timber harvest, and the development of sea ports and residential property (Drake et al. 2010).

Juvenile yelloweye rockfish are not typically found in intertidal waters (Love et al. 1991; Studebaker et al. 2009). A few juveniles have been documented in shallow nearshore waters (Love et al. 2002; Palsson et al. 2009), but most settle in habitats along the shallow range of adult habitats in areas of complex bathymetry and rocky/boulder habitats and cloud sponges in waters greater than 98 feet (30 m) (Richards 1986; Love et al. 2002; Yamanaka et al. 2006). In British Columbia, juvenile yelloweye rockfish have been observed at a mean depth of 239 feet (73 m), with a minimum depth of 98 feet (30 m) (Yamanaka et al. 2006). Juvenile yelloweye rockfish occur in similar habitats as adults, though in areas with smaller crevices, including cloud sponge formations, crinoid aggregations on top of rocky ridges, and over cobble substrates (Weispfenning 2006; Yamanaka et al. 2006; Banks 2007).

Young-of-year juvenile bocaccio occur on shallow rocky reefs and nearshore areas (Moser 1967; Anderson 1983; Kendall and Lenarz 1986; Carr 1991; Love et al. 1991; Love 1996; Murphy et al. 2000; Love et al. 2002). Young bocaccio associate with macroalgae, especially kelps (*Laminariales*), and sandy areas that support seagrasses. They form aggregations near the bottom in association with drift algae and throughout the water column in association with canopy-forming kelps. It is likely that nearshore habitats used by juvenile bocaccio and other rockfish juveniles offer a beneficial mix of warmer temperatures, food, and refuge from predators (Love et al. 1991). Habitat formed by kelp provides structure for feeding, refuge from predators, and reduced currents that enable energy conservation for juvenile bocaccio. Juvenile bocaccio are exceptionally rare in greater Puget Sound, casting some doubt on whether the current population is capable of reproducing at a rate sufficient to support recovery (Palsson et al. 2009; Drake et al. 2010; NMFS 2017a).

The alteration of Puget Sound shorelines has been found to impact a variety of marine life, ranging from invertebrate fauna (Sobocinski 2003) to surf smelt egg viability (Rice 2006), but consequences of the alteration of Puget Sound shorelines on rockfish habitat such as kelp are less understood. Some areas around Puget Sound have shown a large decrease in kelp. Areas with floating and submerged kelp (families *Chordaceae*, *Alariaceae*, *Lessoniacea*, *Costariaceae*, and *Laminaricea*) support the highest densities of most juvenile rockfish species (Matthews 1989;

Halderson and Richards 1987; Carr 1983; Hayden-Spear 2006). Kelp habitat provides structure for feeding, predation refuge, and reduced currents that enable energy conservation for juveniles. Although loss of nearshore habitat quality is a threat to rockfish, the recovery plan for this species list the severity of this threat as low (NMFS 2017a). As such, the recovery plan lists the severity of this threat as very low in Canada, low in the San Juan Islands, moderate in Hood Canal, and high in the Main Basin and South Sound (NMFS 2017a).

A study of rockfish in Puget Sound found that larval rockfish appeared to occur in two peaks (early spring, late summer) that coincide with the main primary production peaks in Puget Sound. Both measures indicated that rockfish ichthyoplankton essentially disappeared from the surface waters by the beginning of November. Densities also tended to be lower in the more northerly basins (Whidbey and Rosario), compared to the Central and South Sound (Greene and Godersky 2012).

The U.S. portion of the Puget Sound/Georgia Basin that is occupied by yelloweye rockfish and PS/GB bocaccio can be divided into five areas, or Basins, based on the distribution of each species, geographic conditions, and habitat features. These five interconnected Basins are: (1) The San Juan/Strait of Juan de Fuca Basin, (2) Main Basin, (3) Whidbey Basin, (4) South Puget Sound, and (5) Hood Canal. See 79 FR 68041, Nov. 13, 2014 (Puget Sound/Georgia Basin Distinct Population Segments of yelloweye rockfish, Canary rockfish and Bocaccio; Designation of Critical Habitat).

Status of PS/GB Bocaccio

The PS/GB bocaccio distinct population segment (DPS) was listed as endangered on April 28, 2010 (75 FR 22276). In April 2016, we completed a 5-year status review that recommended the DPS retain its endangered classification (Tonnes et al. 2016), and we released a recovery plan in October 2017 (NMFS 2017a). Though PS/GB bocaccio were never a predominant segment of the multi-species rockfish population within the Puget Sound/Georgia Basin, their present-day abundance is likely a fraction of their pre-contemporary fishery abundance. Most PS/GB bocaccio within the DPS may have been historically spatially limited to several basins within the DPS. They were apparently historically most abundant in the Central and South Sound with no documented occurrences in the San Juan Basin until 2008 (Pacunski et al. 2013). The apparent reduction of populations of PS/GB bocaccio in the Main Basin and South Sound represents a further reduction in the historically spatially limited distribution of PS/GB bocaccio, and adds significant risk to the viability of the DPS (Tonnes et al. 2016).

The VSP criteria described by McElhaney et al. (2000), and summarized at the beginning of Section 2.2, identified spatial structure, diversity, abundance, and productivity as criteria to assess the viability of salmonid species because these criteria encompass a species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. These viability criteria reflect concepts that are well founded in conservation biology and are generally applicable to a wide variety of species because they describe demographic factors that individually and collectively provide strong indicators of extinction risk for a given species (Drake et al. 2010), and are therefore applied here for PS/GB bocaccio.

General Life History: The life history of PS/GB bocaccio includes a larval/pelagic juvenile stage that is followed by a juvenile stage, and subadult and adult stages. As with other rockfish, PS/GB bocaccio fertilize their eggs internally and the young are extruded as larvae that are about 4 to 5 mm in length. Females produce from several thousand to over a million offspring per spawning (Love et al. 2002). The timing of larval parturition in PS/GB bocaccio is uncertain, but likely occurs within a five- to six-month window that is centered near March (Greene and Godersky 2012; NMFS 2017a; Palsson et al. 2009). Larvae are distributed by prevailing currents until they are large enough to actively swim toward preferred habitats, but they can pursue food within short distances immediately after birth (Tagal et al. 2002). Larvae are distributed throughout the water column (Weis 2004), but are also observed under free-floating algae, seagrass, and detached kelp (Love et al. 2002; Shaffer et al. 1995). Unique oceanographic conditions within Puget Sound likely result in most larvae staying within the basin where they are released rather than being broadly dispersed (Drake et al. 2010). Recent modeling of passive particles serving as larval rockfish analogs, however, has demonstrated that this assumption can be substantially violated under certain conditions, resulting in larval transport among basins as well out both into and out of the DPS (Andrews et al. 2020).

At about 3 to 6 months old and 1.2 to 3.6 inches (3 to 9 cm) long, juvenile PS/GB bocaccio gravitate to shallow nearshore waters where they settle and grow. Rocky or cobble substrates with kelp is most typical, but sandy areas with eelgrass are also utilized for rearing (Carr 1983; Halderson and Richards 1987; Hayden-Spear 2006; Love et al. 1991 and 2002; Matthews 1989; NMFS 2017a; Palsson et al. 2009). Young of the year rockfish may spend months or more in shallow nearshore rearing habitats before transitioning toward deeper water habitats (Palsson et al. 2009). As PS/GB bocaccio grow, their habitat preference shifts toward deeper waters with high relief and complex bathymetry with rock and boulder-cobble complexes (Love et al. 2002), but they also utilize non-rocky substrates such as sand, mud, and other unconsolidated sediments (Miller and Borton 1980; Washington 1977). Adults are most commonly found between 131 to 820 feet (40 to 250 m) (Love et al. 2002; Orr et al. 2000). The maximum age of PS/GB bocaccio is unknown, but may exceed 50 years, and they reach reproductive maturity near age six.

Spatial Structure and Diversity: The PS/GB bocaccio DPS includes all bocaccio from inland marine waters east of the central Strait of Juan de Fuca and south of the northern Strait of Georgia. The waters of Puget Sound and Straits of Georgia can be divided into five interconnected basins that are largely hydrologically isolated from each other by relatively shallow sills (Burns 1985; Drake et al. 2010). The basins within US waters are: (1) San Juan, (2) Main, (4) South Sound, and (4) Hood Canal. The fifth basin consists of Canadian waters east and north of the San Juan Basin into the Straights of Georgia (Tonnes et al. 2016). Although most individuals of the PS/GB bocaccio DPS are believed to remain within the basin of their origin, including larvae and pelagic juveniles, some movement between basins occurs, and the DPS is currently considered a single population. Research intended to assess this assumption using genetic techniques was unable to collect sufficient samples for analysis (Andrews et al. 2018), but is ongoing.

Abundance and Productivity: The PS/GB bocaccio DPS exists at very low abundance and observations are relatively rare. No reliable range-wide historical or contemporary population estimates are available for the PS/GB bocaccio DPS. It is believed that prior to contemporary fishery removals, each of the major PS/GB basins likely hosted relatively large, though unevenly distributed, populations of PS/GB bocaccio. They were likely most common within the South Sound and Main Basin, but were never a predominant segment of the total rockfish abundance within the region (Drake et al. 2010). The best available information indicates that between 1965 and 2007, total rockfish populations have declined by about 70 percent in the Puget Sound region, and that PS/GB bocaccio have declined by an even greater extent (Drake et al. 2010; Tonnes et al. 2016; NMFS 2017a).

Limiting Factors: Factors limiting recovery for PS/GB bocaccio include:

- Fisheries removals (commercial and recreational bycatch)
- Derelict fishing gear in nearshore and deep-water environments
- Degraded water quality (chemical contamination, hypoxia, nutrients)
- Climate change
- Habitat disruption

Yelloweye Rockfish

Spatial Structure: PS/GB yelloweye rockfish occupy the waters of the Pacific coast from California to Alaska. Yelloweye rockfish in the waters of the Puget Sound/Georgia Basin were determined to be a Distinct Population Segment (DPS) (75 Fed. Reg. 22276). The Puget Sound/Georgia Basin DPS of yelloweye rockfish was listed as “threatened” under the ESA on April 28, 2010 (75 FR 22276). The DPSs include all yelloweye rockfish a found in waters of Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca east of Victoria Sill.

Diversity: New collection and analysis of PS/GB yelloweye rockfish tissue samples reveal significant genetic differentiation between the inland (DPS) and coastal samples. These new data are consistent with and further support the existence of a population of Puget Sound/Georgia Basin yelloweye rockfish that is discrete from coastal populations (Ford 2015; Tonnes et al. 2016). In addition, yelloweye rockfish from Hood Canal were genetically differentiated from other Puget Sound/Georgia Basin yelloweye rockfish, indicating a previously unknown degree of population differentiation within the DPS (Ford 2015; Tonnes et al. 2016). Other genetic analysis has found that yelloweye rockfish in the Georgia Basin had the lowest molecular genetic diversity of a collection of samples along the coast (Siegle et al. 2013). Although the adaptive significance of such microsatellite diversity is unclear, it may suggest low effective population size, increased drift, and thus lower genetic diversity in the PS/GB DPS.

Abundance: Yelloweye rockfish within the Puget Sound/Georgia Basin (in U.S. waters) are very likely the most abundant within the San Juan Basin of the DPS. Yelloweye rockfish spatial structure and connectivity is threatened by the apparent reduction of fish within each of the basins of the DPS. This reduction is probably most acute within the basins of Puget Sound proper. The severe reduction of fish in these basins may eventually result in a contraction of the DPS’ range. Recent research has found evidence for two populations of yelloweye rockfish within the DPS—one in Hood Canal and one within the rest of the Puget Sound/Georgia Basin.

In Puget Sound, catches of PS/GB yelloweye rockfish have declined as a proportion of the overall rockfish catch (Figure 2 and Figure 3, from Drake et al. 2010). Analysis of SCUBA surveys, recreational catch, and WDFW trawl surveys indicated total rockfish populations in the Puget Sound region are estimated to have declined between 3.1 and 3.8 percent per year for the past several decades, which corresponds to a 69 to 76 percent decline from 1977 to 2014 (Tonnes et al. 2016)

Productivity: Life history traits of yelloweye rockfish and PS/GB bocaccio suggest generally low levels of inherent productivity because they are long-lived, mature slowly, and have sporadic episodes of successful reproduction (Musick 1999; Tolimieri and Levin 2005). Yelloweye rockfish productivity may also be impacted by an Allee effect. This situation arises when reproductive adults are removed from the population and remaining individuals are eventually unable to encounter mates. This process then further reduces population density and can lead to extinction. Adult PS/GB yelloweye rockfish typically occupy relatively small ranges (Love et al. 2002), and the extent to which they may move to find suitable mates is unknown. However, there is insufficient information to determine that this is currently occurring for yelloweye rockfish and further research is needed (Hutchings and Reynolds 2004).

2.2.2 Status of Critical Habitats

This section examines the status of designated critical habitat affected by the proposed action by examining the condition and trends of essential physical and biological features (PFBs) throughout the designated areas. Critical habitat expected to be adversely affected by the proposed action in the action area includes PS Chinook salmon. PS steelhead critical habitat is not designated within the action area and the magnitude of the action's effects on PS Chinook salmon is not expected to translate to measurable effects to SRKW critical habitat PBFs (effects to PS Chinook salmon discussed in section 2.3.5). As described previously (section 1.3.1) PS/GB rockfish critical habitat that overlaps with the open water disposal site was evaluated in a 2015 NMFS Biological Opinion and is considered as part of the environmental baseline for the purposes of this Opinion.

Based on the natural history of PS/GB bocaccio and their habitat needs, NMFS identified two physical or biological features, essential for their conservation: (1) Deepwater sites (>30 meters) that support growth, survival, reproduction, and feeding opportunities; and (2) Nearshore juvenile rearing sites with sand, rock and/or cobbles to support forage and refuge. NMFS has determined that there are no effects to rockfish critical habitat in the action area in deep-water habitats that are not already addressed by the 2015 opinion (NMFS 2015). Critical habitat features associated with nearshore juvenile rearing are not present in the action area.

Salmon and Steelhead Critical Habitat

For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each listed species they support. The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS's critical habitat analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area (NOAA Fisheries 2005). Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or if it serves another important role (e.g., obligate area for migration to upstream spawning areas).

The physical or biological features of nearshore marine areas that would be affected by the proposed action include, ample forage, areas free of artificial obstructions, sufficient natural cover, and adequate water quality and quantity to support adult growth, sexual maturation, and migration as well as nearshore juvenile rearing. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow juvenile fish to grow and mature before migrating to the ocean.

<u>CHART Salmon and Steelhead Critical Habitat Assessments</u>: The CHART for each recovery domain assessed biological information pertaining to occupied habitat by listed salmon and steelhead, determine whether those areas contained PCEs essential for the conservation of those species and whether unoccupied areas existed within the historical range of the listed salmon and steelhead that are also essential for conservation. The CHARTs assigned a 0- to 3-point score for the PCEs in each HUC5 watershed for:

- Factor 1: Quantity,
- Factor 2: Quality—Current Condition,
- Factor 3: Quality—Potential Condition,
- Factor 4: Support of Rarity Importance,
- Factor 5: Support of Abundant Populations, and
- Factor 6: Support of Spawning/Rearing.

Thus, the quality of habitat in a given watershed was characterized by the scores for Factor 2 (quality—current condition), which considers the existing condition of the quality of PCEs in the HUC5 watershed; and Factor 3 (quality—potential condition), which considers the likelihood of achieving PCE potential in the HUC5 watershed, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility.

<u>Puget Sound Recovery Domain</u>: Critical habitat has been designated in Puget Sound for PS Chinook salmon, PS steelhead, and Hood Canal Summer Run chum salmon (HCSRC). Major tributary river basins in the Puget Sound basin include the Nooksack, Samish, Skagit, Sauk, Stillaguamish, Snohomish, Lake Washington, Cedar, Sammamish, Green, Duwamish, Puyallup, White, Carbon, Nisqually, Deschutes, Skokomish, Duckabush, Dosewallips, Big Quilcene, Elwha, and Dungeness rivers and Soos Creek.

Critical habitat for PS Chinook salmon was designated on September 2, 2005 (70 FR 52630). Critical habitat includes 1,683 miles of streams, 41 square mile of lakes, and 2,182 miles of nearshore marine habitat in Puget Sounds. The Puget Sound Chinook salmon ESU has 61 freshwater and 19 marine areas within its range. Of the freshwater watersheds, 41 are rated high conservation value, 12 low conservation value, and eight received a medium rating. Of the marine areas, all 19 are ranked with high conservation value.

Critical habitat for PS steelhead was designated on February 24, 2016 (81 FR 9252). Critical habitat includes 2,031 stream miles. Nearshore and offshore marine waters were not designated for this species. There are 66 watersheds within the range of this DPS. Nine watersheds received a low conservation value rating, 16 received a medium rating, and 41 received a high rating to the DPS. Critical habitat for PS steelhead includes freshwater spawning sites, freshwater rearing sites, and freshwater migration corridors.

Critical habitat is designated for PS Chinook salmon in estuarine and nearshore areas. Designated critical habitat for PS steelhead does not include nearshore areas, as this species does not make extensive use of these areas during juvenile life stage.

The following discussion is general to salmon and steelhead critical habitat in the Puget Sound basin. More specific information for each individual species' critical habitat is presented after the general discussion.

Landslides can occur naturally in steep, forested lands, but inappropriate land use practices likely have accelerated their frequency and the amount of sediment delivered to streams. Fine sediment from unpaved roads has also contributed to stream sedimentation. Unpaved roads are widespread on forested lands in the Puget Sound basin, and to a lesser extent, in rural residential areas. Historical logging removed most of the riparian trees near stream channels. Subsequent agricultural and urban conversion permanently altered riparian vegetation in the river valleys, leaving either no trees, or a thin band of trees. The riparian zones along many agricultural areas are now dominated by alder, invasive canary grass and blackberries, and provide substantially reduced stream shade and large wood recruitment (SSPS 2007).

Diking, agriculture, revetments, railroads and roads in lower stream reaches have caused significant loss of secondary channels in major valley floodplains in this region. Confined main channels create high-energy peak flows that remove smaller substrate particles and large wood. The loss of side-channels, oxbow lakes, and backwater habitats has resulted in a significant loss of juvenile salmonid rearing and refuge habitat. When the water level of Lake Washington was lowered 9 feet in the 1910s, thousands of acres of wetlands along the shoreline of Lake Washington, Lake Sammamish and the Sammamish River corridor were drained and converted to agricultural and urban uses. Wetlands play an important role in hydrologic processes, as they store water that ameliorates high and low flows. The interchange of surface and groundwater in complex stream and wetland systems helps to moderate stream temperatures. Forest wetlands are estimated to have diminished by one-third in Washington State (FEMAT 1993; Spence et al. 1996; SSPS 2007).

Loss of riparian habitat, elevated water temperatures, elevated levels of nutrients, increased nitrogen and phosphorus, and higher levels of turbidity, presumably from urban and highway runoff, wastewater treatment, failing septic systems, and agriculture or livestock impacts, have been documented in many Puget Sound tributaries (SSPS 2007).

Peak stream flows have increased over time due to paving (roads and parking areas), reduced percolation through surface soils on residential and agricultural lands, simplified and extended drainage networks, loss of wetlands, and rain-on-snow events in higher elevation clear cuts (SSPS 2007). In urbanized Puget Sound, there is a strong association between land use and land cover attributes and rates of coho spawner mortality likely due to runoff containing contaminants emitted from motor vehicles (Feist et al. 1996). Recent studies have shown that coho salmon show high rates of pre-spawning mortality when exposed to chemicals that leach from tires (McIntyre et al. 2015). Researchers have recently identified a tire rubber antioxidant as the cause (Tian et al. 2020). Although Chinook salmon did not experience the same level of mortality, tire leachate is still a concern for all salmonids. Traffic residue also contains many unregulated toxic chemicals such as pharmaceuticals, polycyclic aromatic hydrocarbons (PAHs), fire retardants, and emissions that have been linked to deformities, injury and/or death of salmonids and other fish (Trudeau 2017; Young et al. 2018).

Dams constructed for hydropower generation, irrigation, or flood control have substantially affected PS salmon and steelhead populations in a number of river systems. The construction and operation of dams have blocked access to spawning and rearing habitat (e.g., Elwha River dams block anadromous fish access to 70 miles of potential habitat) changed flow patterns, resulted in elevated temperatures and stranding of juvenile migrants, and degraded downstream spawning and rearing habitat by reducing recruitment of spawning gravel and large wood to downstream areas (SSPS 2007). These actions tend to promote downstream channel incision and simplification (Kondolf 1997), limiting fish habitat. Water withdrawals reduce available fish habitat and alter sediment transport. Hydropower projects often change flow rates, stranding and killing fish, and reducing aquatic invertebrate (food source) productivity (Hunter 1992).

Juvenile mortality occurs in unscreened or inadequately screened diversions. Water diversion ditches resemble side channels in which juvenile salmonids normally find refuge. When diversion head gates are shut, access back to the main channel is cut off and the channel goes dry. Mortality can also occur with inadequately screened diversions from impingement on the screen, or mutilation in pumps where gaps or oversized screen openings allow juveniles to get into the system (WDFW 2009). Blockages by dams, water diversions, and shifts in flow regime due to hydroelectric development and flood control projects are major habitat problems in many Puget Sound tributary basins (SSPS 2007).

The nearshore marine habitat has been extensively altered and armored by industrial and residential development near the mouths of many of Puget Sound's tributaries. A railroad runs along large portions of the eastern shoreline of Puget Sound, eliminating natural cover along the shore and natural recruitment of beach sand (SSPS 2007).

Degradation of the near-shore environment has occurred in the southeastern areas of Hood Canal in recent years, resulting in late summer marine oxygen depletion and significant fish kills. Circulation of marine waters is naturally limited, and partially driven by freshwater runoff, which is often low in the late summer. However, human development has increased nutrient loads from failing septic systems along the shoreline, and from use of nitrate and phosphate fertilizers on lawns and farms. Shoreline residential development is widespread and dense in many places. The combination of highways and dense residential development has degraded certain physical and chemical characteristics of the near-shore environment (HCCC 2005; SSPS 2007).

In summary, critical habitat for salmon and steelhead throughout the Puget Sound basin has been degraded by numerous management activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large wood, intense urbanization, agriculture, alteration of floodplain and stream morphology (i.e., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, logging, and mining. Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common limiting factors in areas of critical habitat. As mentioned above, development of shoreline and estuary areas of Puget Sound is expected to continue to adversely impact the quality of marine habitat for PS salmonids. Projected changes in nearshore and estuary development based on documented rates of developed land cover change in Bartz et al. (2015) show that between 2008 and 2060, an additional 14.7 hectares of development of shoreline areas and 204 hectares of estuary development can be expected.

Chinook salmon critical habitat
The PS recovery domain CHART for PS Chinook salmon (NOAA Fisheries 2005) determined that only a few watersheds with PCEs for Chinook salmon in the Whidbey Basin (Skagit River/Gorge Lake, Cascade River, Upper Sauk River, and the Tye and Beckler rivers) are in good-to-excellent condition with no potential for improvement. Most HUC5 watersheds are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or a high potential for improvement (Table 8).

Table 8. Puget Sound Recovery Domain: Current and potential quality of HUC5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon and Hood Canal summer-run chum salmon (NOAA Fisheries 2005). Watersheds are ranked primarily by "current quality" and secondly by their "potential for restoration."

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC5 Code(s)	Listed Species	Current Quality	Restoration Potential
Strait of Georgia and Whidbey Basin #1711000xxx			
Skagit River/Gorge Lake (504), Cascade (506) & Upper Sauk (601) rivers, Tye & Beckler rivers (901)	CK	3	3
Skykomish River Forks (902)	CK	3	1
Skagit River/Diobsud (505), Illabot (507), & Middle Skagit/Finney Creek (701) creeks; & Sultan River (904)	CK	2	3
Skykomish River/Wallace River (903) & Skykomish River/Woods Creek (905)	CK	2	2
Upper (602) & Lower (603) Suiattle rivers, Lower Sauk (604), & South Fork Stillaguamish (802) rivers	CK	2	1
Samish River (202), Upper North (401), Middle (402), South (403), Lower North (404), Nooksack River; Nooksack River (405), Lower Skagit/Nookachamps Creek (702) & North Fork (801) & Lower (803) Stillaguamish River	CK	1	2
Bellingham (201) & Birch (204) bays & Baker River (508)	CK	1	1
Whidbey Basin and Central/South Basin #1711001xxx			
Lower Snoqualmie River (004), Snohomish (102), Upper White (401) & Carbon (403) rivers	CK	2	2
Middle Fork Snoqualmie (003) & Cedar rivers (201), Lake Sammamish (202), Middle Green River (302) & Lowland Nisqually (503)	CK	2	1
Pilchuck (101), Upper Green (301), Lower White (402), & Upper Puyallup River (404) rivers, & Mashel/Ohop(502)	CK	1	2
Lake Washington (203), Sammamish (204) & Lower Green (303) rivers	CK	1	1
Puyallup River (405)	CK	0	2
Hood Canal #1711001xxx			
Dosewallips River (805)	CK/CM	2	1/2
Kitsap – Kennedy/Goldsborough (900)	CK	2	1
Hamma River (803)	CK/CM	1/2	1/2
Lower West Hood Canal Frontal (802)	CK/CM	0/2	0/1
Skokomish River (701)	CK/CM	1/0	2/1
Duckabush River (804)	CK/CM	1	2
Upper West Hood Canal Frontal (807)	CM	1	2
Big Quilcene River (806)	CK/CM	1	1/2
Deschutes Prairie-1 (601) & Prairie-2 (602)	CK	1	1
West Kitsap (808)	CK/CM	1	1
Kitsap – Prairie-3 (902)	CK	1	1
Port Ludlow/Chimacum Creek (908)	CM	1	1
Kitsap – Puget (901)	CK	0	1
Kitsap – Puget Sound/East Passage (904)	CK	0	0
Strait of Juan de Fuca Olympic #1711002xxx			
Dungeness River (003)	CK/CM	2/1	1/2
Discovery Bay (001) & Sequim Bay (002)	CM	1	2
Elwha River (007)	CK	1	2
Port Angeles Harbor (004)	CK	1	1

As mentioned previously, numerous factors have led to the decline of PS Chinook salmon including overharvest, freshwater and marine habitat loss, hydropower development, and hatchery practices, as mentioned in Section 2.2.1, above. Adjustments can, and have been made in the short term to ameliorate some of the factors for decline. Harvest can be adjusted on yearly or even in-season basis. Since PS Chinook salmon were listed, harvest in state and federal fisheries has been reduced in an effort to increase the number of adults returning to spawning grounds. Likewise, hatchery management can, and has been adjusted relatively quickly when practices are detrimental to listed species. To address needed improvements in hydropower, NMFS has issued biological opinions with reasonable and prudent alternatives to improve fish passage at existing hydropower facilities. Unlike the other factors, however, loss of critical habitat quality is much more difficult to address in the short term. Once human development causes loss of critical habitat quality, that loss tends to persist for decades or longer. The condition of critical habitat will improve only through active restoration or natural recovery following the removal of human infrastructure. As noted throughout this Opinion, future effects of climate change on habitat quality throughout Puget Sound are expected to be negative.

Habitat utilization by Chinook salmon and steelhead in the Puget Sound area has been historically limited by large dams and other manmade barriers in a number of drainages, including the Nooksack, Skagit, White, Nisqually, Skokomish, and Elwha river basins (Appendix B in NMFS (2015a)). In addition to limiting habitat accessibility, dams affect habitat quality through changes in river hydrology, altered temperature profile, reduced downstream gravel recruitment, and the reduced recruitment of large woody debris. Such changes can have significant negative impacts on salmonids (e.g., increased water temperatures resulting in decreased disease resistance) (Spence et al. 1996; McCullough 1999). However, over the past several years modifications have occurred to existing barriers, which have reduced the number of basins with limited anadromous access to historical habitat. The completion of the Elwha and Glines Canyon Dam removals occurred in 2014. The response of fish populations to this action is still being evaluated. It is clear; however, that Chinook salmon and steelhead are accessing much of this newly available habitat. Passage operations have begun on the North Fork Skokomish River to reintroduce steelhead above Cushman Dam, although juvenile collection efficiency is still relatively low, and further improvements are anticipated. Similarly, improvements in the adult fish collection facility at Mud Mountain Dam (White River basin) are near completion, with the expectation that improvements in adult survival will facilitate better utilization of habitat above the dam (NMFS 2014b). The recent removal of the diversion dam on the Middle Fork Nooksack Dam (16 July 2020) and the Pilchuck River Dam (late 2020) will provide access to important headwater salmonid spawning and rearing habitats. Similarly, the proposed modification of Howard Hanson Dam for upstream fish passage and downstream juvenile collection in the longer term (NMFS 2019f) will allow winter steelhead to return to historical habitat (Ford, in press).

2.3 Environmental Baseline

The “environmental baseline” refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

2.3.1 Current Status of Puget Sound

Puget Sound can be generally described as nearshore and deep-water areas. NMFS has identified the several nearshore and deep water physical or biological features essential to conservation for salmonids, and rockfish in Section 2.2.2.

The nearshore is the zone where marine water, fresh water, and terrestrial landscapes interact in a complex mosaic of habitats and processes. The nearshore encompasses the shoreline from the top of the upland bank or bluff on the landward side down to the depth of water that light can penetrate and where plants can photosynthesize (photic zone). The upper extent of the nearshore covers the terrestrial upland that contributes sediment, shade, organic material like leaf litter, and even the insects that fish eat. The lower range of the photic zone depends on water clarity; in Puget Sound, underwater vegetation can be found to depths of 30 to 100 feet below Mean Lower Low Water (MLLW) (Williams and Thom 2001). The nearshore includes a variety of environments: marine shallows, eelgrass meadows, kelp forests, mudflats, beaches, salt marshes, rocky shores, river deltas, estuaries, barrier islands, spits, marine riparian zones, and bluffs. This wide range of habitats supports many species. The nearshore forms the basis for the biologic productivity of the Puget Sound basin. Shoreline modification can cause fragmentation of the landscape that disrupts connectivity and reduces the productivity and biological diversity of Puget Sound watersheds. These impacts leave ecosystems less resilient.

Throughout Puget Sound, the nearshore areas have been modified by human activity, disrupting the physical, biological, and chemical interactions that are vital for creating and sustaining the diverse ecosystems of Puget Sound. There are approximately 503,106 acres of overwater structure in the nearshore of Puget Sound (Schlenger et al. 2011). Currently, 27 percent of Puget Sound's shorelines are armored (Simenstad et al. 2011; Meyer el al. 2010). The shoreline modifications are usually intended for erosion control, flood protection, sediment management, or for commercial, navigational, and recreational uses. Seventy-four percent of shoreline modification in Puget Sound consists of shoreline armoring (Simenstad et al. 2011), which usually refers to bulkheads, seawalls, or groins made of rock, concrete, or wood. Other modifications include jetties and breakwaters designed to dissipate wave energy, and structures such as tide gates, dikes, and marinas, overwater structures, including bridges for railways, roads, causeways, and artificial fill. An analysis conducted in 2011 though the Puget Sound Nearshore Ecosystem Restoration Project (Fresh et al, 2011; Simenstad et al 2011) found that since 1850, of the approximately 2,470 miles of Puget Sound shoreline:

- Shoreline armoring has been installed on 27 percent of Puget Sound shores (Table 9).
- One-third of bluff-backed beaches are armored along half their length. Roads and nearshore fill have each affected about 10 percent of the length of bluff-backed beaches.
- Forty percent of Puget Sound shorelines have some type of structure that impacts habitat quality (shoreline armoring included).

- Overwater structures cover more than 506,103 acres of Puget Sound nearshore habitat
- There has been a 93 percent loss of freshwater tidal and brackish marshes. The Duwamish and Puyallup rivers have lost nearly all of this type of habitat.
- A net decline in shoreline length of 15 percent as the naturally convoluted and complex shorelines were straightened and simplified. This represents a loss of 1,062 km or 660 miles of overall shoreline length.
- Elimination of small coastal embayments has led to a decline of 46 percent in shoreline length in these areas.
- A 27 percent decline in shoreline length in the deltas of the 16 largest rivers and a 56 percent loss of tidal wetlands in the deltas of these rivers.

The distribution and sizes of over water structures (OWS) in the nearshore[14] are detailed further in Schlenger et al. (2011) and (Simenstad et al. 2011).

Table 9. Length of shoreline armored as a percent of total shoreline length (Simenstad et al. 2011) by marine basin (Beechie et al. 2017).

Marine Basin	Armoring (miles)	Shoreline Length (miles)	Percent Armored
Hood Canal	63.9	359.7	17.7%
North Puget Sound	103.3	720.4	14.3%
South Central Puget Sound	397.0	832.6	47.7%
Strait of Juan de Fuca	33.0	210.3	15.7%
Whidbey Basin	68.3	343.4	19.9%
Grand Total	**665.3**	**2466.3**	**27.0%**

Puget Sound nearshore and deep marine waters are fundamental to many life histories of salmon and steelhead and particularly crucial for PS Chinook salmon juvenile (parr, fry, sub-yearling), and sub adult life stages. Juvenile salmon use nearshore habitat extensively during the early marine period (Duffy et al. 2005), a critical time for salmon growth, as larger, faster-growing fish have increased probabilities of surviving to adulthood (Beamish et al. 2004; Duffy and Beauchamp 2011). As mentioned in section 2.2.1 above, the loss of nearshore habitat is considered a factor in the loss of PS Chinook salmon abundance and productivity. Reduction in nearshore habitat quality has reduced survival at multiple life stages. Marine survival rates of PS Chinook salmon in Puget Sound have declined drastically since 1980 (Ruggerone and Goetz 2004, Sharma et al. 2012, Ruff et al. 2017). Smolt-to-adult survival rates for hatchery-reared sub-yearling Chinook salmon within Puget Sound have averaged less than one percent over the past three decades (Kilduff et al. 2014).
There is also evidence that loss of nearshore habitat quality may be eliminating PS Chinook salmon life history strategies that make use of nearshore areas during the early life stages.

[14] The nearshore area includes the area from the deepest part of the photic zone (approximately 10 meters below Mean Lower Low Water [MLLW]) landward to the top of shoreline bluffs, or in estuaries upstream to the head of tidal influence (Clancy et al. 2009).

Campbell et al. (2017) found less than three percent of adults returning to the Green and Puyallup Rivers to exhibit the fry migrant life history concurrent with approximately 95 percent of their estuary habitat having been eliminated. The converse was true from the Skagit and Nooksack estuaries where approximately 50 percent of the estuary remained in a natural state (Beechie et al. 2017) and 36 and 24 percent of the adult population we examined returned from small fry sized fish, respectively.

From 2005 to 2011, in Puget Sound an average of 1.1 miles per year of new shoreline armoring was permitted in and 2.3 miles per year of replacement armoring was permitted (Johannessen et al. 2014). These figures do not include unpermitted structures, which can exceed those constructed with permits. For example, in the Green/Duwamish River Watershed (Water Resources Inventory Area 9), permitted structures comprised only 38 percent of all the armoring physically surveyed in 2012 and 2013 (King County 2014).

Residential parcels make up 57 percent of Puget Sound shorelines and 48 percent of these are armored. In some areas, armoring is even more prevalent: more than 50 percent of the residential parcels are armored in King, Kitsap, Pierce, Snohomish, Mason, and Thurston counties. Overall, 26 percent of residential parcels are in forage fish spawning grounds and 58 percent of those are armored (PSMNGP 2014). In a survey of HPAs issued by WDFW in Puget Sound between January 2005 and December 2010 the data recorded the installation of 6.5 miles of new armor and 14.45 miles of replacement armor. This starkly contrasts with data from that same time period that shows only 0.61 miles of armor were removed (Carman et al 2011). More recent studies have suggested a less dramatic rate of new armoring, but those studies were limited in their geographic scope and types of shoreline modification.[15] The studies have, however, corroborated that the bulk of permitted shoreline armoring activities continue to be repair and replacement. This demonstrates that the lifecycle of structures that includes the repair or replacement of aging armoring and other in- or over-water structures in Puget Sound extends the duration of degraded baseline conditions and retains limits on habitat features and corresponding carrying capacity.

The duration of impairment of habitat condition and function that derive from decades of persistent anthropogenic changes in the amount of and character of estuarine habitat, is made more detrimental due to the compounding nature of these effects, occurring because: (1) regulatory and permitting measures do not avoid all impacts and largely fail to include methods to rectify unavoidable impacts; (2) development pressure continues to impact habitat in the marine and freshwater portion of the range; (3) improvements in human use patterns to minimize resource impacts are slow at best; and (3) few of the 2020 improvement targets identified by the Puget Sound Partnership (PSP)[16] have been reached (Puget Sound Partnership 2018). In more detail, this most recent report points out the following issues:

- Chinook salmon, steelhead and SRKW: ongoing decline.
- Herring stocks: declining

[15] Shoreline Permitting through TACT (Spring 2015) (TACT is an acronym for: Trouble-Shooting, Action Planning, Course Correction, and Tracking and Monitoring).

[16] The PSP Action Agenda is an EPA-approved recovery plan under the National Estuary Program.

- Loss of non-federal forested land cover to developed land cover: continuing. Loss of 1,196 acres of non-federal forested land per year between 2006 and 2011.
- Shoreline armoring: Stable between 2011 and 2014. No recent net increase, restoration actions balance out increase from private shoreline armoring. However, this could be related to poor economic conditions. More years of data are needed to determine trends.
- Accelerated conversion/loss of vegetation cover on ecologically important lands: 0.18 percent loss for 2011-2016. This is even more loss than the cautious 2020 Target: Basin-wide loss of vegetation cover on ecologically important lands under high pressure from development does not exceed 0.15 percent of the total 2011 baseline land area over a 5-year period.
- Marine water quality: Overall, trends have been getting worse with closures of beaches and shellfish harvest in some bays. While there has been some increase between 2011 and 2014 in the amount of shellfish beds open to harvest, about 19 percent are still closed. PCB levels in fish are still high.
- Native Eelgrass (*Z. marina*) abundance seems stable comparing 2011 to 2013 data to baseline from 2000 to 2008. This does not account for losses that occurred prior to 2000.
- Human Sound Behavior Index: No change in average behavior. Thus, an increase in human population is likely to continue to degrade habitat quality. (The Sound Behavior Index tracks 28 human use practices[17] that likely affect habitat and water quality and quantity).
- Over Water Structure (OWS): not assessed by PSP. Current percent of nearshore coverage is 0.63 percent for all of Puget Sound, as detailed below.

The PSP concludes the overall decline in habitat conditions and native species abundance in the Puget Sound has been caused by development and climate change pressures. Over the last 150+ years, 4.5 million people have settled in the Puget Sound region. With the level of infrastructure development associated with this population growth the Puget Sound nearshore has been altered significantly. Major physical changes documented include the simplification of river deltas, the elimination of small coastal bays, the reduction in sediment supplies to the foreshore due to beach armoring, and the loss of tidally influenced wetlands and salt marsh (Fresh et al. 2011).

In addition to beach armoring, other shoreline changes including OWS, marinas, roads, and railroads reduce habitat quality. The amount of these changes varies, and their source varies by region, generally correlating with development, but overall is substantial (Simenstad et al. 2011). The simplification of the largest river deltas has caused a 27 percent decline in shoreline length compared to historical (pre-1890s) conditions. Of 884 historic small embayments, 308 have been eliminated. About 27 percent of PS's shorelines are armored and only 112 of 828 shoreline segments remain in properly functioning condition. The loss of tidal wetlands in the largest deltas averages 26 percent (Fresh et al. 2011). Each of these habitat changes is related to development and overall reduces the quality and quantity of PS Chinook salmon in the Puget Sound nearshore.
Existing shoreline armoring on nearshore and intertidal habitat function has diminished sediment supply, diminished organic material (e.g. woody debris and beach wrack) deposition, diminished

[17] Human use practices include among others: (a) Number of residents with native vegetation on banks of waterways; (b) number of residents using pump stations for boat wastewater; (c) residents using herbicides and pesticides; and (d) pasture practices for residents with livestock.

overwater (riparian) and nearshore in-water vegetation (SAV), diminished prey availability, diminished aquatic habitat availability, diminished invertebrate colonization, and diminished forage fish populations (see Toft et al. 2007; Shipman et al. 2010; Sobocinski et al. 2010; Morley et al. 2012; Toft et al. 2013; Munsch et al. 2014; Dethier et al. 2016). In some locations shoreline armoring has caused increased beach erosion waterward of the armoring, which, in turn, has created beach lowering, coarsening of substrates, increases in sediment temperature, and reductions in invertebrate density (Fresh et al. 2011; Morley et al. 2012; Dethier et al. 2016).

Shoreline armoring has reduced suitable habitat for forage species (Pacific sand lance and surf smelt) spawning and likely has reduced their abundance and productivity. Bulkheads alter habitat conditions for the duration that they are present and simultaneously diminish or eliminate intertidal habitat for forage species including sand lance, an obligate upper intertidal spawner (Whitman et al. 2014). As stated in Fresh et al. (2011) "we can only surmise how much forage fish spawning habitat we have lost because we lack comprehensive historical data on spawning areas." Considering that these forage fish are an essential food source for salmon, beach armoring has multiple negative effects on salmon including reductions in prey and reductions in access to shallow water rearing habitat and refuge (Davis et al. 2020).

<u>Marine Vessels</u>

Commercial, recreational, military, and public ferry vessel traffic occurs throughout Puget Sound. Vessels range in size from massive commercial shipping container ships to kayaks. Vessels can access Puget Sound through the Strait of San Juan de Fuca, the Strait of Georgia, ports, public and private marinas, naval bases, single-family piers, public boat ramps, and freshwater piers and marinas. Several studies have shown fish to respond physiologically and biologically to increased noise (Mueller 1980; Scholik and Yan 2002; Picciulin et al. 2010). Xie et al. (2008) report that adult migrating salmon avoid vessels by swimming away. Graham and Cooke (2008) studied the effects of three boat noise disturbances (canoe paddling, trolling motor, and combustion engine (9.9 horsepower) on the cardiac physiology of largemouth bass (*Micropterus salmoides*). Exposure to each of the treatments resulted in an increase in cardiac output.

Vessels are subject to existing federal regulations prohibiting approach closer than 200 yards or positioning in the path of the whales within 400 yards (with exemptions for vessels lawfully engaged in commercial or treaty Indian fishing that are actively setting, retrieving, or closely tending fishing gear). State regulations also mandate protections for SRKWs (see RCW 77.15.740, mandating 300 to 400-yard approach limits, 7 knots or less speed within ½ nautical mile of the whales). NMFS and other partners have outreach programs in place to educate vessel operators on how to avoid impacts to whales. The average number of vessels with the whales decreased in 2018, 2019 and 2020 likely due to decreased viewing effort on SRKWs by commercial whale watching vessels, with an average of 10, 9, and 10.5 vessels with the whales at any given time, respectively (Frayne 2021). NMFS initiated scoping in 2019 to evaluate the need to revise existing federal regulations.

Stormwater

Mackenzie et al. 2018 found that stormwater is the most important pathway to Puget Sound for most toxic contaminants, transporting more than half of the Sound's total known toxic load (Ecology & King County 2011). During a robust Puget Sound monitoring study, toxic chemicals were detected more frequently and at higher concentrations during storm events compared with base flow for diverse land covers, pointing to stormwater pollution (Ecology 2011). The Puget Sound basin has over 4,500 unnatural surface water and stormwater outfalls, 2,121 of which discharge directly into the Sound (WDNR 2014).

In general, the pollutants in the existing stormwater discharge are diverse. The discharge itself comes from rainfall or snowmelt moving over and through the ground, also referred to here as "runoff." As the runoff travels along its path, it picks up and carries away natural and anthropogenic pollutants (U.S. EPA 2016b). Pollutants in stormwater discharge typically include

- Excess fertilizers, herbicides, insecticides and sediment from landscaping areas.
- Chemicals and salts from de-icing agents applied on sidewalks, driveways, and parking areas.
- Oil, grease, PAHs and other toxic chemicals from roads and parking areas used by motor vehicles.
- Bacteria and nutrients from pet wastes and faulty septic systems.
- Metals (arsenic, copper, chromium, lead, mercury, and nickel) and other pollutants from the pesticide use in landscaping, roof runoff (WDOE 2014), decay of building and other infrastructure, and as airborne particles from street and tire wear.
- Atmospheric deposition from surrounding land uses.
- Erosion of sediment and attached pollutants due to hydromodification.

(Buckler and Granato 1999; Colman et al. 2001; Driscoll et al. 1990; Kayhanian et al. 2003; Van Metre et al. 2005).

Landscape overview

When considered at the landscape scale, the baseline condition of Puget Sound nearshore habitat is degraded, with reduced water quality, reduced forage and prey availability, reduced quality of forage and prey communities, reduced amount of estuarine habitat, reduced quality of nearshore and estuarine habitat, and reduced condition of migration habitat due to structures noise and vessel perturbations. Each of these conditions of the baseline exerts downward pressure on all populations of each listed species considered in the Opinion for the duration of their time in the action area. Loss of production of Chinook salmon from habitat degradation reduces available forage for SRKWs. The baseline currently constrains the carrying capacity of the action area and limits its potential for serving recovery of these species. Overall, the nearshore is impacted in many areas by the degradation from coastal development and pollution. The status of deep-water habitat is impacted by remaining derelict fishing gear and degraded water quality among other factors. The input of pollutants affects water quality, sediment quality, and food resources in the nearshore and deep-water areas of critical habitat.

NMFS's management strategy for conservation and recovery of listed salmonids in the West Coast has long been premised on reducing adverse effects among all of the "4 Hs" namely, Hatcheries, Hydropower, Harvest, and Habitat. Each has had a role in the factors for decline of West Coast salmonids, each has been the subject of section 7 consultations, and each has been found to have continuing negative influence on species' viability. Example dams such as White River Dam, previously operated by Puget Sound Energy, Mud Mountain Dam (NMFS 2014a) operated by the USACE for the purpose of flood control operations, and as needed to facilitate maintenance activities at the downstream White River diversion dam, and Howard Hanson Dam (NMFS 2019c) operated by the USACE for downstream flood damage reduction, have each been found to jeopardize ESA listed fish, and in the case of Mud Mountain and Howard Hanson dams, jeopardy to PS Chinook salmon posed a secondary threat of jeopardy to SRKW.

The outcomes of those jeopardy opinions include the surrender of the White River FERC license. Puget Sound Energy retired the hydro project in 2004. Cascade Water Alliance purchased it from the company in 2009 and intends to complete a habitat conservation plan for its water. Passage improvements at Mud Mountain Dam have already reduced fish mortality, and while a new passage is being designed for Howard Hanson Dam, the USACE is evaluating modifications to its retention and release schedule of water to benefit egg in spawning areas downstream of the dam. In each case, modifications to avoid jeopardizing listed species are being undertaken.

On November 9, 2020, NMFS issued a biological opinion on 39 proposed projects in the nearshore of Puget Sound (WCRO-2020-01361). The 39 individual consultations proposed to construct new overwater or shoreline armoring structures or repair or replace existing in- or overwater or armoring structures, and were consolidated together by NMFS into a single biological opinion based on the locations of the proposed projects and their similar impacts on ESA-listed species and their critical habitat designated under the ESA. In this opinion, we determined the Corps' proposed action, to permit the 39 projects, was likely to jeopardize the continued existence of listed PS Chinook salmon and SRKW. We also concluded the proposed action was likely to adversely modify those species' designated critical habitats. We also determined that the proposed action was not likely to jeopardize listed PS steelhead, PS/Georgia Basin bocaccio rockfish, yelloweye rockfish, or Hood Canal Summer-run chum salmon or adversely modify designated critical habitat for those four species. Our conclusion was based on:

- PS Chinook populations are far from meeting recovery goals and trends in abundance and productivity are mostly negative.
- Nearshore habitat quality is insufficient to support conservation of this ESU. SRKW prey is at a fraction of historical levels. Under the current environmental baseline, nearshore habitat in Puget Sound cannot support the biological requirements of PS Chinook salmon.
- Fewer populations of PS Chinook salmon contributing to SRKW's prey base will reduce the representation of diversity of life histories, resiliency in withstanding stochastic events, and redundancy to ensure there is a margin of safety for the salmon and SRKWs to withstand catastrophic events.
- The condition of the environmental baseline is such that additional impacts on the quality of nearshore habitat is likely to impair the ability of that habitat to support conservation of these species.
- The proposed actions would further reduce the quality of nearshore habitat in Puget Sound.

- The proposed actions would also exacerbate habitat limiting factors identified by the PS Chinook salmon and SRKW recovery plans and are inconsistent with recovery action listed in these plans. Due to demand for future human development cumulative effects on nearshore habitat quality are expected to be mostly negative.

The 2020 jeopardy opinion included an RPA with five elements, including on site habitat improvements; offsite habitat improvements; funding from a habitat restoration sponsor; purchase of credits from a conservation bank in-lieu fee program, or crediting provider; and, project modifications.

The environmental baseline would also include the projected effects of climate change for the time period commensurate with the effects of the proposed actions. Mauger et al (2015) predict that circulation in Puget Sound is projected to be affected by declining summer precipitation, increasing sea surface temperatures, shifting streamflow timing, increasing heavy precipitation, and declining snowpack. While these changes are expected to affect mixing between surface and deep waters within Puget Sound, it is unknown how these changes will affect upwelling. Changes in precipitation and streamflow could shift salinity levels in Puget Sound by altering the balance between freshwater inflows and water entering from the North Pacific Ocean. In many areas of Puget Sound, variations in salinity are also the main control on mixing between surface and deep waters. Reduced mixing, due to increased freshwater input at the surface, can reduce phytoplankton growth, impede the supply of nutrients to surface waters, and limit the delivery of dissolved oxygen to deeper waters. Patterns of natural climate variability (e.g., El Niño/La Niña) can also influence Puget Sound circulation via changes in local surface winds, air temperatures, and precipitation.

All three ESA-listed Puget Sound salmonids were classified as highly vulnerable to climate change in a recent climate vulnerability assessment (Crozier et al. 2019). In estuarine environments, the two greatest concerns associated with climate change are rates of sea-level rise and temperature warming (Wainwright and Weitkamp 2013, Limburg et al. 2016). While the effects of climate change-induced ocean acidification on invertebrate species are well known, the direct exposure effects on salmon remains less certain (Crozier et al. 2019).

The world's oceans are becoming more acidic as increased atmospheric CO_2 is absorbed by water. The North Pacific Ocean is already acidic compared to other oceans, making it particularly susceptible to further increases in acidification (Lemmen et al. 2016). Laboratory and field studies of ocean acidification show it has the greatest effects on invertebrates with calcium-carbonate shells, and relatively little direct influence on finfish; see reviews by Haigh et al. (2015) and Mathis et al. (2015). Consequently, the largest impact of ocean acidification on salmon is likely to be its influence on marine food webs, especially its effects on lower trophic levels, which are largely composed of invertebrates such as pteropods, larval crabs, and krill, which play a significant role in some salmon diets (Haigh et al. 2015, Mathis et al. 2015, Wells et al. 2012). Marine invertebrates fill a critical gap between freshwater prey and larval and juvenile marine fishes, supporting juvenile salmon growth during the important early-ocean residence period (Daly et al. 2009, 2014).

Physiological effects of acidification may also impair olfaction, which could hinder homing ability (Munday et al. 2009), along with other developmental effects (Ou et al. 2015). Although a recent review of ocean acidification studies on fish has called into question many of the behavioral effects of ocean acidification (Clark et al. 2020). Using the criteria of Morrison et al. (2015) for scoring, PS Chinook salmon, HC Chum salmon, and PS steelhead had low-to-moderate sensitivity to ocean acidification (Crozier et al. 2019).

The same document states that "sea level rise is projected to expand the area of some tidal wetlands in Puget Sound but reduce the area of others, as water depths increase and new areas become submerged. For example, the area covered by salt marsh is projected to increase, while tidal freshwater marsh area is projected to decrease. Rising seas will also accelerate the eroding effect of waves and surge, causing unprotected beaches and bluffs to recede more rapidly. The rate of sea level rise in Puget Sound depends both on how much global sea level rises and on regionally-specific factors such as ocean currents, wind patterns, and the distribution of global and regional glacier melt. These factors can result in higher or lower amounts of regional sea level rise (or even short-term periods of decline) relative to global trends, depending on the rate and direction of change in regional factors affecting sea level" (Mauger et al. 2015).

2.3.2 Current Status of Commencement Bay

Industrial development of Commencement Bay began in the late 19th century (Corps et al. 1993) and fragmented estuarine habitats by altering shorelines with vertical or steeply sloping bulkheads and piers (Kerwin 1999). By 1917, several waterways, including the Blair Waterway, had been constructed by dredging and filling mudflats in the Puyallup River delta and Commencement Bay. Side channels, sloughs, and saltwater transition zones historically used by anadromous fish have largely been eliminated. Chemical contamination of sediments within Commencement Bay has compromised the suitability of the remaining habitat (Corps et al. 1993; USFWS & NOAA 1997; Collier et al. 1998). Despite extensive alterations to the natural habitat within Commencement Bay, some species still use the remaining habitat (USFWS & NOAA 1997).

Historically, intertidal mudflats covered an estimated 2,100 acres of Commencement Bay. In 1992, approximately 180 acres remained (Corps et al. 1993). Dredging, diking, and other anthropogenic activity within Commencement Bay are responsible for this change in habitat. Since 1993 several habitat mitigation and restoration sites have been established and approximately 292 additional acres of marine and estuarine habitat within the action area has been restored[18]. The majority of the remaining mudflat habitat is located near the mouth of the Puyallup River, within the Hylebos, Middle, Milwaukee, St. Paul, and Wheeler-Osgood Waterways (Corps et al. 1993; USFWS & NOAA 1997).

The action area within Commencement Bay, has been highly developed and numerous overwater structures and extensive shoreline armoring exist within the vicinity of the project. The natural shoreline has been almost completely replaced by impervious surfaces and nearshore riparian vegetation is absent. The shorelines of Commencement Bay have been highly altered using

[18] Quantity provided by Jennifer Stebbings, Port of Tacoma on January 10, 2022 via a preliminary draft review comment.

riprap, and other materials to provide bank protection. The Port of Tacoma waterways were developed for industrial and commercial operations and the upland areas are heavily industrialized. Blair Waterway comprises seven percent of the total of armored shoreline that covers 71 percent of the length of the Commencement Bay shoreline. Commencement Bay contains dense industrial, commercial, and residential development and is a major shipping route for containerized and bulk cargo, which is consequently subject to high volumes of marine traffic.

Aquatic portions of the project area are composed of intertidal and subtidal habitats. Intertidal habitat along the shorelines of the project area is limited by shoreline armoring and overwater structures. Commencement Bay has been highly modified by industrial development with large areas of fill, dredging, stabilization, and infrastructure (Simenstad 2000). Overwater structures in the form of piers for ship loading are prevalent along the shorelines of the project area. Based on shoreline surveys and aerial photo interpretation of the area, approximately five miles, or 20 percent of the Commencement Bay shoreline, is covered by wide over-water structures (Kerwin 1999). This shading affects the community of the subtidal organisms that serve as fish food or habitat structure in the form of eelgrass and kelp (Nightingale and Simenstad 2001). Piers and other overwater structures can inhibit juvenile salmon migration as physical barriers, shading that causes avoidance, and increased susceptibility to predation (Simenstad et al. 1982).

The depth of sea floor in most of Commencement Bay (30-100 meters; 98-330 feet) and the Blair Waterway (-51 MLLW) is not commonly habitat that salmonids select for feeding or refuge. Some estuarine and marine fish and sub-tidal marine invertebrates inhabit and feed at deeper subtidal elevations within the action area. Additionally, the invertebrates inhabiting the substrate of the Blair Waterway, such as polychaete and nematode worms, do not contribute significantly to the salmonid food chain (Hiss and Boomer 1986). The Blair Waterway has artificial side slopes of 2H:1V throughout most of the waterway.

Baseline conditions include regular disruptions on a daily basis when large shipping vessels transit the channel and displace fish and wildlife due to underwater noise and physical presence. Tacoma Harbor already receives calls from the 14,000 twenty-foot equivalent unit (TEU) capacity Thalassa Axia, which began calling in November 2018. The Thalassa Axia is the largest ship calling at Tacoma Harbor as of December 2019.

2.3.3 Current Status of Blair Waterway

The Blair Waterway, a congressionally authorized federal navigation channel, is a permanent component of the integrated Port system. The Blair Waterway was artificially created and generally has a 2H:1V side slope and piers with varying degrees of slope strengthening (e.g., bulkheads, piles, and riprap) along the length of the channel (28,566 linear feet). The federal navigation channel, infrastructure/facilities, and vessel traffic, within the Blair Waterway are included as part of the environmental baseline considered in this Opinion.

The Blair Waterway was first constructed prior to 1920 by private interests. Over the last 100 years, at least 14 different dredge/cleanup projects have shaped the waterway to its current configuration. It has been at its current length since the mid-1960s. In the last 25 years, there have been several deepening actions, some conducted as part of the Commencement Bay

Nearshore/Tideflats (CB/NT) Superfund cleanup; at least five different cutback actions for widening the waterway; bridge abutment fill removal; slip fills; and pier realignments. During this same 25-year period, there have been numerous pier redevelopments, realignments, expansions, and new construction. The Blair Waterway comprises seven percent of the total armored shoreline within Commencement Bay.

The Blair Waterway has a long history as an integral structure to support marine cargo shipping in the Puget Sound. Since its creation, the Blair Waterway has been actively operated, managed, and maintained as an industrial and commercial navigable waterway. From its initial construction prior to 1920 to 1956, the Blair Waterway (first named Wapato Waterway and then Port Industrial Waterway), was incrementally deepened, widened, and lengthened through actions under the River and Harbors Act of 1935, and the Rivers and Harbors Act of 1954. In 1956, the waterway was approximately 800 feet wide, and -30 feet MLLW, from the mouth to approximately Lincoln Avenue. Following the Rivers and Harbors and Flood Control Act of 1962, the waterway was lengthened to its present configuration (approximately 2.6 miles) and a turning basin was added at the head of the navigation channel. The project was completed in 1969 and the waterway was renamed the Blair Waterway.

In 1983-1984, investigations showed concentrations of arsenic, copper, lead, and zinc in surface water runoff from the area exceeded federal and state marine water quality criteria. In the mid-1990s, the Blair Waterway navigation channel and berth areas were dredged as part of the Sitcum Waterway Remediation Project under the CB/NT Superfund cleanup. The waterway was deepened from -30 feet to approximately -48 feet MLLW from the mouth to approximately 1,000 feet upstream of Lincoln Avenue, and to approximately -45 feet MLLW for the remainder of the waterway, including the turning basin. However, after cleanup, concentrations of metals (arsenic and lead) in soil exceeded MTCA (Model Toxics Control Act) Method A cleanup levels for industrial sites. In addition, arsenic concentrations in stormwater exceeded water quality criteria (surface water runoff at the site discharges to the Blair Waterway). When an environmental covenant exists for a cleanup site, The Washington Department of Ecology (Ecology) reviews site conditions about every five years to ensure the long-term effectiveness of the cleanup action. Ecology inspected the site on April 3, 2019, and investigated current conditions of the cap and the stormwater collection system. Conditions of the cap continues to prevent direct contact with contaminated soil and prevent stormwater from contacting or infiltrating the capped soils.

Sediment within the Blair Waterway have been classified by Ecology as Waters of Concern (Category 2) for hexachlorobenzene and sediment bioassays. A small section of the waterway has also been classified as impaired waters that do not require a TMDL (Category 4b) for sediment bioassays. Soil, groundwater, and nearshore sediment in the uplands around the Blair Waterway are potentially contaminated with residual hazardous materials including total petroleum hydrocarbons, metals, volatile organic compounds (VOCs), semi-volatile organic compounds, and polychlorinated biphenyls (PCBs).

In 1999, the Corps evaluated the Blair Waterway and determined deepening the navigation channel from -48 feet and -45 feet MLLW to -51 feet MLLW in its entirety would eliminate navigation inefficiencies for post-Panamax shipping vessels and would not result in significant environmental impacts. The entire Blair Waterway navigation channel was dredged in 2000 to its current depth of -51 feet MLLW. Two pier realignments and two maintenance dredges have occurred in the Blair Waterway in the last 15 years. First, 600 feet of the Blair Terminal was demolished, the bank cutback to align with the Washington United Terminal (WUT) and 600 feet of new pier was added to the south end of WUT. A small maintenance dredge (approximately 3,300 cubic yards) was performed at WUT in 2009. Next, a maintenance dredge was conducted at Husky Terminal (approximately 42,100 cubic yards) around 2011 to remove high spots from shoaling and sloughed material. Most of Pier 4 at Husky Terminal was demolished and the bank cutback to align with Pier 3 starting in 2014. Part of that action was conducted as an emergency cleanup coordinated by the EPA due to very high levels of Tributyltin found during sediment characterization. Finally, the Corps estimates operation and maintenance dredging occurs within the Blair Waterway approximately every 25 years and removes roughly 30,000 cubic yards of material to maintain navigability of the congressionally authorized channel.

Sediments within the Blair Waterway are predominantly fine-grained, and generally consist of sand and silty sand, as well as organic sediments that enter the action areas from the Puyallup River and Wapato Creek. High turbidity is a major factor within the Blair Waterway, primarily due to propeller wash from vessel activities and turbidity from the Puyallup River, which can enter the waterways during high tides. High levels of turbidity in inner Commencement Bay occur routinely due to the naturally high turbidity of the Puyallup River. In deep-water areas, turbidity is generally lower than surface turbidity.

With the exception of mitigation/restoration sites, the Blair Waterway shoreline is armored along its entire length with riprap, bulkheads (sheetpile or secant walls), or wooden piles. The extent of armoring depends on the location, and ranges from riprap from at least +10 feet above mean lower low water (MLLW) to -2 MLLW, to extensive overwater structures such as piers and docks. In many places armoring goes all the way to the bottom of the water (-51 MLLW) and below to a rock key. A rock key is part of the riprapped slope that extends below the mudline at the bottom of the slope. The proposed action would expand the channel width at various points along the length of the channel and as a result require slope stabilization measures (see Figure 2 in section 1.3.2). Currently, all four locations are stabilized with small to medium sized angular rocks at a 2:1 slope (Figure 7).

The Blair Waterway, in its current congressionally authorized state, lacks high quality nearshore habitat that would provide adequate ecological function necessary to continuously support the ESA-listed species evaluated in this Opinion. The highly developed state and channelized nature of the waterway precludes utilization of the area by most species. The lack of shallow water habitats, suitable substrate, submerged aquatic vegetation, and natural cover and the intense industrial use inhibit species from using these areas as feeding, growth, and reproductive opportunities.

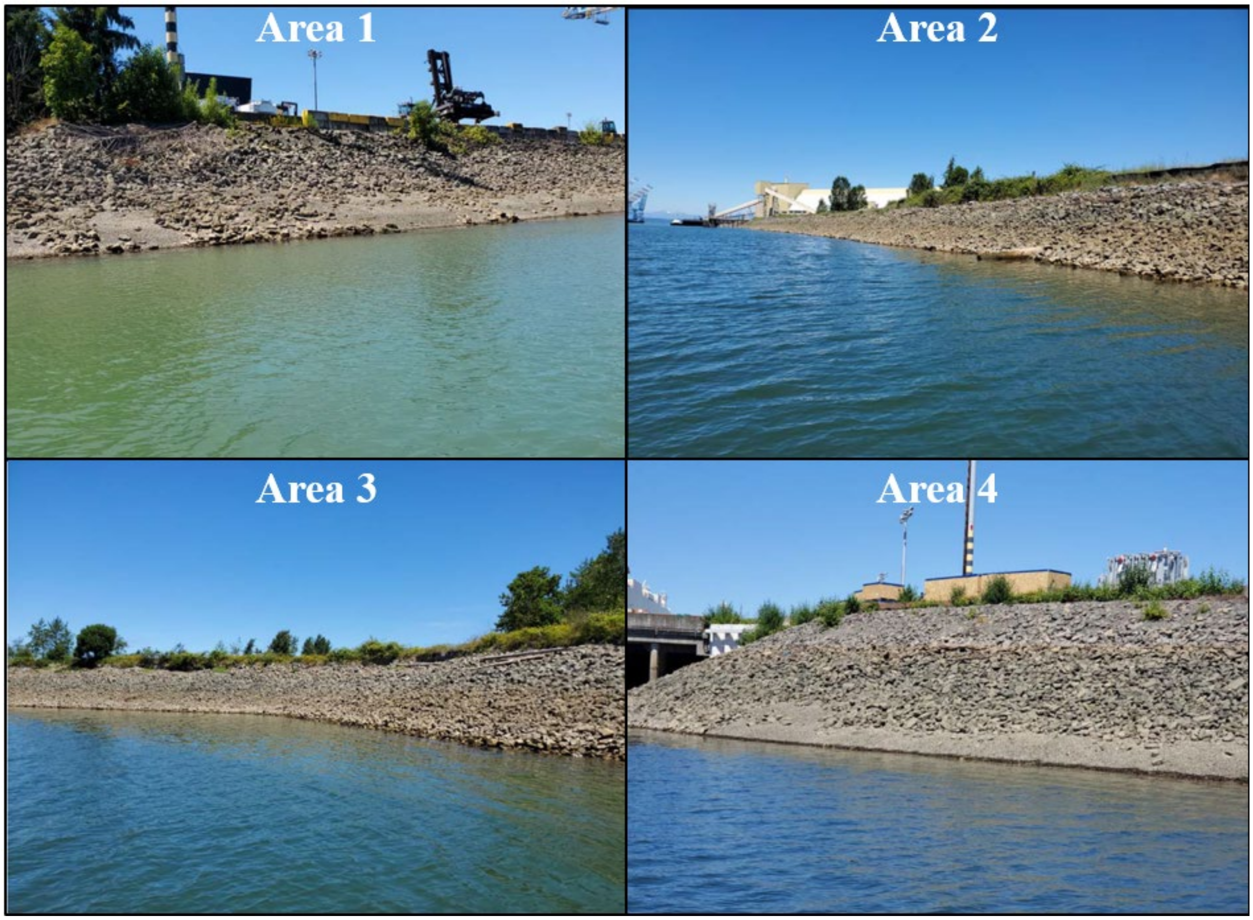

Figure 7. Current habitat conditions of Areas 1- 4 within Blair Waterway proposed added shoreline stabilization as a result of proposed channel widening. Currently, the 2:1 slopes are stabilized by riprap. Areas 1 and 4 are proposed to be stabilized using riprap. Areas 2 and 3 are proposed to be stabilized with secant wall armoring.

2.3.4 Current Status of Saltchuk

The Saltchuk site is located approximately one mile north of Blair Waterway along the shoreline. Within Saltchuk, habitat is degraded due to development of Commencement Bay and previous log storage at the site. Wood waste has accumulated over approximately 100 years and is not known to be chemically treated, and thus not a suspected source of hazardous, toxic, or radioactive waste (HTRW). Three primary locations accounting for approximately 13 percent of the total 64-acre Saltchuk site were observed to contain wood waste during a 1999 dive survey. One large area of wood waste was observed from shore during a low tide event (GeoEngineers 2014a, as cited in GeoEngineers 2015) extending from the lower shore zone to a depth of approximately -30 MLLW. The site contains approximately 53 acres of deep subtidal zone habitat (below -10 MLLW). The majority of the deep subtidal habitat at the site consists of brown and black silt with wood waste over gray clay.

Macroalgae in the lower shore zone is largely composed of sea lettuce (Ulva ssp.) and was observed at approximately the MLLW line. One patch of eelgrass was identified to the southeast of the project area near Hylebos Waterway at depths of approximately -6 feet to -10 MLLW during an August 2014 underwater video survey. Lower shore zone (LSZ) habitat (from +5 to -10 MLLW) is composed of a coarse substrate that transitions to sand and silt near MLLW.

2.3.5 Species in the Action Area

Species considered in this Opinion likely to be present during construction in Commencement Bay, Blair Waterway, or Saltchuk site include PS Chinook salmon, PS steelhead, and PS/GB rockfish (yelloweye and bocaccio).

Regular presence of either PS Chinook salmon or steelhead within Blair Waterway in high numbers is unlikely. However, based on the proximity of Blair Waterway to the Puyallup River, Hylebos Creek, and Wapato Creek, some ESA-listed Chinook salmon or PS steelhead may be present in the area during construction. Specific salmon and steelhead populations likely to be present Commencement Bay during construction include Puyallup River, Carbon River, and White River.

The Puyallup River enters Puget Sound via Commencement Bay west of Blair Waterway. Nine anadromous salmonids have been documented in the Puyallup River basin including winter steelhead, bull trout, coastal cutthroat trout, and spring/fall Chinook, fall chum, coho, sockeye, and odd-year pink salmon (Dames and Moore 1981; NWIFC 2019). Rearing and foraging by juvenile salmonids occurs along the limited shoreline areas that are shallow or retain natural structural diversity. Juvenile salmonids may use the nearshore reaches and Commencement Bay to transition into marine waters. Returning adult salmon typically congregate at the mouth of the Puyallup River prior to upstream migration.

Puyallup, Carbon, and White River salmon and steelhead are also expected to be present in Commencement Bay during construction. Puyallup River (including Carbon River fish) native-origin fall Chinook salmon abundance has been in steady decline since 2000 (Figure 8) and productivity has consistently failed to meet recovery goals since the late 1990’s (Figure 9). A similar trend has been documented in the White River spring Chinook salmon population. White River spring Chinook salmon are of significant importance because they are the only remaining spring Chinook salmon stock in the south/central Puget Sound region (Marks et al. 2018). The other concerning trend is the ratio of wild to hatchery spawners in the Puyallup Basin. Since the late 1990’s native-origin fall Chinook salmon abundance in the Puyallup River and spring Chinook salmon in the White River have been declining, meaning that populations are highly reliant on hatchery supplementation (Figure 10). PS steelhead abundance and productivity in the Puyallup Basin has slowly been improving since the mid 2000’s (Figure 11 and Figure 12). However, abundance remains well below recovery goals; the five-year geometric mean abundance is 136 compared to a recovery goal of 4,500 (Ford, in press).

Adult Chinook salmon would only hold temporarily within the waters of Blair Waterway before migrating to the Puyallup Basin, although, are not likely to be present for an extended period of time. Furthermore, Chinook salmon use of Blair Waterway is up to three times greater near the mouth of the waterway than near the head, where they are found in very low numbers (Duker et al. 1989). Similarly, juvenile Chinook salmon are not expected to spend significant time within the Blair Waterway, but could potentially rear within the nearshore waters of Commencement

Bay. No part of the waterway provides suitable spawning habitat for Chinook salmon, as the waterway is in a marine environment.

Blair Waterway has some suitable habitat for migrating adults and out-migrating juvenile PS steelhead. PS steelhead have been documented in Blair Waterway, Wapato Creek[19] (via the Blair Waterway), Hylebos Creek (via Hylebos Waterway), and Commencement Bay (SalmonScape[20]). Adult and juvenile steelhead most likely use the waterways as holding areas before they enter migration corridors. Outmigration of juveniles typically occurs between approximately the middle of March through the middle of July, and rearing juveniles could be present in Commencement Bay or adjacent waters of Puget Sound at any time of the year, including in Blair Waterway.

Hylebos Creek is a large independent drainage to the Puyallup Basin and flows from its headwaters near Federal Way into Commencement Bay via Hylebos Waterway (Figure 3). The area surrounding Hylebos Creek has been intensely developed and habitat quality is generally poor. Chinook salmon and steelhead have both been observed spawning within Hylebos Creek, although annual abundance is generally low. This suggests that a proportion of the salmon and steelhead exposed to project effects would originate from Hylebos Creek.

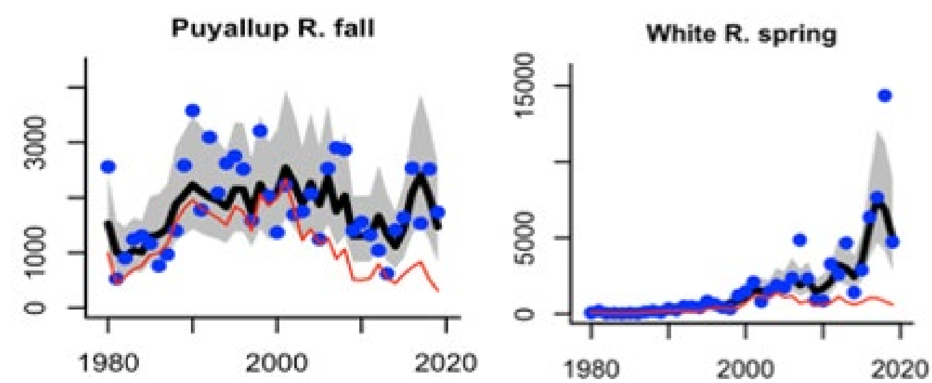

Figure 8. Smoothed trends in estimated total (hatchery and natural origin) (thick black line, with 95% confidence interval in grey) and natural (thin red line) abundance of Puyallup River fall Chinook salmon (left) and White River spring Chinook salmon (Adapted from Ford, in press).

[19] PS steelhead have not been documented in Wapato Creek for at least 20 years.
[20] http://apps.wdfw.wa.gov/salmonscape/map.html

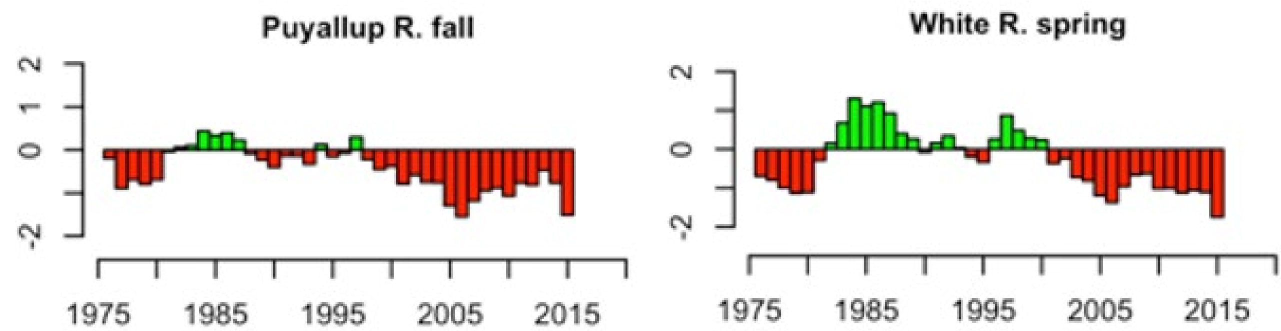

Figure 9. Annual trends in population productivity calculated as the difference of the log of the smoothed natural origin spawning abundance in year *t* and the smoothed natural origin spawning abundance in year *t* – 4 for Puyallup River fall Chinook salmon and White River spring Chinook salmon (Adapted from Ford, in press).

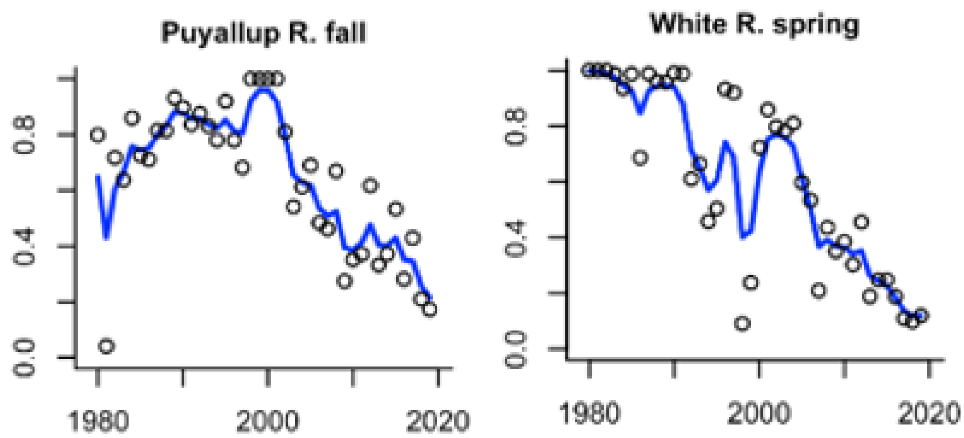

Figure 10. Smoothed trend in estimated fraction of natural-origin spawner abundances (blue line), and annual raw fraction of wild estimates (points) of Puyallup River fall Chinook salmon (left panel) and White River spring Chinook salmon (right panel) (Adapted from Ford, in press).

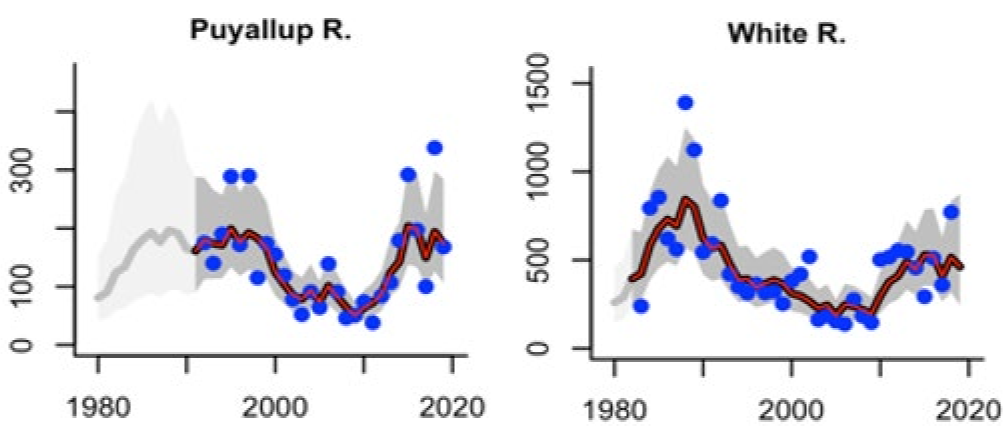

Figure 11. Smoothed trends in estimated total (thick black line, with 95% confidence interval in grey) and natural (thin red line) abundance of Puyallup River (left) and White River steelhead (Adapted from Ford, in press).

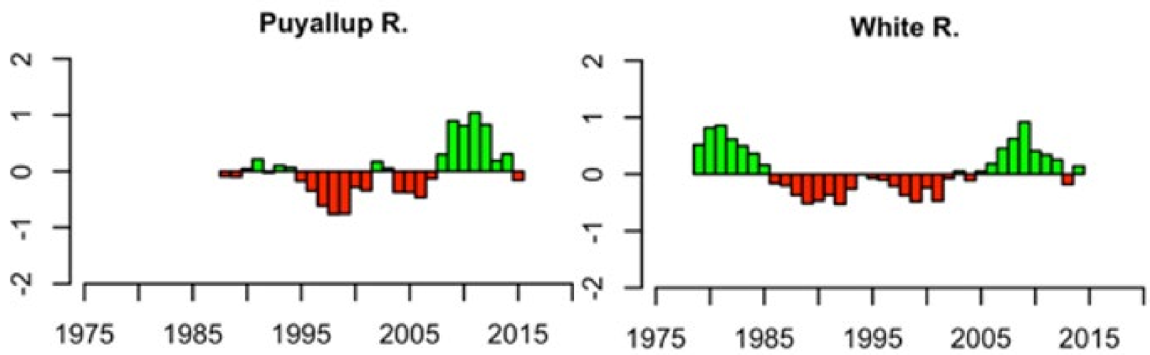

Figure 12. Annual trends in population productivity calculated as the difference of the log of the smoothed natural origin spawning abundance in year *t* and the smoothed natural origin spawning abundance in year *t* – 4 for Puyallup and White River steelhead (Adapted from Ford, in press).

Less information exists regarding the use of Commencement Bay and surrounding areas by PS/GB rockfish. The south Puget Sound Basin is within their historical range, however data is lacking to determine historical presence and abundance within the immediate project area. Adult rockfish are highly mobile and typically utilize deep water areas with large rocks and cover. Larval bocaccio and yelloweye drift for long periods before moving into rockier and deeper habitat once their swimming ability is full developed. Given the overlap of the work window with the second rockfish spawning event and the duration of time larvae drift it is likely that larval rockfish would be in the project area during construction. Larval rockfish have been documented throughout all major basins of Puget Sound (Greene and Godersky 2012).

2.3.6 Distinguishing Baseline from Effects of the Action

As described in more detail in Sections 2.3 and 2.4, the effects of an action are the consequences to listed species or critical habitat that would not occur but for the proposed action and are reasonably certain to occur. The environmental baseline refers to the condition of the listed species or its designated critical habitat in the action area without the consequences caused by the proposed action (50 CFR 402.02).

Relative to this consultation, we must distinguish the impacts from the existing operation and configuration of the congressionally authorized federal navigation channel as the baseline (which is not within the Corps' discretion to alter) compared to the time, place, and manner of the proposed construction to alter the proposed channel, any effects caused by the deepening and widening of the channel, the reduction in intermittent effects caused by marine vessels, and the beneficial use of dredge material placement at Saltchuk, all of which are within the Corps' discretion. The Blair Waterway is congressionally authorized and it is not within the Corps' discretion to modify its current configuration. Therefore, effects associated with the proposed action include those that would not occur but for the proposed action; in this case the deepening and widening of the existing federally authorized waterway, reducing vessel traffic, and placing dredged materials at the Saltchuk site.

With that understanding, the effects of the proposed action are evaluated relative to the current conditions, which include the infrastructure, shipping traffic, and regular maintenance associated with the Blair Waterway. Without the inherent infrastructure and maintenance, the federal channel would fail to operate in its current condition. The ongoing consequences to the environment resulting from the presence and operation of the facilities and structures in the federal navigation channel under the current configuration constitute the environmental baseline. These effects compromise habitat quality for listed species. Under the current environmental baseline, the federal navigation channel within the Blair Waterway would remain a highly developed area incapable of providing quality habitat for listed species.

While maintaining the current configuration of the federal channel is outside of the Corps' discretion, the manner and timing in which that maintenance occurs does fall within Corps' authority. That means the timing and methods used to maintain the proposed width and depth of the Blair Waterway is determined by the Corps and is therefore subject to future ESA Section 7 consultations. Effects of future maintenance dredging and repairs to infrastructure would be evaluated in a future consultation.

2.4 Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action (see 50 CFR 402.02). A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

The proposed action is reasonably certain to cause temporary, intermittent and enduring effects. Temporary effects include: (1) reductions in water quality from increased suspended sediment, turbidity, and contaminants; (2) increased underwater noise resulting from dredging; and (3) entrainment or strike of fish during dredging operations. These effects are likely to occur for the next four years when construction is proposed to be completed within Blair Waterway. Most effects would be expected to be localized and temporary. The proposed action is reasonably certain to cause intermittent effects, including a beneficial reduction in vessel traffic. We also evaluated the effects of an increase in vessel size for impacts to listed species. Specifically, we evaluated the potential for a change in noise, ship strikes, and wake effects on Puget Sound shorelines resulting from the proposed action. NMFS found no information that supported an increase in negative impacts to listed fish or marine mammals. Enduring effects include reductions in available benthic and forage prey resulting from disturbed benthic habitats after channel deepening and widening; however, the deposition of sediments at Saltchuk is likely to increase subtidal and intertidal habitat for juvenile salmon and juvenile bocaccio.

2.4.1 Temporary Effects during Construction

The proposed dredging project would cause direct temporary effects on the fish and habitat that are present during in-water work through exposure to dredging-related elevated noise, bucket strike or entrainment, degraded water quality, and propeller wash. The proposed dredging would also cause indirect effects on fish and habitat through forage contamination and altered benthic habitat. While we classify the following effects as temporary, we expect the effects to persist for the entirety of the annual in-water work window given that dredging work would occur nearly 24 hours a day. The continuous nature of in-water work would ensure that degraded habitat conditions would not abate until the end of the in-water work window each year (August 16 – February 15) or once the project is completed after four years. Finally, certain aspects of species and habitat recovery would not occur until after construction is completed and temporary effects cease (i.e., benthic habitat).

Water Quality
Water quality is likely to be affected during in-water work associated with mechanical dredging, shoreline stabilization, and associated vessel operation within the Blair Waterway and sediment deposition at Saltchuk. Effects to water quality during construction include increased turbidity, decreased DO, and re-suspension of unsuitable materials.

Turbidity and Dissolved Oxygen
Dredging, vessel operation, and material placement would result in increased turbidity and decreased dissolved oxygen due to suspended sediments. Coarser sediments are likely to redeposit close to the dredge location, while finer particles are likely to travel with currents and remain in suspension for longer periods of time. We expect the low current velocity in the Blair Waterway would limit the distance fine particles would travel from dredging site. Resuspension occurs with much greater severity when subsurface debris is encountered. This is due to the dredging bucket not being able to close fully (often because it is obstructed by debris) before removing sediments to the surface. A different type of clamshell bucket (environmental clamshell), which encloses unsuitable sediments is described below.

The dredging BMPs included in the proposed action (see Section 1.3.4) are expected to reduce the amount of suspended sediments to some degree. However, some resuspension of unsuitable material during dredging is unavoidable, even with implementation of BMPs. Propeller wash from vessels may also spread turbidity during construction and transport of dredged materials. Turbidity is expected to extend radially from the path traveled by the vessel but not outside of the action area based on suspended sediment plumes observed from the adjacent Puyallup River.

Suspension of anoxic sediment compounds during in-water work can result in reduced DO in the water column within the mixing zone area as the sediments oxidize. Some dredged material may contain sediment with biological and chemical oxygen demand that could temporarily lower local ambient DO levels during dredging. The upper portion of sediment is classified as loam to silt loam while native sediments are sand to loamy sand. Infaunal and benthic organisms inhabit the upper sediment, thus the likelihood of finding much anaerobic sediment in this stratum of sediment is low. Deeper sediment within the dredge prism is more likely to include anoxic compounds. Based on a review of six studies on the effects of suspended sediment on DO levels, LaSalle (1988) concluded that, when relatively low levels of suspended material are generated and counterbalancing factors such as flushing exist, anticipated DO depletion around in-water work activities would be minimal. High levels of turbidity are also expected to cause reductions in DO within the same affected area.

Clamshell dredging, material placement at Saltchuk, and installation of shoreline stabilization measures are expected to result in short-term increases in turbidity and decreases in DO in a linear plume down current from the activity. The small patch of eelgrass near the mouth of the Hylebos Waterway would be at a small risk of becoming buried under fine sediment during material placement at Saltchuk. However, water quality BMP measures described in the BA and additionally in Section 1.3.3, which limit impacts to eelgrass, would be used (e.g., turbidity curtains). The Corps has proposed to monitor turbidity while dredging to adhere to state water quality requirements outlined in the project's Water Quality Certification and would adjust construction actions based on monitoring results to remain in compliance with Washington State water quality standards.

Re-suspended Contaminants
Any sediments determined to be unsuitable for aquatic disposal would be hauled off-site to an appropriate upland disposal site (see Section 2.3.2 for a discussion on chemicals found in the waterway historically). While this removes potentially toxic sediment from the aquatic environment, some amount of resuspension would occur during the dredging process. Bioaccumulated toxins have appeared in fish tissues collected throughout the Puget Sound region, especially in urban areas (Puget Sound Action Team 2007). Concentrations of PCBs and other bioavailable contaminants in biota may increase during dredging, material placement, and installation of shoreline stabilization structures in the Blair Waterway. We anticipate that the increase in contamination concentrations in biota would be a temporary effect due to low concentration levels, which may persist until the cessation of dredging. However, longer term bioaccumulation of some contaminants in higher trophic species, such as PS Chinook salmon and SRKW are possible without strict adherence to BMPs.

Construction Contaminants
Barges and tugs would be used for dredging and material placement. Minor discharges of hydraulic fluid, oils, or fuels from construction equipment is likely to result from the proposed action. The operation of vessels at each location is likely to cause small incidental discharges caused by drippage from engines, which would introduce very small amounts of fuels, oils, or lubricants into the water. Incidental discharge of oils or fuels, and polycyclic aromatic hydrocarbons (PAHs) may also result from exhaust from these kinds of construction vessels, or from accidental introduction of oils or fuels from equipment in contact with water. Best management practices include inspecting all equipment daily for fluid leaks and each vessel would be equipped with a spill kit at all times and would minimize incidental events (see Section 1.3.4 for a list of BMPs). We expect these PAHs and other contaminants to be introduced into the water column during and immediately following the proposed activity. Because these materials can disperse quickly, they can become quite widespread at very low concentration. The environmental fate of each type of PAH depends on its molecular weight. In surface water, PAHs can volatilize, photolyze, oxidize, biodegrade, bind to suspended particles or sediments, or accumulate in aquatic organisms, with bioconcentration factors often in the 10-10,000 range. PAHs can have persistent negative effects on listed species and their critical habitats and are discussed in more detail in Sections 2.4.4 and 2.4.5. Due to the proposed BMPs, no major discharges of PAHs or other contaminants is expected to occur.

Elevated In-water Noise
Noise is expected as a short-term consequence from construction activities during in-water work to dredge and to stabilize the shoreline within Blair Waterway and placement of materials at Saltchuk. Background noise conditions within the waterway are already higher than other marine areas given the intense industrial use associated with the surrounding area.

Noise generated by clamshell dredges is characterized as continuous, since the elevated sound pressure occurs over several seconds (not milliseconds, as is the case with pulsed noise). It is assumed that clamshell dredging would generate noise levels lower than 125 dB_{RMS}. Several pieces of equipment would be operating and producing underwater noise for up to 24 hours per day during the in-water work window for up to four years. It is assumed only one dredge would be operating at a time, but would be running nearly continuously. One to two tugboats for towing barges would be transiting between the waterway and the open-water disposal site and would increase the amount of noise in an area surrounding each construction site and their transit paths. Tugboats have a dominant frequency range of 100-500Hz with a peak output at 170d_{BRMS}. A survey vessel would slowly transit the area to measure dredging progress. Since the aquatic habitat in the waterway is 200 to 250 meters wide (650 to 820 feet wide), even when the dredge is in the center of the channel, there would be a large area available for avoidance of harassment noise levels. Construction generated sound would be attenuated by the surrounding land limiting the radial extent of the elevated noise. Additionally, given that listed species are only expected to be in the Blair Waterway in very low abundances only a small number of fish would be at risk or exposure.

Elevated noise would also occur during installation of shoreline stabilization structures. Secant walls would be installed using augering methods as opposed to impact or vibratory methods, so as to minimize noise during installation. Drilling (augering) is considered a continuous, non-impulsive noise source (NMFS 2020). Dazey et al. (2012) compared vibratory and auger drilling methods and found no significant difference between the two methods. The Corps found as part of a previous evaluation in the Blair Waterway that noise levels were not expected to exceed 160 dB_{RMS} when driving 12-24 inch concrete piles using vibratory methods (BergerADAM 2012). This suggests that augering would result in less noise than alternative methods and remain well below noise thresholds harmful to fish. Area 2 and 3 are located well within the waterway, which would contain drilling noise to the immediate vicinity of the installation site. Site 2, the area closest to the mouth of the Blair Waterway where marine mammals (especially those listed under the ESA) are more likely to be present than inside the waterway, is about 2,200 meters from the mouth of the waterway. Finally, the current 2H:1V riprap slope would attenuate drilling noise as dredging and slope regrading would occur after secant walls are installed. Placement of riprap at areas 1 and 4 is not expected to generate significant noise. Given the high background noise associated with the waterway, the level of noise expected during augering, the amount of time required for installation, and proposed locations within the waterway we do not expect noise to reach harmful levels or to extend outside of the waterway into Commencement Bay.

Forage and Prey Reduction
Removing bottom substrate in Blair Waterway would simultaneously remove the benthic communities that live within those sediments and reduce prey availability in the footprint of the dredge. Among prey fishes, short-term and intermittent exposure to reduced water quality could

result in minor reductions in forage species via gill damage of forage fishes. Suspended sediment would eventually settle in the area adjacent to the dredge prism, which can disrupt benthic prey species, and if the sediments are contaminated, then sublethal toxicity of benthic prey species could occur. These prey then can become a source of bioaccumulation when exposed to toxins, which can degrade the quality of the prey species for salmonids and SRKW. Prey is expected to be reduced in total abundance and in quality during and following construction, and this diminishment would persist for weeks to months after dredging is completed.

Placement of dredged material at the Saltchuk site would likely kill invertebrates present where the bulk of material lands. Negative effects of disposal events include increased turbidity and burial. While turbidity increases dramatically during deposition events, the effects are expected to be transitory (Roegner et al. 2021) and larger organisms would generally be able to flee the area. Sediments would be a similar type and coarseness as what is already present at the site; generally fine grained and silty sand (see section 2.3.2). Other areas with wood waste or fine material would be covered by native material. Covering the wood waste with native material may initially harm habitat during early consolidation because any infauna and epifauna would be exposed to the pore water forced upwards from the wood waste below. Depending on the nature of the disposal material, and the wood waste being covered, this may be a transient, short-lived effect. The overall depth of the area would be reduced to provide shallow water habitat for juvenile salmonids and rockfish. In a relatively short period, organisms from adjacent non-disturbed areas would reestablish in the placement area.

Entrainment and Strike

In this context, entrainment refers to the uptake of aquatic organisms by dredge equipment. Dredge buckets entrain slow-moving and sessile benthic epifauna along with burrowing infauna that are removed with the sediments as well as algae and aquatic vegetation. There is little evidence of mechanical dredge entrainment of mobile organisms such as fish. In order to be struck by or entrained in a dredge bucket, an organism must be directly under the bucket when it drops. The small size of the bucket, compared against the distribution of the organisms across the available habitat make this situation unlikely. That likelihood would decrease after the first few bucket cycles, because mobile organisms are most likely to move away from the disturbance. Further, dredges move very slowly during dredging operations, with the excavator typically staying in one location for many minutes to several hours, while the bucket is repeatedly lowered and raised within an area limited to the range of the crane arm.

Fish that become captured within a digging bucket (entrainment) or that are struck by the bucket as it descends would likely be killed. However, the documented occurrence of these events for mobile fish species are extremely rare. In the Southeast Region of the US, where closely monitored heavy dredging operations occur regularly in areas inhabited by sturgeon and sea turtles, only two live sturgeon (NMFS 2012) and two live sea turtles (NMFS 2011) are known to have been entrained by clamshell dredging since 1990. However, in recent (2019) dredging in Grays Harbor, Washington, a shark or skate was entrained and killed during hydraulic hopper dredging (USACE 2021b). Hydraulic hopper dredging is different than other dredge methods in that the hopper dredge operates for prolonged periods, generating continuous fields of suction forces around and under the dragheads as they are pulled along the substrate at relatively high speeds (NMFS 2018b). Due to differences in methodology the likelihood of entrainment or strike during mechanical dredging is unlikely; small bucket footprint, operation from a stationary crane position, and slow vertical bucket movements decrease risk of entrainment.

2.4.2 Intermittent Effects

Reduced Vessel Traffic

During consultation, NMFS identified current vessel use associated with the existing operation and configuration of the federal navigation channel as part of the environmental baseline (See Section 2.3). Because the deepening of the channel would allow larger vessels to use the Blair Waterway with fewer overall vessel trips, the proposed action would result in a reduction of vessel traffic throughout the action area. A reduction in vessel traffic would result in positive impacts in the Port, Commencement Bay and the shipping channels of Puget Sound. These positive effects, include a reduction of: (a) water quality impacts from vessel use; (b) reduced noise from vessel operation; (c) reduced scour from vessel operation; and (d) a reduction in risk of marine mammal strikes.

The proposed action is estimated to result in about 27% fewer vessel trips to transport the forecasted cargo in 2030 (Table 3). A similar reduction in vessel trips is predicted for 2035 (28%). Reduction is vessel trips would mean reduced underwater noise throughout the central and northern half of Puget Sound on a daily basis, year-round. Specifically, fewer Post Panamax and Super Post-Panamax vessels would call to the Blair Waterway once channel deepening and widening is completed (Table 3). Ultra Post and New Post Panamax vessel calls would remain the same after the channel deepening and widening action is completed. However, it is unclear how long this beneficial effect would last because human population in the Puget Sound and along the west coast is expected to continue to grow and would likely cause shipping demands to increase. In fact, according to the analysis of vessel traffic completed by the Corps, traffic is expected to increase, regardless of channel depth, by 8% from 2030 to 2035. This suggests that over the 50-year period analyzed here vessel traffic could increase by nearly 75% by 2080 (assuming an annual increase of 8% every 5 years). However, based on the Corps' analysis this level of growth would also occur under current channel conditions. The proposed action would cause fewer vessels to be used despite the increased shipping demands. This is discussed in more detail in the Cumulative Effects section (2.5).

As explained above, because the action will enlarge the existing channel, we expect larger vessels to use the waterway, which will result in a decrease the overall number of vessels. We evaluated whether a shift to larger vessels may cause effects on species or habitat, including the potential for a change in noise, ship strikes, and wake effects on Puget Sound shorelines and concluded it would not. We reviewed Coast Guard guidance and regulations governing the safe passage of these vessels (USCG 2019), along with other available information. We found insufficient data to indicate that the larger vessels would cause an increase in negative impacts to listed fish or marine mammals. Therefore, we conclude that any impacts resulting in noise, vessel strikes on marine mammals, and wave height impacts to shorelines will not change compared with the current baseline conditions.

In summary, the proposed action would widen and deepen the federal navigation channel in the Blair Waterway. The action would allow larger vessels, which are capable of carrying more cargo than smaller vessels, to call at the Port of Tacoma. As a result, vessel trips are expected to decrease, at least through 2035. At the same time, vessel traffic overall is expected to increase as a result of increasing demand for products and commodities in the Pacific Northwest. However, that increase does not result from the proposed action, and is expected to be smaller than it would be without the proposed action.

2.4.3 Enduring Effects

Several enduring effects are expected to result from the proposed action including disruption of benthic and shoreline margin productivity within Blair Waterway and improved nearshore habitat quantity and quality at Saltchuk.

Disrupted Habitat Processes – Channel Deepening
The existing channel depth is -51 feet MLLW (environmental baseline), and the proposed action will deepen the Blair Waterway to a depth of -57 feet MLLW. Substrate composition includes sand and silt intermixed with gravel. The proposed dredging of 6 feet is not expected to alter substrate composition or sizes of those materials. However, areas where sediment is removed by dredging will greatly reduce benthic prey communities. The speed of recovery by benthic communities is affected by several factors, including the intensity of the disturbance, with greater disturbance increasing the time to recovery. Additionally, the ability of a disturbed site to recolonize is affected by whether or not adjacent benthic communities are nearby that can recolonize the affected area, and the composition of the species that recolonize the area may differ from a less frequently perturbed area, as disturbances caused by dredging may lead to a decline in sensitive species, to be subsequently replaced by more tolerant species (Ceia et al. 2013). The available information to describe ecosystem responses to dredging indicates that little recovery occurs during the first seven months after dredging. After that, early successional fauna would begin to dominate over the next six months (Jones and Stokes 1998). During that time, the resulting loss of benthic invertebrates reduces the availability of their larvae, as well as the availability of copepods, daphnids, and larval fish that prey on them, which in turn are prey for juvenile salmon (NMFS 2006a).

Disrupted Habitat Processes – Channel Widening
Other than the temporary loss of benthic invertebrates, the proposed widening of the federal navigation channel is not expected to reduce habitat quality for salmonids or rockfish. This is because the navigation channel is not nearshore habitat and under the current environmental baseline, could not return to nearshore habitat. Increasing the depth of deep-water habitat that might provide marginal migration and foraging areas for salmon and rockfish does not result in a loss of habitat quality.

Disrupted Habitat Processes – Shoreline Stabilization
Approximately 2,500 feet (762 meters), around 8% of the shoreline in the federal navigation channel, would require replacement shoreline stabilization to support channel widening efforts. Areas 1 and 4 would require rock-toe riprap armoring and areas 2 and 3 would require secant wall armoring (Figure 2 and Figure 7). Currently, all four areas are armored with riprap and slopes are approximately 2H:1V (Figure 2 and Figure 7). Installation of replacement riprap at areas 1 and 4 would modify slopes to 1.5H:1V and secant wall installation at areas 2 and 3 would maintain 2:1 slopes waterward of the new secant walls. The impacts of hard armor along shorelines are well documented. Armoring of the nearshore can reduce or eliminate shallow

water habitats via two distinct mechanisms. First, bulkheads cause a higher rate of beach erosion waterward of the armoring because there is higher wave energy, compared to a natural shoreline. This leads to beach lowering, coarsening of substrates, increases in sediment temperature, leading to reductions in primary productivity and invertebrate density within the intertidal and nearshore environment (Bilkovic and Roggero 2008; Fresh et al. 2011; Morley et al. 2012; Dethier et al. 2016). As a result of deepening of the intertidal zone adjacent to the bulkhead, as well as increased wave energy, bulkheads also reduce SAV (Patrick et al. 2014). Reduced SAV can reduce spawning habitat (i.e., eelgrass) for Pacific herring, another forage species of Chinook salmon and juvenile PS/GB bocaccio. Reduced SAV also diminishes habitat for juvenile rockfish, which in their pelagic stage rely on SAV for prey and cover for several months. Under baseline conditions, SAV is very limited within the channel and implementation of the proposed shoreline stabilization is unlikely to further reduce SAV density or abundance from its current state. Additionally, shoreline armoring under the proposed action is unlikely to erode current shorelines in the Blair Waterway because those slopes are already heavily armored under the current Congressional authority.

Second, shoreline armoring located within the intertidal zone (below HAT) prevent upper intertidal zone and natural upper intertidal shoreline processes such as accumulation of beach wrack (Sobocinski et al. 2010; Dethier et al 2016). This is an additional mechanism that reduces primary productivity within the intertidal zone and diminishes invertebrate populations associated with beach wrack (Sobocinski et al. 2010; Morley et al. 2012; Dethier et al. 2016). Reductions in forage from shoreline armoring then affects primary productivity and invertebrate abundance in both the intertidal and nearshore environments. Invertebrates are an important food source for juvenile PS/GB bocaccio and PS Chinook salmon and for forage fish prey species of salmonids. However, in this case these natural tidal processes and primary productivity are already severely diminished given the intense industrial development and use within and surrounding the channel.

Commonly, beach erosion is increased by wave energy adjacent to shoreline armoring structures, which prevents the delivery of upland sediment from reaching the beach and erodes sediment waterward of armoring structures. Finer material like gravel and sand provide important spawning substrate for sand lance and surf smelt. Therefore, a reduction of this substrate type within the intertidal and nearshore zone as a result of armoring would reduce potential spawning habitat availability and fecundity of both species (Rice 2006; Parks et al. 2013), which are both important prey species for ESA-listed salmonids. Thus, the loss of material below armoring, together with the loss of upland sources of material from above the armoring, over time, can affect the migration and growth of juvenile salmonids (primarily PS Chinook salmon) by reducing the amount of available shallow habitat that juveniles rely on for food and cover, and by preventing access to habitat upland of armoring at high tides. Both salmonids and juvenile bocaccio are affected by the loss of prey communities. However, current shoreline habitat in the Blair Waterway is fully developed and would not deliver suitable forage fish spawning habitat if the proposed action were not to occur.

Along with the physical loss of habitat, the impacts of nearshore modification commonly include the loss of functions such as filtration of pollutants, floodwater absorption, shading, sediment sources, and nutrient inputs. Shoreline armoring generally reduces the sediment available for transport by disconnecting the sediment source, e.g. a feeder bluff, from the drift cell, potentially causing loss of beach width and height as transport of material outpaces supply. This can occur at the site of the structure or down the drift cell. Structures in the intertidal zone change the hydrodynamics of the waves washing up on the beach. Hard structures reflect waves without dissipating their energy the way a natural beach would, especially if vegetation is present. This energy can lower the beach, make it steeper, and wash away fine sediments. Dikes and fill reduce estuarine wetlands and other habitat for salmon, forage fish, and eelgrass.

When the physical processes are altered, there is also a shift in the biological communities. The number and types of invertebrates, including shellfish, can change; forage fish lose spawning areas; and juvenile salmon and forage fish lose the feeding grounds that they use as they migrate along the shore (Shipman et al. 2010). Native shellfish and eelgrass have specific substrate requirements and altered geomorphic processes can leave shellfish beds and eelgrass meadows with material that is too coarse or with too much clay exposed. Shoreline armoring can also physically bury forage fish spawning beaches when structures are placed in or too close to the intertidal zone. When shoreline development removes vegetation, the loss of shading and organic material inputs can increase forage fish egg mortality (Penttila 2007). Surf smelt, for example, use about 10 percent of Puget Sound shorelines for spawning and many bulkheads are built in forage fish spawning habitat, threatening their reproductive capacity (Penttila 2007). The effects of nearshore modification cascade through the Puget Sound food web. The consequences can be seen in the population declines of a variety of species that depend on these ecosystems, from shellfish, herring, and salmon to orcas, great blue heron, and eelgrass.

Habitat conditions within the federal navigation channel are poor and provide little utility for salmonids or rockfish. However, the proposed stabilization measures would further degrade habitat relative to current conditions. Specifically, shoreline slopes would become steeper as a result of the action in areas 1 and 4, where slopes would increase to 1.5H:1V from 2H:1V. Increased slopes would result in reduced wave attenuation and increased energy and erosion rates. Wave attenuation would decrease along riprap armored shore and would reduce habitat for benthic invertebrates by increasing scour along the shoreline.

Improved Habitat Quantity and Quality at Saltchuk

Beneficial use of dredged material at Saltchuk is expected restore nearshore intertidal and subtidal habitat substrate conditions. Based on the capacity of Saltchuk, the quantity estimated for nearshore placement is approximately 1.8 million cubic yards from the Blair Waterway, to convert approximately 40.9 acres of deep zone (DZ) habitat to lower shore zone (subtidal and intertidal habitat). At full build-out, the shallow subtidal bench would start at approximately -10 MLLW and slope gradually up to approximately -6 MLLW across the bench. Eelgrass may establish in this area naturally from the nearby eelgrass patch. Increasing eelgrass habitat would increase potential spawning habitat for Pacific herring and create important nursery habitat for other marine species including ESA-listed salmonids and rockfish. Target species to benefit from the material placement include juvenile and adult Chinook salmon, adult and juvenile PS steelhead, and larval and juvenile PS/GB bocaccio as well as other ESA-listed species, like bull trout.

Although a relatively long-term and enduring benefit, the sediment placement at Saltchuk is only proposed during the four years of proposed dredging. For the purposes of this analysis, NMFS assumes that over time the benefits would likely diminish as sediment is transported to other areas via currents and tidal fluctuations. The beneficial effects of placing materials at the Saltchuk site would slowly diminish over time under erosion pressures from vessel traffic and natural wave energy if not maintained to a point that natural processes are self-sustaining[21]. As described in Section 1.3.2, NMFS assumes that a fully developed Saltchuk site plan is reasonably likely to occur in collaboration with NMFS and the non-federal sponsor; however, insofar as the project details are unavailable for analysis, we assume that the deposit of beneficial use sediment will occur at the Saltchuk site, but we do not assume that the site will remain for more than 50 years or develop into a fully restored site without future efforts.

2.4.4 Effect on Critical Habitat

Critical habitat for PS Chinook salmon is designated within the action area and would be impacted by temporary and enduring effects of the proposed action. Critical habitat for PS steelhead, PS/GB bocaccio and PS/GB Yelloweye rockfish has not been designated in the Blair Waterway or at the Saltchuk site. NMFS reviews the proposed actions effect on critical habitat by examining how the PBFs of critical habitat would be altered, the duration of such changes, and the influence of these changes on the potential for the habitat to serve the conservation values for which it was designated.

PBFs of nearshore habitat for PS Chinook salmon include complexity, absence of artificial obstructions, natural cover, adequate water, and high water-quality. The nearshore environment supports various life stages of PS Chinook salmon including growing and sexually maturing adults, migrating spawners, and rearing and growing juveniles.

The proposed action would occur for four years between August 16 and February 15. Dredging, shoreline stabilization, and material placement at Saltchuk would disturb bottom substrates, causing temporary effects to the following PBFs of critical habitat for PS Chinook salmon:

1. Estuarine areas free of obstruction and excessive predation with: water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater;
2. Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and
3. Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Intermittent and enduring effects to PS Chinook salmon critical habitat include reduced vessel traffic and increased nearshore habitat quantity and quality at Saltchuk, respectively. Other than the temporary loss of benthic invertebrates, the proposed widening and deepening of the federal navigation channel is not expected to reduce habitat quality for salmonids. This is because the

[21] Further modeling and analysis during PED may provide additional information to inform this assumption. Moreover, monitoring of the site would provide important data on how the site changes over time and whether sediment remains in place.

navigation channel is not currently nearshore habitat, and under the current environmental baseline, could not return to nearshore habitat. Increasing the depth of deep-water habitat that might provide marginal migration and foraging areas for salmon does not appreciably result in a loss of habitat quality; and widening the channel actually provides more habitat that can be occupied by salmon and rockfish, albeit that habitat is of very limited quality.

Water Quality

<u>Turbidity and Dissolved Oxygen</u>
Dredging would degrade water quality in the Blair Waterway surrounding the area actively being dredged by temporarily elevating suspended sediments and turbidity and decreasing DO. We do not expect water quality degradation to extend past the 3-mile radius that would be affected by dredging, disposal, and construction. Similar water quality degradations are expected at Saltchuk during material placement. Dredging in Blair Waterway and material placement at Saltchuk is not expected to cause measurable changes in water temperature and salinity. Turbidity, suspended sediments, and DO are expected to return to baseline within a matter of days after work ceases. However, given that the dredging equipment is expected to operate continuously throughout the in-water work window (August 16 – February 15) water quality would remain degraded for a significant portion of the year and likely preclude fish access to Blair Waterway and Saltchuk by disrupting passage until construction is completed each year. As such, elevated turbidity and reduced DO would force any fish utilizing the Blair Waterway or Saltchuk restoration site to seek suitable habitat elsewhere. These sites are unlikely to return to baseline conditions until after work ceases in February at the conclusion of each construction year and fish would not be expected to return until baseline conditions return. The Corps would work with the Washington Department of Ecology for certification under Section 401 of the Clean Water Act to ensure the project meets state water quality standards and area of mixing are minimized to less than 300-feet.

<u>Suspended Contaminants</u>
Contaminants held in benthic sediments unsuitable for aquatic disposal would be re-suspended into the water column during dredging activities. This aspect of water quality degradation would temporarily impair the value of critical habitat for growth and maturation of juvenile salmonids during the in-water work window (August 16 – February 15) by exposing them to pollutants with both immediate and latent health effects, and could incrementally impair forage/prey communities that are exposed to the contaminants, delaying the speed that these communities re-establish after being physically disrupted by dredging. This impairment of the water quality PBF is also expected to persist for the duration of annual in-water work due to the continuous operation of dredging and construction equipment. Even though suspended contaminants typically resettle in the benthos after a short period of time (hours to days depending on currents) the continuous operation of dredging and construction equipment would ensure that benthic sediments and any associated contaminants remain suspended until sufficient time has passed following cessation of construction to allow contaminants to redeposit in benthic sediments. This temporary impairment results in adverse effects to water quality PBFs for PS Chinook salmon.

Forage and Prey
Designated critical habitat for PS Chinook salmon would experience temporary declines in forage and prey communities.

Dredging and material placement would disturb sediment, and consequently disrupt the benthic communities that live within those sediments, reducing prey availability in the footprint of the dredging area and adjacent areas where suspended sediment settles out. Among prey fishes, short-term and intermittent exposure to reduced water quality could result in minor reductions in juvenile salmonid prey species via gill damage to forage fishes. Suspended sediment would eventually settle out in the area adjacent to dredged sites, which can smother benthic prey species. Additionally, if the sediments are contaminated, then sublethal toxicity effects of benthic prey species may occur.

Dredging activities cause short-term changes in the characteristics of the benthic in-faunal biota, of which the majority are expected to recover within a few months to two years after dredging is completed. For example, Romberg et al. (2005), studying a subtidal sand cap placed to isolate contaminated sediments in Elliott Bay, identified 139 species of invertebrates five months after placement of the cap. The benthic community reached its peak population and biomass approximately two and one-half years after placement of the cap, while the number of species increased to 200 (Wilson and Romberg 1996).

In this case, because dredging within Blair Waterway is expected to take four years, as is the associated placement of dredged material at Saltchuk, recovery of benthic communities within the impacted areas to baseline conditions is unlikely to begin until after the project is completed. This means that full recovery may not occur until two years after completion of the project. While disruption of the benthic environment in the Blair Waterway would be temporary and recover to baseline in a manner of months to years after the project is completed, the benthic communities would be impaired during that time resulting in adverse effects to the forage and prey PBF of salmon critical habitat.

Conversely, over months to one year, material placement at Saltchuk is expected to improve critical habitat conditions for benthic communities and forage fish, providing a positive impact on the quality of PS Chinook salmon critical habitat at Saltchuk (discussed in more detail in the Effect on Species section below). Overtime, the beneficial use of dredged materials at Saltchuk would increase prey base, increase forage opportunities, create new rearing habitat and cover opportunities, and improve migratory pathways for juveniles and adults. While benefits may be realized within months of material placement, it would take several years with additional restoration to be fully functional. Additional restoration measures, such as establishing aquatic vegetation or supplementing the sediment through time, would be necessary to achieve full restoration potential of the Saltchuk site. Without additional maintenance and restoration measures, we expect the benefits of material placement at Saltchuk to diminish during the 50-year period analyzed in this Opinion as sediment is transported by currents and tidal fluctuations.

Degraded Shoreline Habitat
Bank armoring degrades sediment conditions, forage base, and access to shallow water waterward of the structures. Armoring also prevents access to forage and shallow water habitat upland of the structures during high tides. Shoreline armoring is extensive in urban areas worldwide, but the ecological consequences are poorly documented. A study by Morley et al. (2012) mapped shoreline armoring along the Duwamish River estuary and evaluated differences in temperature, invertebrates, and juvenile salmon diet between armored and unarmored intertidal habitats. Epibenthic invertebrate densities were over tenfold greater on unarmored shorelines and taxa richness double that of armored locations. Over 66 percent of the Duwamish shoreline is armored, similar to much of south and central Puget Sound, the impacts from armoring, and denying access to potential food sources, can effect overall fish health, growth, and survival.

As described above, shoreline armoring typically coarsens sediments waterward of shoreline armoring by concentrating marine energy and washing away finer sediments. Because armoring located within the intertidal zone (below HAT) would typically prevent upper intertidal zone and natural upper intertidal shoreline processes such as deposition and accumulation of beach wrack from occurring a reduction of primary productivity within the intertidal zone and diminish invertebrate populations would be expected (Sobocinski et al. 2010; Morley et al. 2012; Dethier et al. 2016). Reductions in forage may result from armoring effects on primary productivity and invertebrate abundance in the intertidal and nearshore environments. Invertebrates provide an important food source for juvenile PS Chinook salmon and for forage fish prey species of salmonids. Under the degraded and industrialized condition of the Blair Waterway, both physical and biological conditions are unlikely to be severely changed as a result of the proposed action.

The loss of marine shoreline material, over time, can affect the migration areas of juvenile salmonids by reducing the amount of available shallow habitat that juveniles, both by steepening shore areas waterward of armoring, and, particularly during high tides, creating a physical barrier that obstructs water from reaching high shore areas.

While the amount of shoreline habitat providing any value to listed species in the navigation channel is extremely limited, the installation of shoreline armoring would degrade shoreline areas further by slightly increasing channelization and erosion. The riprap may provide some substrate for macroinvertebrates, cover and forage opportunities for juvenile salmonids and rockfish, and the shallower slope reduces predation risk. The proposed 1.5H:1V riprap armoring at areas 1 and 4 would not change habitat conditions substantially from current conditions. In summary, the degraded and industrialized baseline condition of the Blair Waterway is unlikely to change physical and biological conditions as a result of the proposed action, although these actions will continue to prolong recovery of listed populations in the action area.

Summary of Effects to Critical Habitat
Impairment to PS Chinook salmon PBFs would result from temporary adverse effects to water quality, including turbidity, low DO, and re-suspending unsuitable sediments. Within months to one year, material placement at Saltchuk is expected to improve critical habitat conditions for PS Chinook salmon PBF. Over a period of years to a few decades, the beneficial use of dredged

materials at Saltchuk would increase prey base, increase forage opportunities, create new rearing habitat and cover opportunities, and improve migratory pathways for juveniles and adults.

2.4.5 Effects on Species

Effects on listed species is a function of (1) the numbers of animals exposed to habitat changes or effects of an action; (2) the duration, intensity, and frequency of exposure to those effects; and (3) the life stage at exposure.

As noted above, the project has temporary, intermittent, and enduring effects. Our exposure and response analysis identifies the multiple life stages of listed species that use the action area, and whether they would encounter these effects, as different life-stages of a species may not be exposed to all effects, and when exposed, can respond in different ways to the same habitat perturbations.

Period of Exposure and Species Presence

Dredging would occur throughout the in-water work window of August 16 through February 15 for up to four years to achieve target depths. The in-water work window co-occurs with the presence of various PS Chinook salmon and PS steelhead life stages in Commencement Bay and its tributaries including the Puyallup River, Hylebos Creek, and Wapato Creek (Table 10).

Table 10. Expected use of the Commencement Bay and Blair Waterway action areas by listed species. Spring Chinook salmon are exclusive of the White River, while fall Chinook salmon and winter steelhead are widely dispersed throughout the greater Puyallup River basin.

Species		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
IWWW													
Spring Chinook				Adult Migration									
		Juvenile Migration											
Fall Chinook							Adult Migration						
		Juvenile Migration											
Winter Steelhead		Adult Migration											
				Juvenile Migration									
Rockfish				Juveniles					Juveniles				

<u>*Chinook salmon*</u>
Two distinct populations of Chinook salmon are present in the Puyallup River Basin: White River spring Chinook and Puyallup River fall Chinook salmon. White River spring Chinook salmon are the only remaining spring stock in the south/central Puget Sound region (Marks et al. 2018, Ruckelshaus et al. 2002, NWFSC 2015, and Ford, in press). Adult spring Chinook salmon migrate through Commencement Bay to the Puyallup River as early as March or April, while adult fall Chinook salmon generally enter the Puyallup River June through early November on their way to spawning habitat (Marks et al. 2018) (Table 10). Adults are expected to occur in the

deep, open-water areas around the Blair Waterway and in Commencement Bay during the winter of their upstream spawning migration. Adult fish would typically be oriented to the outflow of the Puyallup River. The work window avoids spring Chinook salmon presence, but does not avoid all exposure in the fall (between August 15 and November).

Juvenile Chinook salmon typically use shallow water marine habitat to rear, grow, and feed. These components were mostly eliminated by the industrial development and use of the estuary. Juvenile salmonid trapping by the Puyallup Tribal Fisheries Department observed juvenile Chinook salmon emigrating from the lower Puyallup River (River Mile 10.6) as early as January and as late as August, although the peak outmigration is typically late May (Marks et al. 2018) (Table 10). Historic beach seine sampling (1980-1995) in the Blair Waterway generally captured juvenile Chinook salmon after mid-February and before mid-August, with a peak around the end of May (Pacific International Engineering 1999). Additionally, data suggests that Chinook salmon fry and sub-yearlings that out-migrate past the Puyallup River before June spend more time in the lower Puyallup River to become acclimated to the salinity, and fish that move into Commencement Bay before reaching 55 mm have a higher mortality than larger juveniles later in the season (Marks et al 2018). The proposed dredging to occur in January and February would have limited overlap with early-migrating juvenile Chinook salmon because many would still be rearing in the lower Puyallup River. The proposed work window would minimize overlap of temporary construction effects with outmigrating and rearing juvenile Chinook salmon in the Blair Waterway and Commencement Bay, but would not avoid all exposure.

<u>PS Steelhead</u>
Two distinct populations of steelhead occur in the Puyallup Basin: 1) Puyallup/Carbon winter steelhead and 2) White River winter steelhead (Hard et al. 2015; WDFW 2015). These populations typically enter the river in January and then hold throughout the river until moving to spawning grounds between March and June (NMFS 2005b) (Table 10). However, a few summer-run strays, likely from the Green or Skykomish rivers, are caught annually during August and September in the lower Puyallup (Marks et. al 2014). Mainstem spawning occurs as low as RM 10 in the Puyallup River and RM 3 on the Carbon River (Pierce County 2013). Adults are expected to occur in the deep, open-water areas around the Blair Waterway during the winter of their upstream spawning migration, and would be oriented to the outflow of the Puyallup River.

Juvenile steelhead outmigration in the Puyallup River system generally occurs between April and July (Berger et al. 2011) (Table 10). However, steelhead smolts have been found in low abundances in the marine nearshore, outside of their natal estuary, between May and August (Brennan et al. 2004), which overlaps about 2 weeks with the in-water work window. Juveniles are not anticipated to be in the nearshore zone of the project area in large numbers because the majority of steelhead smolts migrate directly to the open ocean and do not rear extensively in the estuarine or coastal environments (Burgner et al. 1992; Goetz et al. 2015). The proposed work window would minimize overlap of temporary construction effects with the presence in nearshore habitat of juvenile PS steelhead in the action area, but would not avoid all exposure.

Rockfish
Larval rock fish presence peaks twice in the spawning period, once in spring and once in late summer (Table 10). As described in the Species Status section (2.2.1) PS/GB bocaccio frequently utilize nearshore environments during larval and juvenile life stages. Studies have observed rockfish larvae at the Commencement Bay open-water disposal site during the proposed in-water work window (August 16 through February 15), suggesting larvae may be present during dredging and material placement at Saltchuk (Greene and Godersky 2012; NMFS 2015). The in-water work window avoids the earliest and largest density peaks of rockfish in April and August. Observations of rockfish larvae density at the Commencement Bay open water disposal site between April 2011 and February 2012 reached 150 larvae per 1,000 cubic meters in May, 100 larvae per 1,000 cubic meters, and fell to zero in the winter (Greene and Godersky 2012) (Figure 13).

The presence of adult PS/GB bocaccio and yelloweye rockfish in the action area is extremely low. Suitable habitat is extremely limited in the work area for is this life stage as preferred habitat depths and features such as rugosity are lacking. Adult rockfish are not expected to occur in Blair Waterway given that the channel contains shallow sandy-bottom habitat and is not near typical rockfish spawning locations. However, given the ability of this species to move throughout the marine environment, we cannot preclude that they would not occasionally enter in the Blair Waterway. It is likely that adult rockfish would be present in Puget Sound shipping lanes associated with the Port of Tacoma (Figure 1), but it would be unlikely that they would be exposed to project effects due to the depth of habitat they typically occupy.

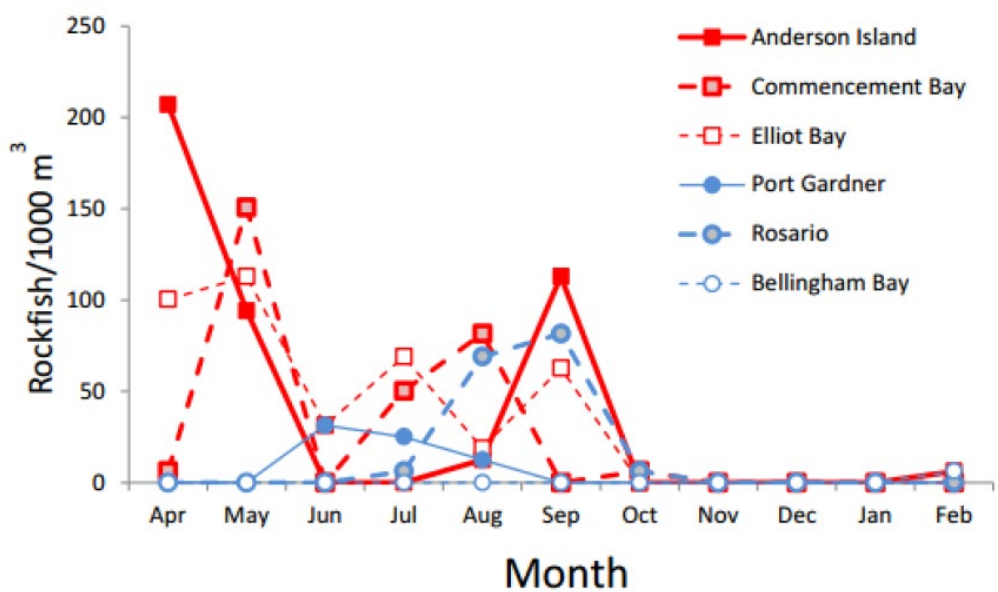

Figure 13. Rockfish density per 1,000 cubic meters at six sediment disposal sites in the Puget Sound from April 2011 through February 2012. (Adapted from Green and Godersky 2012).

Temporary Effects

<u>Response to Degraded Water Quality</u>
The proposed in-water work would temporarily affect water quality through increased turbidity and mobilized unsuitable sediments during dredging and material disposal at Saltchuk. It may also temporarily reduce DO. NMFS estimates that all detectable water quality impacts would be limited to the extent of the project-related turbidity, up to 3-miles radially, and would return to background levels shortly after the end of construction (hours to days).

<u>Turbidity and Dissolved Oxygen</u>
Dredging and project-related tugboat propeller wash would mobilize bottom sediments and cause turbidity plumes with relatively low concentrations of total suspended sediments (TSS). The intensity of turbidity is typically measured in Nephlometric Turbidity Units (NTU) that describe the opacity caused by the suspended sediments, or by the concentration of TSS as measured in milligrams per liter (mg/L). A strong positive correlation exists between NTU values and TSS concentrations. Depending on the particle sizes, NTU values roughly equal the same number of mg/L for TSS (i.e. 10 NTU = ~ 10 mg/L TSS, and 1,000 NTU = ~ 1,000 mg/L TSS) (Campbell Scientific Inc. 2008; Ellison et al. 2010). Therefore, the two units of measure are easily compared.

Water quality is considered adversely affected by suspended sediments when turbidity is increased by 20 NTU over background conditions for a period of 4 hours or more (Berg and Northcote 1985; Robertson et al. 2007). The effects of turbidity on fish are somewhat species and size dependent. In general, severity typically increases with sediment concentration and duration of exposure, and decreases with the increasing size of the fish. Bjornn and Reiser (1991) report that adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that may be mobilized during storm and snowmelt runoff episodes. However, empirical data from numerous studies report the onset of minor physiological stress in juvenile and adult salmon after one hour of continuous exposure to suspended sediment concentration levels between about 1,100 and 3,000 mg/L, or to three hours of exposure to 400 mg/L, and seven hours of exposure to concentration levels as low as 55 mg/L (Newcombe and Jensen 1996). The authors reported that serious non-lethal effects such as major physiological stress and reduced growth were reported after seven hours of continuous exposure to 400 mg/L and 24 hours of continuous exposures to concentration levels as low as about 150 mg/L.

Mechanical dredging in areas containing high levels of fine-grained material is likely to cause suspended sediment plumes that could extend 200 to 500 feet down-current from the point of dredging, and may take hours after work has stopped to return to background levels. LaSalle et. al. (1991) reported suspended sediment concentrations of about 700 mg/L at the surface, and 1,100 mg/L near the bottom, about 300 feet from clamshell dredging in areas containing high levels of fine-grained material. During monitored clamshell dredging of inner Grays Harbor, the suspended sediment concentrations exceeded 500 mg/L in 23 of 600 samples, and seven of those samples were for tests of ambient conditions (COE 2011b). The single highest reported concentration was 3,000 mg/L when the ambient TSS concentration was 700 mg/L. The dredging contractors would be required to monitor and limit turbidity according to the water quality monitoring plan. State water quality standards require that turbidity not exceed 5 NTUs above background when ambient conditions are less than 50 NTUs; and no more than 10 NTUs above background when ambient conditions are above 50 NTUs.

Tugboat propeller wash would also mobilize bottom sediments. The intensity and duration of the resulting turbidity plumes are uncertain, and would depend on a combination of the tugboat's thrust, the water depth under it, and the type of substrate. The higher the thrust and the finer the sediment, the more sediment that is likely to be mobilized. Fine material (silt) remains mobilized longer than coarse material (sand). The shallower the water, the more thrust energy that would reach the substrate. A recent study described the turbidity caused by large tugboats operating in Navy harbors (ESTCP 2016). At about 13 minutes, the plume extended about 550 yards (500 m), where the TSS concentration was about 80 mg/L. The plume persisted for hours and extended far from the event, but the TSS concentration fell to 30 mg/L within 1 hour and to 15 mg/L within 3 hours. At its highest concentration, the plume was below the concentrations required to elicit physiological responses reported by Newcombe and Jensen (1996). The exact extent of turbidly plumes from tugboat operations for this project are unknown, but it is extremely unlikely that would exceed those described above. Based on that information, and on the consultations for similar projects in the region, sediment mobilization from tugboat propeller wash would likely consist of relatively low-concentration plumes that could extend to about 300 feet from the site, and last a low number of hours after the disturbance. However, work-related tugboat turbidity would be indistinguishable from the turbidity caused by the high levels of routine vessel operations in and around the project site. Shipping traffic throughout the action areas routinely disturbs sediments. Any temporary increase in turbidity as a result of the proposed action is not anticipated to measurably exceed levels caused by normal periodic increases due to this industrial traffic or highly turbid water from the Puyallup River within the waterways. The generally slow velocity of water movement within the navigation channel would also greatly minimize the potential negative effects of temporarily increased turbidity.

Elevated suspended sediments affect ESA-listed species in several ways, including: (1) reduction in feeding rates and growth, (2) physical injury, (3) physiological stress, (4) behavioral avoidance, and (5) delayed migration. Laboratory studies have consistently found that the 96-hour median lethal concentration of fine sediments for juvenile salmonids is above 6,000 mg/L (Stober et al. 1981) and 1,097 mg/L for 1 to 3-hour exposure (Newcombe and Jensen 1996). Lethal concentrations and duration of exposure are not likely to occur for several reasons. LaSalle et al. (1991) determined that, within 300 feet of bucket dredging fine silt or clay, the expected concentrations of suspended sediment would be about 700 and 1,100 mg/L at the surface and bottom of the water column, respectively. Studies have shown that salmonids have an ability to detect and distinguish turbidity and other water quality gradients (Quinn 2005; Simenstad 1988), and that larger juvenile salmonids are more tolerant to suspended sediment than smaller juveniles (Servizi and Martens 1991; Newcombe and Jensen 1996).

In addition to this behavioral response, however some exposure to suspended sediments is likely and can elicit an array of responses. Even moderate levels of suspended sediment exposure not associated with gill damage can affect the respiratory ability of salmonids (Waters, 1995) and trigger an acute stress response (Michel et al., 2013). Some sediment-associated stress responses include elevated plasma glucose and plasma cortisol (Redding et al. 1987, Servizi and Martens, 1992), increased cardiac output (Bunt et al., 2004), and changes in hematological parameters (Lake and Hinch, 1999, Michel et al., 2013). Suspended solids are also known to impact fish's feeding ability (e.g. due to impaired spotting of prey), routine activity, and stress levels (Berg and Northcote, 1985, Sweka and Hartman, 2001, De Robertis et al., 2003, Robertson et al., 2007, Awata et al., 2011). Behavioral responses (e.g., alarm reaction and avoidance of the plume) can occur with only six minutes of exposure (Newcombe and Jensen 1996). Physiological effects (e.g., gill flaring and coughing) may occur with 15 minutes of exposure, temporary reduced feeding rates and success with 1 hour of exposure, and moderate levels of stress with 3 hours of exposure (Newcombe and Jensen 1996).

Disposal of sediment at the Saltchuk site would also expose juvenile salmonids and juvenile and larval rockfish to elevated turbidity and associated adverse effects. While we expect juvenile/larval rockfish presence to be low, we cannot rule out the possibility of individuals occupying the site. For periods when larval rockfish and dredge disposal co-occur, determining the extent of effect is dependent upon the frequency of disposal, estimated sediment concentrations, and the relative abundance of ESA-listed rockfish. Furthermore, the concentrations and duration of suspended sediments within the water column depends upon the depth, currents, and composition of the material, and concentrations would injure or kill them or alter their feeding rate. A number of studies have assessed suspended sediment effects on Pacific herring larvae, as well as other marine fish. Larval herring death rates ranged from 82.8 to 99.4%, compared to 23.6% of the control group when they were exposed to suspended sediment levels of 10,000, 5,000, and 500 mg/l for four days (Morgan and Levings 1989). Larval herring had abraded yolk sacs that increased relative to the concentration when exposed for 24 hours to suspended sediment concentrations of up to 8,000 mg/l (Boehlert 1984), and their feeding rates were observed to maximize when concentrations reached 500 mg/l, and decreased at higher concentrations (Boehlert and Morgan 1985). When exposed to 10,000, 5,000, and 500 mg/l for ten days, larval lingcod death rates ranged from 90 to 98%, compared to 18% in a control group (Morgan and Levings 1989). None of the aforementioned studies replicate the short term but very high concentrations of suspended sediment that would result from sediment disposal at Saltchuk.

Given the extreme fragility of larval rockfish, some fish within the water column at Saltchuk would be injured or killed by ruptured capillaries, maceration of highly vascular organs and internal bleeding. As an example of their fragility, larval rockfish were observed to be injured by strong flowing water in laboratory-rearing environments (Canino and Francis 1989). We do not expect juvenile Chinook salmon or steelhead or juvenile rockfish to be nearly as susceptible to the effects from sediment disposal as larval rockfish, due to the swimming abilities of juveniles being more advanced than the larval lifestage. However, we do expect proportional or exposed juveniles to be harmed and or killed as a result of sediment disposal at Saltchuk. Therefore, we find the effects of sediment disposal in the form of elevated turbidity to be adverse.

Mobilization of anaerobic sediments can decrease dissolved oxygen levels (Hicks et al., 1991; Morton 1976). The impact on dissolved oxygen is a function of the oxygen demand of the sediments, the amount of material suspended in the water, the duration of suspension, and the water temperature (Lunz and LaSalle 1986). Reduced dissolved oxygen can affect salmonid swimming performance (Bjornn and Reiser 1991), as well as cause avoidance of water with low dissolved oxygen levels (Hicks 1999).

Despite being present during a small portion of the work window, juvenile PS steelhead are not nearshore dependent and are not expected to be in the nearshore in large numbers. Juvenile steelhead (smolts) are between 150 – 250 mm upon entering the marine environment and are considered agile swimmers. Those present are expected to be only briefly in the area where elevated suspended sediment would occur (within a 150- to 300-foot radius to account for the point of compliance for aquatic life turbidity criteria) and to have strong capacity as larger juveniles to avoid areas of high turbidity. In the event that there is a contemporary decrease in DO within sediment plumes, we do not anticipate a significant behavioral response from steelhead to reduced DO because we expect that they would have only brief exposure to the affected area. Therefore, we consider temporary exposure to low DO would not be sufficient to cause any injury or harmful behavioral response to juvenile PS steelhead.

Juvenile PS Chinook salmon are likely to be present during in-water construction activities and likely to be exposed to the temporary construction effects, most notably elevated levels of suspended sediment. Turbidity and TSS levels would return to background levels quickly and be localized to the in-water construction areas (150- to 300-foot radius turbidity mixing zone). Again, decreased DO is expected to be contemporaneous with and in the same footprint of the suspended sediment. While juvenile PS Chinook salmon may encounter these areas, they can detect and avoid areas of high turbidity, and exposure is expected to be brief. Thus, duration and intensity of exposure of juvenile PS Chinook salmon is also unlikely to cause injury or a harmful response. Those that engage in avoidance behaviors or with raised cortisol levels may have decreased predator detection and avoidance increasing the likelihood of predation.

Larval yelloweye and bocaccio rockfish would be present at the project site because they passively drift and distribute with prevailing currents, although we find the likelihood of a large abundance of individuals to be relatively low (see section 2.4.5 – Period of Exposure and Species Presence) (Greene and Godersky 2012). However, larval rockfish, given their limited swimming abilities may be disproportionally exposed to effects from the resulting plume and harmed by the high turbidity and low DO conditions. Because the Blair Waterway lacks deep water, suitable rocky substrate, and preferred aquatic vegetation (kelp and eelgrass), the likelihood of adult and juvenile rockfish presence is low. The turbidity plume and low DO expected resulting from dredging the sandy substrate of Blair Waterway may have sublethal effects such as gill irritation, and would cause juvenile rockfish to flee the area or find refuge in clearer water outside of the dredging footprint. While we expect abundance to be low, larval or juvenile rockfish that are exposed to high turbidity and associated degraded DO are likely to be harmed or killed as a result.

Re-suspended Contaminants

Dredging within Blair Waterway and material disposal at the Saltchuk site would re-suspend toxic contaminants. Saltchuk exists within the Commencement Bay, Nearshore/Tide Flats Superfund site, although there are no HTRW sites that overlap with Saltchuk. The Blair Waterway was historically considered a Superfund site, although it was delisted in 1996. Both sites have the potential to harbor contaminants in stored in sediments. A feasibility-level sediment characterization regarding the potential suitability of up to 2.5 million cubic yards (cy) of dredged material from the Blair Waterway for open-water disposal at the Commencement Bay disposal site or for potential beneficial use was summarized in an advisory memorandum (DMMP 2019). Concentrations of PAHs and PCBs in the sediments within the project area were quite low in the advisory characterization (DMMP 2019). PCBs exceeded the DMMP screening level (SL) in only one location, which was a sideslope area near Washington United Terminal. A screening level of 2,000 µg/kg was used for determining potential for beneficial use of sediment based on a 2014 NMFS proposed total PAH SL[22]. There were no SL exceedances for any individual or summed PAHs in any of the samples. The proposed action would cause chemicals such as PAHs to be re-suspended into the water column. There are two pathways for PAH exposure to listed fish species in the action area, direct uptake through the gills and dietary exposure (Lee and Dobbs 1972; Neff et al. 1976; Karrow et al. 1999; Varanasi et al. 1993; Meador et al. 2006; McCain et al. 1990; Roubal et al. 1977). Fish rapidly uptake PAHs through their gills and food but also efficiently remove them from their body tissues (Lee and Dobbs 1972; Neff et al. 1976). Juvenile Chinook salmon prey, including amphipods and copepods, uptake PAHs from contaminated sediments (Landrum and Scavia 1983; Landrum et al. 1984; Neff 1982). Varanasi et al. (1993) found high levels of PAHs in the stomach contents of juvenile Chinook salmon in the Duwamish estuary. The primary response of exposed salmonids, from both uptake through their gills and dietary exposure, are immunosuppression and reduced growth. Karrow et al. (1999) characterized the immunotoxicity of creosote to rainbow trout (*O. mykiss*) and reported a lowest observable effect concentration for total creosote of 17 µg/l or 611.63 ng/l PAHs. Varanasi et al. (1993) found greater immune dysfunction, reduced growth, and increased mortality compared to control fish. In order to isolate the effects of dietary exposure of PAHs on juvenile Chinook salmon, Meador et al. (2006) fed a mixture of PAHs intended to mimic those found by Varanasi et al. (1993) in the stomach contents of field-collected fish. These fish showed reduced growth compared to the control fish. Of the listed fish exposed to PAHs and other contaminants, all are likely to have some degree of immunosuppression and reduced growth, which, generally, increases the risk of death.

The number of years that detectable amounts of contaminants would be biologically available at the site is uncertain. Similarly, the annual numbers of juvenile PS Chinook salmon and juvenile PS steelhead that may be exposed to construction-related contaminated forage are uncertain and likely to be highly variable, as are the amounts of contaminated prey that individual fish may consume, or the intensity of effects that exposed individuals may experience. We expect that some individual listed fish species would experience sublethal effects from elevated turbidity, low DO, and re-suspended contaminants such as stress and reduced prey consumption, some may respond with avoidance behaviors, and some may be injured. We expect sediment impacts would adversely affect PS Chinook salmon and PS steelhead at multiple life stages, and juvenile and larval PS/GB yelloweye and bocaccio rockfish.

Response to Entrainment and Strike During Dredging

In this context, entrainment refers to the uptake of aquatic organisms by dredge equipment (i.e., the dredge bucket). Dredge buckets entrain slow-moving and sessile benthic epifauna along with burrowing infauna that are removed with the sediments. They also entrain algae and aquatic

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[22] The National Marine Fisheries Service (NMFS) proposed a screening level of 2,000 µg/kg total PAH for the protection of fish at the Regional Sediment Evaluation Team annual meeting in November 2014 (DMMP 2019).

vegetation. Fish that become captured within a digging bucket or that are struck by the bucket as it descends would likely be killed. However, the documented occurrence of these events for mobile fish species are extremely rare. In the Southeast Region of the US, where closely monitored heavy dredging operations occur regularly in areas inhabited by sturgeon and sea turtles, only two live sturgeon (NMFS 2012) and two live sea turtles (NMFS 2011) are known to have been taken by clamshell dredging since 1990. However, recently dredging in Grays Harbor, Washington a shark was killed after it was entrained by a hopper dredge (USACE 2021b).

The rarity of these occurrences is likely due to a combination of factors. In order to be entrained in a clamshell bucket, a fish must be directly under the bucket when it drops. The relatively small size of the bucket, compared against the scattered and low-density distribution of the fish across the available habitat within the project area strongly suggest that the potential for overlap between fish and bucket presence is very low, and that potential would decrease after the first few bucket cycles because mobile organisms such as salmon are likely to move quickly away from the noise and turbid water. Further, mechanical dredges typically stay within an area limited to the range of the crane/excavator arm for many minutes to several hours before moving to an adjacent area. The risk of bucket strike and entrainment would lowered further by conducting the work within a full-depth sediment curtain that would act as a fish exclusion device. Therefore, based on the best available information, in the very unlikely event that listed fish would be present during in-water work, it would be extremely unlikely that any individuals would be struck by or entrained in the clamshell bucket.

Adult PS Chinook salmon and PS steelhead may pass through the area during migration to their natal streams. Adult PS Chinook salmon and adult PS steelhead are strong swimmers that are likely to avoid the noise and activity, which would reduce the likelihood of entrainment or strike. Similarly, juvenile PS Chinook and PS steelhead are unlikely to be entrained or struck by construction equipment for the same reasons and are unlikely to be in the area in appreciable number further reducing the encounter potential. Based on the best available information described above, NMFS considers the risk of entrainment or strike occurring to adult and juvenile PS Chinook salmon PS steelhead to be low. Risk to adult rockfish, yelloweye and bocaccio, is also low because they are unlikely to be present in the dredging areas. Juvenile rockfish are also at low risk of entrainment because they would respond to the initial disturbance and avoid the area. Entrainment and strike risk is higher for larval rockfish given their lack of mobility.

While the risk of entrainment is very low, we cannot rule out the possibility of fish being entrained or struck while dredging is occurring and any individual fish harmed or killed as a result of being entrained or struck by a dredge constitutes an adverse effect.

Response to Reduced Forage and Prey Communities

The effect of dredging activities on macrofauna assemblage recovery depends on the methods used, duration and frequency of dredging, the area and amount of material to be dredged, substrate characteristics, resulting sedimentary profile of the affected seabed, local hydrology, seasonal effects (Barrio Froján et al., 2011, Newell et al., 1998) and biotic interactions (Ólfasson et al., 1994). Areas where sediment is removed by dredging would diminish benthic prey communities. In areas where suspended sediment settles on the bottom, some smothering can occur which also disrupts the benthic communities. The speed of recovery by benthic communities is affected by several factors, including the intensity of the disturbance, with greater disturbance increasing the time to recovery (Dernie et al., 2003). Additionally, the ability of a disturbed site to recolonize is affected by whether or not adjacent benthic communities are nearby that can recolonize the affected area, and the composition of the species that recolonize the area may differ from a less frequently perturbed area, as disturbances caused by dredging may lead to a decline in sensitive species, to be subsequently replaced by more tolerant species (Ceia et al. 2013). Lastly, suspended sediment would eventually settle in the area adjacent to the dredge prism, which can disrupt benthic prey species, and if the sediments are contaminated, then sublethal toxicity of benthic prey species could occur. These prey then can become a source of bioaccumulation, which degrades the quality of the prey.

We expect only the cohorts of PS Chinook salmon and PS steelhead that are present in Blair Waterway and Saltchuk to be exposed to this temporary reduction of prey. Therefore, feeding, growth, development, and fitness of the exposed individuals would be affected during the months of construction activity. We consider the temporary effects of reduced forage on any juvenile PS Chinook salmon and PS steelhead in the action area to be unlikely to cause injury at the population scale.

On the other hand, juvenile PS/GB bocaccio feed on the young of other rockfish, surfperch, and jack mackerel in nearshore areas (Love et al. 1991; Leet et al. 1992). Juveniles also eat all life stages of copepods and euphausiids (MacCall et al. 1999). Because juvenile rockfish are less able to access adjacent areas compared with salmon species, reductions in benthic prey communities, and in SAV from disturbance in work areas would reduce available forage for PS/GB bocaccio in their nearshore settlements, reducing growth and fitness of affected individuals.

Response to Elevated In-water Noise

The effects to fish caused by exposure to noise vary with the hearing characteristics of the fish, the frequency, intensity, and duration of the exposure, and the context under which the exposure occurs. At low levels, effects may include the onset of behavioral disturbances such as acoustic masking (Codarin et al. 2009), startle responses and altered swimming (Neo et al. 2014), abandonment or avoidance of the affected area (Mueller 1980; Picciulin et al. 2010; Sebastianutto et al. 2011; Xie et al. 2008) and increased vulnerability to predators (Simpson et al. 2016). At higher intensities and longer exposure durations, effects may include temporary hearing damage (a.k.a. temporary threshold shift or TTS, Scholik and Yan 2002) and increased stress (Graham and Cooke 2008). At even higher levels, exposure may lead to physical injury that can range from the onset of permanent hearing damage (i.e., permanent threshold shift or PTS) and mortality. The best available information about the auditory capabilities of the fish considered in this Opinion suggest that their hearing capabilities are limited to frequencies below 1,500 Hz, with peak sensitivity between about 200 and 300 Hz (Hastings and Popper 2005; Picciulin et al. 2010; Scholik and Yan 2002; Xie et al. 2008).

NMFS uses two metrics to estimate the onset of injury for fish exposed to high intensity impulsive sounds (Stadler and Woodbury 2009). The metrics are based on exposure to peak sound level and sound exposure level (SEL), respectively. Both are expressed in decibels (dB). The metrics are: 1) exposure to 206 dB_{peak}; and 2) exposure to 187 dB SEL_{cum} for fish 2 grams or larger, or 183 dB SEL_{cum} for fish under 2 grams. Further, any received level (RL) below 150 dB_{SEL} is considered “Effective Quiet”. The distance from a source where the RL drops to 150 dB_{SEL} is considered the maximum distance from that source where fishes can be affected by the noise, regardless of accumulation of the sound energy (Stadler and Woodbury 2009). Therefore, when the range to the 150 dB_{SEL} isopleth exceeds the range to the 187 dB SEL_{CUM} isopleth, the distance to the 150 dB_{SEL} isopleth is the range at which detectable effects would begin, with the 187 dB SEL_{CUM} isopleth identifying the distance within which sound energy accumulation would intensify effects. However, when the range to the 150 dB_{SEL} isopleth is less than the range to the 187 dB SEL_{CUM} isopleth, only the 150 dB_{SEL} isopleth would apply because fish would be extremely unlikely to detect or be affected by the noise outside of the 150 dB_{SEL} isopleth.

The above-discussed criteria specifically address fish exposure to impulsive sound. Stadler and Woodbury (2009) make it clear that the thresholds likely overestimate the potential for impacts on fish from non-impulsive sounds (e.g., vibratory pile driving). Non-impulsive sounds have less potential to cause adverse effects in fish than impulsive sounds. Impulsive sources cause short bursts of sound with very fast rise times and the majority of the energy in the first fractions of a second. Whereas, non-impulsive sources cause noise with slower rise times and sound energy that is spread across an extended period of time; ranging from several seconds to many minutes in duration. Therefore, application of the criteria to non-impulsive sounds is also likely to overestimate the potential effects in fish. However, these criteria represent the best available information. Therefore, to avoid underestimating potential effects, this assessment applies these criteria to provide a conservative measure of the potential effects that fish may have experienced due to exposure to project-related sounds.

The estimated in-water source levels (SL, sound level at 1 meter from the source) used in this assessment are based on the best available information, as described in a recent acoustic assessment for a similar project (NMFS 2016a), and in other sources (Blackwell and Greene 2006; COE 2011a; Dickerson et al. 2001; Reine et al. 2014; Richardson et al. 1995). The best available information supports the understanding that all of the SLs would be below the 206 dB_{peak} threshold for the onset of instantaneous injury in fish.

In the absence of location-specific transmission loss data, variations of the equation RL = SL – #Log(R) are often used to estimate the received sound level at a given range from a source (RL = received level (dB); SL = source level (dB, 1 m from the source); # = spreading loss coefficient; and R = range in meters (m). Numerous acoustic measurements in shallow water environments support the use of a value close to 15 for projects like this one (CalTrans 2015). This value is considered the practical spreading loss coefficient, and was used for all sound attenuation calculations in this assessment.

Application of the practical spreading loss equation to the expected SLs suggests that noise levels above the 150 dB_{SEL} threshold could extend to 72 feet (22 m) around tugboats, and about 13 feet (4 m) around dredging work (Table 11). Individual fish that are beyond the 150 dB_{SEL} isopleth for any of these sources would be unaffected by the noise. However, fish within the 150 dB_{SEL} isopleth are likely to experience a range of impacts that would depend on their distance from the source and the duration of their exposure.

Several pieces of equipment would be operating and producing underwater noise for up to 24 hours per day during the in-water work windows, for up to four years. Tugboats have a dominant frequency range of 100-500Hz with a peak output at 170dB_{RMS}. However, their frequent movement is expected to preclude any concern for impacts on fish from accumulated sound energy. Grading the slope to the appropriate channel depth would have in-water noise effects similar for dredging. Although in-water dredging would be source of continuous noise during the project, is extremely unlikely that any fish would remain within 13 feet of that work long enough for accumulated sound energy to have an effect. Further, the full-depth sediment curtain that would surround the project site would act as a fish exclusion device that would be installed more than 13 feet from the dredging area. Additionally, these sound sources are very unlikely to have any additive effects with each other due the differences in the frequencies and other characteristics of their sound. At most, the combination of the various types of equipment noise during any given day would cause fish-detectable in-water noise levels across the entire workday.

Adult salmon and steelhead are unlikely to be affected by noise caused by dredging, installation of shoreline stabilization measures, and material placement at Saltchuk because noise levels would be well below the 150 dB_{RMS} threshold for behavioral effects and essentially the same as the background noise level in the Port. Displacement of adults may occur on a minor scale as the dredge operates in a small area compared to the entire width of the navigation channel and aquatic habitat available. Larval yelloweye rockfish and larval and juvenile PS/GB bocaccio would also be exposed in uncertain numbers. During the in-water work window, all exposed PS Chinook salmon and PS steelhead individuals would be at least two grams, which reduces the likelihood of lethal response. Larval rockfish and younger juvenile PS/GB bocaccio would be less than two grams, making them more vulnerable to die.

Table 11. Estimated in-water source levels for the loudest project-related activities and the associated distances thresholds are expected to attenuate.

Source	Acoustic Signature	Source Level (dBSEL)	Threshold (dBSEL; meters)
Tugboat Propulsion	< 1 kHz Combination	170	150; 22
Dredge Bucket Strike	< 370 Hz Impulsive	167	150; 4

Intermittent Effects

<u>Response to Reduced Vessel Traffic</u>
Vessel traffic is expected to decrease as a result of the proposed action because load capacity per vessel would increase as a result of the increased depth of Blair Waterway. Less vessel traffic translates to a reduction in underwater noise, associated pollution, and disruption of benthic prey. This would likely result in a slight increase in growth rates, carrying capacity, and survival of juvenile and adult listed PS steelhead, PS Chinook salmon, PS/GB yelloweye rockfish, and PS/GB bocaccio. We also evaluated the effects of an increase in vessel size for impacts to listed species. Specifically, we evaluated the potential for a change in noise, ship strikes, and wake effects on Puget Sound shorelines resulting from the proposed action. NMFS found no

information that supported an increase or a decrease in negative impacts to listed fish or marine mammals from larger vessels in Puget Sound.

Enduring Effects

<u>*Response to channel deepening and widening*</u>
The proposed dredging of 6 feet (plus two feet of over-depth) is not expected to alter substrate composition or sizes of those materials. Although areas where sediment is removed by dredging will greatly reduce benthic prey communities in the near-term, the speed of recovery by benthic communities is likely to occur within two years (NMFS 2006a). Other than the temporary loss of benthic invertebrates, the proposed widening and deepening of the federal navigation channel is not expected to reduce habitat quality for salmonids or rockfish. This is because the navigation channel is not nearshore habitat and, under the current environmental baseline, could not return to nearshore habitat. Increasing the depth of deep-water habitat that might provide marginal migration and foraging areas for salmon and rockfish does not result in a loss of habitat quality as we expect benthic organisms to recolonize within two years.

<u>*Response to Modified Shoreline*</u>

The shoreline of the Blair Waterway, in its current state, is highly industrialized and lacks high quality nearshore habitat and does not provide the ecological function necessary to sustain the ESA-listed species evaluated in this Opinion. The lack of shallow water habitats, suitable substrate, submerged aquatic vegetation, and natural cover and the intense industrial use precludes ESA-listed rockfish and salmonids species from using most of these areas as feeding, growth, and reproductive opportunities. Due to current Congressional authorization, the Corps is required to maintain the current condition and functionality of the channel, meaning the current depth, width, and quantity of shoreline armoring would be maintained in its current state without implementation of the proposed action (see section 2.3.3). We do not expect adverse effects to occur as a result of the proposed shoreline stabilization measures because conditions would not appreciably change from current conditions. However, the proposed shoreline armoring at all four locations would prolong the recovery of the species considered in this Opinion as conditions would remain degraded as a result.

<u>*Response to Improved Nearshore Conditions at Saltchuk*</u>
The proposed action would add approximately 1.8 million cubic yards of dredged materials at the 64-acre Saltchuk site, increasing productive intertidal and subtidal habitat (Figure 1). Over the long term, improved habitat conditions at Saltchuk are expected to increase feeding and rearing opportunities for juvenile salmonids including PS Chinook salmon, PS steelhead, and bull trout. These benefits may take many years to be fully realized, but would be expected to benefit juveniles in the nearshore, likely increasing abundance, survival, and growth rates as long as the dredged material remains on site and suitable habitat remains. Habitat complexity would likely slowly develop, providing important cover and refugia from piscivorous fish and avian predators. Commencement Bay carrying capacity would also slightly increase as a result of the improved nearshore habitat. Juvenile PS Chinook salmon are most likely to benefit from the proposed improvements to the nearshore given their reliance on nearshore habitats during their marine growth and rearing life stage. These positive effects would likely attenuate over time, as

placement of material and the site would not result in a permanent improvement in habitat without maintenance and additional restoration actions under consideration by the Corps (COE 2021a).

Summary of Effects to Species

Based on the low but not insignificant probability that juvenile and adult PS Chinook salmon and PS steelhead and larval and juvenile PS/GB bocaccio and PS/GB yelloweye rockfish may be present during temporary and localized effects of construction, this project may affect and is likely to adversely affect individuals via degraded water quality (high turbidity, low DO, suspended contaminants), equipment entrainment and strike, reduced forage and prey communities, and elevated in-water noise, but it will not measurable affect populations. Conversely, over the long-term the project may benefit these species through reduced vessel traffic, and improved nearshore habitat at Saltchuk. NMFS did not find literature supporting positive or negative effects to listed species in Puget Sound as a result of large vessel size. The proposed widening and deepening of the federal navigation channel is not expected to reduce habitat quality for salmonids or rockfish.

Effects to Population Viability

We assess the importance of habitat effects in the action area to the species by examining the relevance of those effects to the characteristics of VSP. The characteristics of VSPs are sufficient abundance, population growth rate (productivity), spatial structure, and diversity. While these characteristics are described as unique components of population dynamics, each characteristic exerts significant influence on the others. For example, declining abundance can reduce spatial structure of a population; and when habitats are less varied, then diversity among the population declines. We expect a temporary negative effect from the proposed action on the survival of juvenile PS Chinook salmon, juvenile steelhead, and larval and juvenile PS/GB rockfish. We expect populations from the Puyallup River basin to be present in the action area and impacted by the proposed action.

<u>Abundance</u>: As discussed in Section 2.3.2, the Blair Waterway and its associated facilities have degraded and industrialized the estuarine and marine nearshore environment. Effects to individual fishes from the proposed action would not appreciably increase the effects of the two Chinook salmon populations that use the action area. While we cannot quantify these long-term structure-related effects, we believe them to be limited and proportional to the size of affected habitat. Because PS juvenile steelhead do not commonly reside in the estuarine or marine nearshore habitat, we do not expect the proposed project to notably affect the abundance of PS steelhead. We do expect larval and juvenile rockfish abundance to be incrementally affected each year of construction given their limited swimming ability and general fragility to disturbance. PS/GB bocaccio are likely to be affected at a larger magnitude compared to yelloweye rockfish given their greater reliance on nearshore area during juvenile/larval life stages.

<u>Productivity</u>: Productivity is likely to be negatively impacted over the short-term, but increase over the long-term once construction is complete due to a slight increase in nearshore habitat area and quality at Saltchuk. The resulting slight increase in nearshore habitat area and quality is

expected to slightly increase PS Chinook salmon and PS/GB rockfish productivity and carrying capacity by creating more feeding/foraging opportunities as well as natural cover. A slight increase in nearshore habitat is not likely to improve steelhead productivity because of their limited use of the nearshore environment.
Spatial Structure: We expect the proposed project to marginally affect the spatial structure of the PS Chinook salmon ESU, and PS/GB bocaccio DPS as the majority of impacts would be isolated to the Blair Waterway and Saltchuk site. The addition of beneficial material at the Saltchuk site will improve spatial structure for juvenile Chinook salmon and bocaccio by increasing access to productive habitat and refugia from predators.

Diversity: Salmon have complex life histories and changes in the estuarine environment would have a greater effect on specific life history traits that make prolonged use of this habitat. This would likely result in a slight, proportional to the limited habitat alteration, decline in PS Chinook salmon diversity by differentially affecting specific populations that encounter the developed area in greater frequency during their early estuarine life history. We do not expect the proposed project to affect the diversity of PS steelhead, PS/GB bocaccio, or PS/GB yelloweye rockfish.

2.5 Cumulative Effects

"Cumulative effects" are those effects of future State or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation (50 CFR 402.02 and 402.17(a)). Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline vs. cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described earlier in the discussion of environmental baseline (Section 2.3).

Future actions in the nearshore and along the shoreline of Puget Sound are reasonably certain to include port and ferry terminal expansions, residential and commercial development, shoreline modifications, road and railroad construction and maintenance, and agricultural development. Some of these developments will occur without a federal nexus, however, activities that occur waterward of the OHWM (freshwater) or HTL (marine water) require a Corps permit and therefore involve federal activities. Such activities may include additional berth deepening and widening within federal navigation waterways and modifications at Saltchuk.

The repair, replacement, construction and removal of shoreline armoring that may not require federal authorization will continue. However, based on current trends, there could continue to be a net reduction in the total amount of shoreline armoring in Puget Sound (PSP 2018). Changes in tributary watersheds that are reasonably certain to affect the action area include reductions in water quality, water quantity, and sediment transport. Future actions in the tributary watersheds whose effects are reasonably certain to extend into the action area include operation of hydropower facilities, flow regulations, timber harvest, land conversions, disconnection of floodplain by maintaining flood-protection levees, effects of transportation infrastructure, and growth-related commercial and residential development.

All future non-federal actions in the nearshore as well as in tributary watersheds will cause long-lasting environmental changes and will continue to harm ESA-listed species and their critical habitats. Especially relevant effects include the loss or degradation of nearshore habitats, pocket estuaries, estuarine rearing habitats, wetlands, floodplains, riparian areas, and water quality. We consider human population growth to be the main driver for most of the future negative effects on salmon and steelhead and their habitat.

As mentioned above, human populations are expected to increase within the Puget Sound region, and if population growth trends remain relatively consistent with recent trends, we can anticipate future growth at approximately 1.5 percent per year.[23] The human population in the PS region increased from about 1.29 million people in 1950 to about 3.84 million in 2014, and is expected to reach nearly 5 million by 2040 (Puget Sound Regional Council 2020). As of the date of this Opinion, the human population in the Puget Sound Region is 4.2 million, slightly exceeding projections. Thus, future private and public development actions are reasonably certain to continue in and around PS. As the human population continues to grow, demand for agricultural, commercial, and residential development and supporting public infrastructure is also reasonably certain to grow. We believe the majority of environmental effects related to future growth will be linked to these activities, in particular land clearing, associated land-use changes (i.e., from forest to impervious, lawn or pasture), increased impervious surface, and related contributions of contaminants to area waters. Land use changes and development of the built environment that are detrimental to salmonid habitats are reasonably certain to continue under existing regulations. Though the existing regulations minimize future potential adverse effects on salmon habitat, as currently constructed and implemented, they still allow systemic, incremental, additive degradation to occur.

In June 2005, the Shared Strategy presented its recovery plan for PS Chinook salmon and the Hood Canal Coordinating Council presented its recovery plan for Hood Canal summer-run chum salmon to NMFS who adopted and expanded the recovery plans to meet its obligations under the ESA. Together, the joint plans comprise the 2007 PS Chinook and Hood Canal Summer-run Chum Recovery Plan (Shared Strategy 2007; NMFS 2006). Many tribes, not-for-profit organizations and local, state and federal agencies are implementing recovery actions identified in these recovery plans.

The cumulative effects associated with continued development in the action area are reasonably certain to have ongoing adverse effects on all the listed species populations addressed in this Opinion. Only improved, low-impact development actions together with increased numbers of restoration actions, watershed planning, and recovery plan implementation would be able to address growth related impacts into the future. To the extent that non-federal recovery actions are implemented and offset ongoing development actions, adverse cumulative effects may be minimized, but will probably not be completely avoided.

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[23] https://www.psrc.org/whats-happening/blog/region-adding-188-people-day

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

The species considered in this Opinion have been listed under the ESA, based on declines from historic levels of abundance and productivity, loss of spatial structure and diversity, and an array of limiting factors as a baseline habitat condition. Each species would be affected over time by cumulative effects, some positive—as recovery plan implementation and regulatory revisions increase habitat protections and restoration, and some negative—as climate change and unregulated or difficult to regulate sources of environmental degradation persist or increase. Overall, to the degree that habitat trends are negative, as described below, effects on viability parameters of each species are also likely to be negative. In this context we consider the effects of the proposed action's effect on individuals of the listed species at the population scale. The action area provides critical habitat for nearshore marine life histories of PS Chinook salmon, although at a degraded state.

PS Chinook salmon and PS steelhead are both listed as threatened, based on declines from historic levels of abundance and productivity, loss of spatial structure and diversity, and an array of limiting factors. Both species would be affected over time by cumulative effects, some positive—as recovery plan implementation and regulatory revisions increase habitat protections and restoration, and some negative—as climate change and unregulated or difficult to regulate sources of environmental degradation persist or increase. Overall, to the degree that habitat trends are negative, the effects on viability parameters of each species are also likely to be negative. In this context we consider how the proposed action's impacts on individuals would affect the listed species at the population and ESU/DPS scales.

2.6.1 PS Chinook Salmon

PS Chinook salmon are currently listed as threatened with generally negative recent trends in status. Widespread negative trends in natural-origin spawner abundance across the ESU have been observed since 1980. Productivity remains low in most populations, and hatchery-origin spawners are present in high fractions in most populations outside of the Skagit watershed. Available data now shows that most populations have declined in abundance over the last evaluation period (NWFSC 2015; Ford, in press)). Most populations are consistently below the spawner-recruit levels identified by the recovery plan for this ESU.

The environmental baseline within the project area has been degraded by the effects of shoreline development and vessel activities. The baseline has also been degraded by nearby industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance. The environmental baseline includes the current congressionally authorized federal navigation channel in the Blair Waterway. Absent a change in the authorization, the federal navigation channel and Blair Waterway cannot return to a condition that would provide high-quality habitat for salmon.

The timing of the proposed construction and dredging overlaps with adult PS Chinook salmon holding and upstream migration through Commencement Bay. The timing avoids the peak migration of juvenile Chinook salmon downstream from the Puyallup River toward Commencement Bay. However, over the next several decades, low numbers of out-migrating juveniles that pass through Commencement Bay would be exposed to low levels of contaminated forage and other altered habitat conditions, that both individually and collectively, would cause some combination of altered behaviors, reduced fitness, and mortality. The annual numbers of individuals that would be detectably affected by action-related stressors would be extremely low.

As described in Section 2.2, the Puyallup Basin supports several populations critical for recovery of the PS Chinook ESU. PS Chinook salmon were recently evaluated by Ford (in press) to be at moderate risk of extinction. Impacts to Puyallup Basin populations may disproportionately affect recovery efforts and VSP characteristics of the PS Chinook salmon ESU. Early returning White River spring Chinook salmon and Puyallup and Carbon River fall Chinook salmon are the populations that would be impacted by the temporary, intermittent, and enduring effects of the proposed action. White River spring Chinook salmon are the most genetically distinct population of Chinook salmon in the central and south Puget Sound and are the last existing early returning spring Chinook salmon population in the southern Puget Sound basin (NMFS 2007). Currently, White River spring Chinook salmon escapement is well below historical averages and failing to meet recovery goals outlined in the 2007 recovery plan (geometric mean of 4,500) (NMFS 2007). While adult escapement has been high in recent years (see Section 2.3.4 Figure 4), productivity and natural origin abundance has been negative and in perpetual decline, respectively (see Section 2.3.4, Figures 5 and 6). Given the importance of White River spring Chinook salmon relative to the diversity of the PS Chinook salmon ESU even small impacts at the population level from the proposed action could impair recovery of the ESU. The restoration measures included in the proposed action at that Saltchuk site is likely to benefit White River spring Chinook salmon over the long-term, although it remains to be seen at what scale benefits would affect abundance, productivity, or carrying capacity.

Based on the best available information, the scale of the direct and indirect negative effects of the proposed action, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause detectable effects on any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for the affected PS Chinook salmon populations. Despite the slight increase in beneficial habitat improvements at Saltchuk, the degraded baseline of habitat conditions at the Port of Tacoma largely negates improvements to population viability. In addition, since its construction, the Blair Waterway has not provided important rearing habitat for PS Chinook salmon juveniles and the widening and deepening of the channel is unlikely to worsen habitat conditions in any appreciable measure once completed. Furthermore, the in-water work window avoids peak migration periods for both juvenile and adult Chinook salmon further minimizing effects. The proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species because:

- the effect of the dredging proposed to widen and deepen the federal navigation channel are temporary and likely to affect only a few cohorts of the Puyallup Basin populations of PS Chinook salmon;
- the widening and deepening of the federal navigation channel would not cause any meaningful reduction in habitat quality for PS Chinook salmon; and
- the effect at the Saltchuk site would improve the habitat quality for a minimum of several years.

2.6.2 PS Steelhead

The long-term abundance trend of the PS steelhead DPS is negative, especially for native-origin spawners. The extinction risk for most DPSs is estimated to be moderate to high, and the DPS is currently considered "not viable." Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat due to land use activities appear to be the greatest threats to the recovery of PS steelhead. Fisheries activities also continue to impact this species.

The PS steelhead populations most likely to occur in the project area would be winter-run fish from the Puyallup/Carbon River and White River DPSs. Adults are expected to occur in the deep, open-water areas adjacent to the Blair Waterway during the winter of their upstream spawning migration, and juveniles may occur in the shallow nearshore zone during typical outmigration periods in the spring and early summer. Adult fish would typically be oriented to the outflow of the Puyallup River. Historical information suggests that PS steelhead utilized Wapato Creek (drains into Blair Waterway) for rearing and spawning, but recent information suggest current use is low or non-existent.

As described in Section 2.2, the Puyallup Basin supports several populations critical for recovery of the PS steelhead DPS. PS steelhead were recently evaluated by Ford (in press) to at moderate risk of extinction. Impacts to these populations may disproportionately affect recovery efforts and VSP characteristics of the PS steelhead DPS. The Puyallup, Carbon, and White River winter steelhead populations are an integral component to the core MPG of the southern Puget Sound ESU (NMFS 2019). The Green, Puyallup, and Nisqually River basins contain important diverse stream habitats to support core populations. Current abundance of Puyallup/Carbon River and White River winter steelhead remain well below recovery goals and significant recovery efforts would be needed to attain recovery of these populations. Specific measures include reconnecting side channels, wetlands, and floodplains, removing bank armoring and reducing confinement throughout the Puyallup River basin. The proposed action does little to promote steelhead recovery in the Puyallup Basin but also does not result in effects likely to significantly reduce population viability.

The environmental baseline within the project area has been degraded by the effects of shoreline development and vessel activities. The baseline has also been degraded by nearby industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance. Absent a change in the authorization, the federal navigation channel and Blair Waterway cannot return to a condition that would provide high-quality habitat for steelhead.

It is unlikely that juvenile PS steelhead would be directly exposed to the proposed dredging and material placement at Saltchuk. However, over the next several years, low numbers of out-migrating juveniles that pass close to the project site would be exposed to low levels of reduced or contaminated forage that, both individually and collectively, would cause some combination of altered behaviors, reduced fitness, and mortality in some of the exposed individuals. The numbers of individuals that would be detectably affected by action-related stressors would be extremely low.

Based on the best available information, the scale of the direct and indirect effects of the proposed action, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause detectable effects on any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for the affected PS steelhead DIPs. Therefore, the proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species.

2.6.3 Rockfish

PS/GB bocaccio are listed as endangered and abundance of this species likely remains low. PS/GB yelloweye rockfish are listed as threatened but likely persist at abundance levels somewhat higher than bocaccio. In Puget Sound, catches of PS/GB yelloweye rockfish have declined as a proportion of the overall rockfish catch (see Figure 2 and Figure 3, from Drake et al. 2010). Lack of specific information on rockfish abundance in Puget Sound makes it difficult to generate accurate abundance estimates and productivity trends for these two DPSs. Available data suggest that total rockfish declined at a rate of 3.1 to 3.8 percent per year from 1977 to 2014 or a 69 to 76 percent total decline over that period (Tonnes et al. 2016). The two listed DPSs declined over-proportionally compared to the total rockfish assemblage.

Juvenile yelloweye rockfish are not typically found in nearshore habitat and adults are found solely in deep water areas of Puget Sound. Juvenile and larval bocaccio and larval yelloweye rockfish are found in nearshore areas and would likely be exposed to the short-term effects of the proposed construction. However, the proposed actions would only result in short-term impacts to a few cohorts of rockfish over the course of the proposed construction. Given the low overall level of impact, the proposed action would not have any meaningful effect on the numbers, reproduction, or distribution of yelloweye or bocaccio rockfish. Simply stated, the proposed action would affect far too few individuals to have any meaningfully effect on the two rockfish DPSs. Restoration efforts at Saltchuk may improve productivity and abundance of juvenile rockfish; although the scale at which those benefits may occur is unclear as limited data exists to evaluate the long-term benefit of material placement within nearshore environments.

2.6.4 Critical Habitat

At the designation scale, the quality of PS Chinook salmon critical habitat is generally poor with only a small amount of freshwater and nearshore habitat remaining in good condition. Most critical habitat for these species is degraded but nonetheless maintains a high importance for conservation of the species, based largely on its restoration potential. Loss of freshwater and nearshore critical habitat quality is a limiting factor for this species. Development of shoreline and estuary areas of Puget Sound is expected to continue to adversely impact the quality of critical habitat PBFs for PS Chinook salmon.

Modification of nearshore habitat in Puget Sound has resulted in a substantial decrease in critical habitat quality for PS Chinook salmon. As noted in Section 2.3, shoreline development is the primary cause of this decline in habitat quality. Development includes shoreline armoring, filling of estuaries and tidal wetlands, and construction of overwater structures. Currently, 27-30 percent of Puget Sound's shorelines are armored (Meyer el al. 2010; Simenstad et al. 2011).

Given the rate of expected population growth in the Puget Sound area, cumulative effects are expected to result in mostly negative impacts on critical habitat quality. While habitat restoration and advances in best management practices for activities that affect critical habitat could lead to some improvement of PBFs, adverse impacts created by the intense demand for future development is likely to outpace any improvements. Current state and local regulations do not prevent much of the development that degrades the quality of nearshore critical habitats. There is no indication these regulations are reasonably certain to change in the foreseeable future Once human development causes loss of critical habitat quality, that loss tends to persist for decades or longer. The condition of critical habitat will improve only through active restoration or natural recovery following the removal of human infrastructure. As noted throughout this Opinion, future effects of climate change on habitat quality throughout Puget Sound are expected to be negative.

In summary, the status of critical habitat for PS Chinook salmon is poor, particularly in the Blair Waterway. Under the current environmental baseline, the federal navigation channel and Blair Waterway do not provide quality critical habitat for PS Chinook salmon. The presence of the federally authorized navigation channel, ensures that recovery of this habitat is not reasonably certain to occur. The proposed action would result in some temporary loss of habitat quality, but these effects are all expected to be temporary. These temporary effects are not nearly substantial enough to meaningfully impact the conservation value of critical habitat at the designation scale. Moreover, the proposed action would result in a slight increase in quality and quantity of habitat at Saltchuk, but is unlikely to provide a measurable increase in abundance or productivity at the population scale.

2.7 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon, PS steelhead, or PS/GB bocaccio or yelloweye rockfish or adversely modify designated critical habitat for PS Chinook salmon.

2.8 Incidental Take Statement

Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. “Take” is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. “Harm” is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). “Harass” is further defined by interim guidance as to “create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering.” “Incidental take” is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.8.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

- Incidental take in the form of injury or death due to entrainment or strike during clamshell dredging;
- Incidental take in the form of noise during dredging and installation of shoreline armoring;
- Incidental take in the form of permanent habitat alterations, from sediment deposition at Saltchuk;
- Incidental take in the form of harm from diminished water quality (turbidity, suspended contaminants, etc.); and
- Incidental take in the form of contaminated forage and diminished prey availability.

The distribution and abundance of fish that occur within an action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional and may operate across far broader temporal and spatial scales than are affected by the proposed action. Thus, the distribution and abundance of fish within the action area cannot be attributed entirely to habitat conditions, nor can NMFS precisely predict the number of fish that are reasonably certain to be injured or killed if their habitat is modified or degraded by the proposed action.

Therefore, we cannot predict with meaningful accuracy the number of PS Chinook salmon, PS steelhead, or PS/GB rockfish that are reasonably certain to be injured or killed by exposure to any of these stressors. Additionally, NMFS knows of no device or practicable technique that would yield reliable counts of individuals that experience these impacts. In such circumstances, NMFS uses the casual link established between the activity and the likely extent and duration of changes in habitat conditions to describe the extent of take as a numerical level of habitat disturbance. The most appropriate surrogates for take are action-related parameters that are directly related to the magnitude of the expected take.

For this proposed action, the potential for occurrences of 1) injury or death from entrainment or strike, elevated noise, and alteration of habitat and 2) harm from being exposed to elevated turbidity and reductions in forage for juvenile salmonids, is directly related to the amount of dredged material and the timing of the dredge operation.

Injury or death from entrainment or strike by dredge equipment – Since the potential for PS Chinook salmon (juvenile), PS steelhead (juvenile), PS/Georgia Basin DPSs of yelloweye rockfish and bocaccio (larvae and juvenile) to be entrained is most directly determined by the amount of sediment dredged and the timing of the operation, the extent of take identified for the proposed action is related to the amount of dredged material within a timeframe that anticipates the lowest presence of vulnerable life stages of listed fish. Therefore, the extent of take is a maximum of 3.0 million cy of sediment dredged within Blair Waterway to occur between the August 16 – February 15 work windows for four years. Exceeding this indicator for extent of take would trigger the reinitiation provisions of this Opinion.

Injury or death from elevated noise – PS Chinook salmon (juvenile), PS steelhead (juvenile), PS/Georgia Basin DPSs of yelloweye rockfish and bocaccio (larvae and juvenile) will be exposed to construction-related noise resulting from dredging equipment and construction vessels. Disruption of normal feeding and migration, and injury and death can occur from this exposure. The most appropriate and measurable surrogate for take associated with elevated noise is time spent dredging and operating construction vehicles in the August 16 and February 15, annual work windows for four years. Exceeding this indicator for extent of take would trigger the reinitiation provisions of this Opinion.

Harm from altered habitat – Juvenile PS Chinook salmon and PS/GB bocaccio will be exposed to altered habitat conditions at Saltchuk from the deposit of sediment from the Blair Waterway. During the deposition of 1.8 million cy of beneficial use sediment, juvenile Chinook salmon and juvenile and larval bocaccio will be exposed the placement of sediment over existing subtidal habitat. Since the potential for ESA listed fish to be displaced or smothered is most directly determined by the amount of sediment deposited at the Saltchuk site and the timing of the operation, the extent of take identified for the proposed action is related to the amount of deposited material within a timeframe that anticipates the lowest presence of vulnerable life stages of listed fish. Therefore, the extent of take is a maximum of 1.85 million cy of sediment deposited at Saltchuk to occur between the August 16 – February 15 work windows for four years. Exceeding this indicator for extent of take would trigger the reinitiation provisions of thisOpinion.

Harm from degraded water quality – PS Chinook salmon (juvenile), PS steelhead (juvenile), PS/Georgia Basin DPSs of yelloweye rockfish and bocaccio (larvae and juvenile) would be exposed to degraded water quality. Habitat modified temporarily by suspended solid and contaminants would injure fish by impairing normal patterns of behavior including rearing and migrating in the action area and causing potential health effects. Because injury to individuals can occur when exposed to high levels of suspended sediment, or as a result of avoiding areas affected with high levels of sediment, the extent of take is measured as the anticipated area where suspended sediment would be present. The levels of suspended contaminants are expected to be proportional to the amount of injury that the proposed action is likely to cause through physiological stress from elevated suspended sediments and contaminants throughout the duration of the projects' in water activities. Therefore, the maximum extent of take is defined by the relative increase in turbidity to baseline conditions within the annual work windows for four years. Specifically, turbidity levels shall not exceed 5 NTUs more than background levels when background turbidity is 50 NTUs or less, or there shall not be more than a 10 percent increase turbidity when the background turbidity is more than 50 NTUs. These increases would be limited to a 300 foot area of mixing within the 3-mile radius described in the action area. Exceeding this indicator for extent of take would trigger the reinitiation provisions of this Opinion.

Harm from diminished prey availability – Individual PS Chinook salmon (juvenile), PS steelhead (juvenile), PS/Georgia Basin DPSs of yelloweye rockfish and bocaccio (larvae and juvenile) would be affected by a temporary reduction in prey availability during construction activities. Reductions in fitness among juveniles are likely when prey availability is decreased, and competition increases for prey resources. Therefore, the extent of take is a maximum of 3.0 million cy of sediment dredged within Blair Waterway to occur between the August 16 – February 15 annual work window for four years. Exceeding this indicator for extent of take would trigger the reinitiation provisions of this Opinion.

Exceedance of any of the exposure limits described above would constitute an exceedance of authorized take that may trigger the need to reinitiate consultation. In addition, because the analysis included in this Opinion evaluates project effects for 50 years, the amount or extent of take described above is determined based on that length of time. We cannot reasonably predict the amount or extent of take that would occur after 50 years given the uncertainty of how baseline conditions may change as a result of extraneous factors such as climate change or population growth.

Although these take surrogates could be construed as partially coextensive with the proposed action, they still function as effective reinitiation triggers.

2.8.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1. The Corps shall minimize incidental take of listed species resulting from entrainment and strike.

2. The Corps shall minimize incidental take of listed species resulting from elevated noise.

3. The Corps shall minimize incidental take of listed species resulting from suspended sediment and re-suspended contaminants during dredging, shoreline stabilization, and material placement.

4. The Corps shall develop a monitoring and reporting plan to ensure that the RPM's are implemented as required and take exemption for the proposed action is not exceeded, and that the terms and conditions are effective in minimizing incidental take.

5. The Corps shall develop a plan to enhance restoration efforts implemented at the Saltchuk site and improve nearshore habitat conditions for listed species. Additionally, the Corps and non-federal sponsor shall engage NMFS in finalization of construction and beneficial material use designs to ensure take of listed species is minimized.

2.8.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the federal action agency and/or non-federal sponsor must comply with the following terms and conditions. The Corps has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement RPM 1 (minimize entrainment and strike during dredging):
    a. The Corps shall ensure that dredging equipment is lowered to the bottom slowly to allow ESA listed fish the opportunity to escape.
    b. The Corps shall develop a Dredging Monitoring Plan for NMFS review which monitors and analyzes the first dredge clamshell dredged materials in each new area of activity or in the same area of activity after 6 hours of inactivity for any fish. The Dredging Monitoring Plan shall be available for NMFS review a minimum of 60 days prior to dredging activities. The Dredging Monitoring Plan shall include:
        i. Methods of observation, such as videography or physical observers;
        ii. Identification and size of any fish categorized as either entrained or impacted and alive or dead;
        iii. The date and approximate time of the dredge entrainment;
        iv. An annual report of findings shall be provided to NMFS within 2 months after the work window closes.

2. The following terms and conditions implement RPM 2 (elevated noise):
    a. Adhere to in-water work window August 16 – February 15 for the four years of construction.
    b. The Corps shall develop an Underwater Noise Monitoring Plan to monitor underwater noise levels while dredging at the mouth of the Blair Waterway .

The plan shall be available for NMFS review a minimum of 60 days prior to construction. The Underwater Noise Monitoring Plan shall include:

    i. Methods of observation, such as hydrophones
    ii. A list of activities monitored, including underwater clamshell operation, vessel operations, and sediment deposits at Saltchuk;
    iii. An annual report of findings shall be provided to NMFS within 4 months after the work window closes.

3. The following terms and conditions implement RPM 3 (minimize turbidity and suspended sediments during dredge operation):
    a. Comply with Washington State water quality standards by conducting water quality monitoring during dredging activities. Per state permit, turbidity levels shall not exceed 5 nephelometric turbidity units (NTUs) more than background turbidity when the background turbidity is 50 NTUs or less, or there shall not be more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTUs as measured from a distance of 300 feet.
        i. If turbidity levels in the Blair Waterway exceed the standards as described in the Water Quality certification for this project, adhere to exceedance protocol in the Water Quality Monitoring Plan (WQMP), including notification and coordination with Ecology if additional BMPs are necessary to address turbidity.
        ii. If turbidity levels during material placement at Saltchuk exceed the standards as described in the Water Quality certification for this project, adhere to exceedance protocol in the WQMP, including notification and coordination with Ecology if additional BMPs are necessary to address turbidity. This may include use of a floating silt curtain as appropriate.
    b. Dredge in a manner that minimizes spillage of excess sediments from the bucket and minimizes the potential entrainment of fish. This includes, but is not limited to:
        i. Avoiding the practice of washing unsuitable material off the barge and back into the water. This can be accomplished by the use of hay bale and/or filter fabric.
    c. Ensure dredging contractor utilizes a current, accurate Global Positioning System (GPS) dredge positioning to control the horizontal and vertical extent of the dredge to ensure dredging does not occur outside the limits of the dredge prism.
    d. Ensure that an emergency cleanup plan is in place in the event the barge, truck, or railcar has an incident where unsuitable material is spilled. This plan will be on-board the vehicle at all times.

4. The following terms and conditions implement RPM 4 (monitoring and reporting):
    a. The Corps shall develop an Underwater Observation Monitoring Plan associated with dredging in Blair Waterway and material placement at Saltchuk.

b. The Corps shall provide NMFS with an Underwater Observation Monitoring Plan for review a minimum of 60 days prior to the initiation of construction activities. The Underwater Observation Monitoring Plan shall include:
    i. Methods and schedule to monitor ESA-listed fish presence immediately preceding dredging activities within the Blair Waterway;
    ii. Methods to monitor the abundance and diversity of ESA-listed fish utilizing Saltchuk prior to initiation of construction activities during the first year;
    iii. Methods and schedule to monitor the abundance and diversity of fish utilizing Saltchuk immediately preceding the deposition of sediments at Saltchuk during the construction period if "ramping" (e.g., thin-layer placement or excavator-assisted placement) is not used;

c. Submit annual monitoring reports within 4 months after the work window closes in each of the four years of construction, summarizing the following for the previous calendar year:
    i. Hours of dredging completed per day;
    ii. The number of days of dredging per month and for the entire year;
    iii. The total daily and cumulative sediment removal totals;
    iv. Total sediment disposed at each location (Open water site, Saltchuk, upland);
    v. Turbidity levels from monitoring and whether state turbidity compliance was met;
    vi. Results from dredging monitoring
    vii. Results from noise monitoring;
    viii. Results from underwater observation associated with dredging in Blair Waterway and material placement at Saltchuk.
    ix. Monitoring reports shall be submitted to: projectreports.wcr@noaa.gov, include **WCRO-2020-00645** in the subject line.

d. The USACE shall monitor and report the abundance and diversity of ESA-listed fish utilizing Saltchuk in years 3, 5, and 10 following complete construction.

e. The USACE shall monitor and report natural recruitment of eelgrass and SAV at Saltchuk in years 3, 5, and 10 following complete construction to determine if the beneficial use of dredged material is as beneficial as presumed in this Opinion.

5. The following terms and conditions implement RPM 5 (Restoration planning and design finalization):
    a. Develop a Restoration Plan to enhance actions taken at the Saltchuk Restoration Site that includes measures to improve nearshore habitat PBFs for PS Chinook salmon and PS/GB bocaccio. The Restoration Plan shall:
        i. Collaboratively engage with NMFS, state, federal, and tribal agencies in finalizing project designs;
        ii. Provide NMFS with finalized project designs within a minimum of 60 days prior to commencing construction.

Submit Reports. All reports shall contain the WCRO Tracking number and be sent by electronic copy to NOAA's reporting system email address at: projectreports.wcr@noaa.gov.

2.9 Conservation Recommendations

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02). The following two conservation recommendations are discretionary measures that NMFS believes are consistent with this obligation and therefore should be carried out by the Corps.

Recommended conservation measures include:

1. Monitor water quality for PCBs, PBDEs, and PAHs at the mouth of the Blair Waterway prior to and during construction to expand understanding of long-term exposure risks to ESA-listed salmonids and SRKW critical habitat and increase recovery potential for ESA-listed salmonids and rockfish by reducing the exposure of toxins.

2.10 Reinitiation of Consultation

This concludes formal consultation for the Corps.

As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the federal agency or by the Service where discretionary federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.11 "Not Likely to Adversely Affect" Determinations

Southern Resident Killer Whales
The Corps determined that the proposed action was not likely to adversely affect SRKW or adversely modify their critical habitat. NMFS concurs with the Corps' determination.

Between the three pods that comprise this DPS, identified as J, K, and L, some members of the DPS may be present in the Puget Sound at any time of the year based on observational data recorded since 1976. More generally, data shows that all three pods are in Puget Sound June through September, which means that all are likely present in Puget Sound during the designated work window. The whales' seasonal movements are only somewhat predictable and exhibit large inter-annual variability in arrival time and days spent in inland waters. In recent years, late arrivals and fewer days spent in inland waters has been common.

While SRKW are sighted in Commencement Bay, they are not known to enter the Port of Tacoma or nearby areas and typically avoid the high-traffic area around Tacoma Harbor. Vessel speed is the greatest predictor of noise levels received by killer whales. Dredges and associated work vessels will be either stationary or traveling slowly for the purpose of surveying the bottom surface, maneuvering the dredge and barge, or transiting the barge to disposal sites. Slow vessel speeds should minimize emitted sound. Based on the short distance of sound attenuation from the dredges and associated work vessels and that very few killer whales would be present, effects of underwater noise from dredging will be short duration, low intensity, minimal, and therefore insignificant. The number and spread of vessels are not expected to result in blocking movements of the whales in their travel corridors. Therefore, it is unlikely that any small transitory disturbance from vessels that might occur would have more than a very minor effect on passage in designated critical habitat. Lastly, given that the proposed action is expected to result in a 27% reduction in vessel activity throughout Puget Sound, and we did not find any information to indicate the larger vessels would result in an increase in ship strikes on SRKW or other marine mammals in the action area, effects from these activities on passage in SRKWs or their critical habitat is likely to be wholly beneficial.

Concentrations of PCBs and other bioavailable contaminants in biota may increase during dredging. The rate of resuspension is estimated at 3% of material with an increased bioavailability for approximately two to three years (AECOM 2012; Patmont et al. 2018). This minor fraction would have a negligible effect to killer whale prey and an undetectable contribution to the whales themselves. Analysis on continued use of the DMMP disposal sites concluded that effects of transport and disposal of dredged material containing biomagnifying substances to killer whales are discountable. A summary of the rationale provided is that the DMMP uses rigorous testing procedures to quantify effects and disposal sites are showing generally similar or lower concentrations of contaminants compared to nearby locations.

The impairment of prey (PS Chinook salmon) from the temporary construction effects of the proposed action is extremely small, due to the application of the work window to avoid peak presence of this species at the juvenile life stage and the other reasons discussed above. Given the total quantity of prey available to SRKWs throughout their range, this short-term reduction in prey that results from the temporary construction effects is extremely small. Because the annual reduction is so small, there is also a low probability that any of the Chinook salmon killed from implementation of the proposed action would be intercepted by the killer whales across their vast range in the absence of the proposed action. Therefore, the NMFS anticipates that any short-term reduction of Chinook salmon during construction would have little effect on Southern Resident killer whales. While water quality will be briefly reduced by turbid conditions and brief chemical contamination with the removal of the creosote pilings, these diminishments will ameliorate shortly after work ceases, and the features will re-establish their baseline level of function. NMFS did not identify enduring effects on SRKW from the proposed action. SRKW prey species, Chinook salmon, will be adversely affected by the proposed action as described above, but the numbers of individual fish affected, and the degree of these effects are unlikely to alter population level abundance of juvenile fish in a manner that will diminish prey availability of returning adult Chinook salmon. All effects on SRKW PBFs are insignificant.

Humpback Whale
The Corps made no determination of effects to humpback whales as a result of the proposed action.

Humpback whales are occasionally sighted in south Puget Sound, but they have never been documented in the Blair Waterway. Humpback whales if present in the vicinity of the project, would not be expected to venture into Commencement Bay. Humpback whales will not be exposed to the short-term water quality effects because they are unlikely to reach the areas where individuals would be found. The chance of a humpback whale being exposed to any effect caused by the dredging or construction in Commencement Bay is discountable. Any impact resulting from reduced vessel traffic would be wholly beneficial to humpback whales. Based on this analysis, NMFS determined that the proposed action is discountable, and not likely to adversely affect listed humpback whales.

Green Sturgeon
The Corps determined that the proposed action was not likely to adversely affect green sturgeon or adversely modify their critical habitat. NMFS concurs with the Corps' determination.

Effects of the action on green sturgeon are unlikely; if green sturgeon are present in the action area of Puget Sound, they rely on deep bottom areas for feeding and rearing, indicating that the effects of the action are unlikely. The only known spawning areas for green sturgeon are in the Rogue, Klamath, Trinity, Sacramento, and Eel rivers in southern Oregon and Northern California. Therefore, their presence in the project area is considered unlikely and therefore any effects of the action is insignificant.

Eulachon
The Corps determined that the proposed action was not likely to adversely affect eulachon. NMFS concurs with the Corps' determination.

Eulachon are endemic to the eastern Pacific Ocean and range from northern California to southwest Alaska and into the southeastern Bering Sea. The southern DPS of Pacific Eulachon includes populations spawning in rivers south of the Nass River in British Columbia to the Mad River in California. Eulachon primarily spawn in the Columbia River system in Washington State. Eulachon runs are typically found in systems with snow pack or glacier-fed freshets, or extensive spring freshets (Hay and McCarter 2000). Eulachon leave saltwater to spawn in their natal streams in late winter through early summer and typically spawn in the lower reaches of larger rivers fed by snowmelt, glacial runoff, or extensive spring freshets (Gustafson 2010). Spawning begins as early as December and January in the Columbia River system, peaks in February, and can continue through May. Larval outmigration occurs 30 to 40 days after spawning. After hatching, larvae are carried downstream and are widely dispersed by estuarine and ocean currents. Eulachon movements in the ocean are poorly understood. Eulachon are far less common in south Puget Sound drainages and are not considered to be established in the Puget Sound rivers (NMFS 2010). Eulachon may rarely enter the Puget Sound in large schools, but this has seldom been documented; the last such documented large school of Eulachon in the Puget Sound was in 1983 (NMFS 2010). Based on the low likelihood of Eulachon existing in Commencement Bay and Puget Sound we find the effects of the action on species to be unlikely, and therefore insignificant.

3 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)]

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific Coast groundfish (Pacific Fishery Management Council [PFMC] 2005), coastal pelagic species (CPS) (PFMC 1998), and Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The entire action area fully overlaps with identified EFH for Pacific Coast salmon, Pacific Coast groundfish, and coastal pelagic species. Designated EFH for groundfish and coastal pelagic species encompasses all waters along the coasts of Washington, Oregon, and California that are seaward from the mean high water line, including upriver extent of saltwater intrusion in river mouths to the boundary of the U.S economic zone, approximately 230 (370.4 km) offshore (PFMC 1998 a,b). Designated EFH for salmonids species within marine water extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone offshore of Washington, Oregon, and California, north of Point Conception to the Canadian border (PFMC 1999). Groundfish, coastal pelagic, and salmonid fish species that could have designated EFH in the action area are listed in tables 12, 13, and 14.

Additionally, Puget Sound is a Habitat Area of Particular Concern (HAPC), based on importance of the ecological function provided by the habitat. The environmental effects of the proposed project may adversely affect EFH for Pacific groundfish, coastal pelagic species, and Pacific coast salmon in the HAPC for these species.

Table 12. EFH Pacific coast groundfish species likely occupying the action area.

Common Name	Scientific Name	Common Name	Scientific Name
Arrowtooth flounder	*Atheresthes stomias*	Pacific Ocean perch	*Sebastes alutus*
Big skate	*Raja binoculata*	Pacific sanddab	*Ctlharichthys sordidus*
Black rockfish	*Sebastes melanops*	Petrale sole	*Eopsetta jordani*
Bocaccio	*Sebastes Paucispinis*	Quillback rockfish	*Sebastes maliger*
Brown rockfish	*Sebastes auriculatus*	Ratfish	*Hydrolagus colliei*
Butter sole	*Isopsetta isolepis*	Redbanded rockfish	*Sebastes proriger*
Cabezon	*Scorpaenichthys marmoratus*	Rex sole	*Glyptocephalus zachirus*
California Skate	*Raja inomata*	Rock sole	*Lepidopsetta bilineata*
Canary rockfish	*Sebastes pinniger*	Rosethorn rockfish	*Sebastes helvomaculatus*
China rockfish	*Sebastes nebulosus*	Rosy rockfish	*Sebastes rosaceus*
Copper rockfish	*Sebastes caurinus*	Rougheye rockfish	*Sebastes aleutianus*
Curlfin sole	*Pleuronichthys decurrens*	Sablefish	*Anoplopoma fimbria*
Darkblotch rockfish	*Sebastes crameri*	Sand sole	*Psettichthys melanistictus*
Dover sole	*Microstomus pacificus*	Sharpchin rockfish	*Sebastes zacentrus*
English sole	*Parophrys vetulus*	Shorts pine thornyhead	*Sebastolobus alascanus*
Flathead sole	*Hippoglossoides elassodon*	Spiny dogfish	*Squalus acanthias*
Greenstriped rockfish	*Sebastes elongatus*	Splitnose rockfish	*Sebastes diploproa*
Hake	*Merluccuys productus*	Starry flounder	*Platichthys stellatus*
Kelp greenling	*Hexagrammos decagrammus*	Tiger rockfish	*Sebastes nigrocinctus*
Lingcod	*Ophiodon elongatus*	Vermilion rockfish	*Sebastes miniatus*
Longnose skate	*Raja rhina*	Yelloweye rockfish	*Sebastes ruberrimus*
Pacific cod	*Gadus macrocephalus*	Yellowtail rockfish	*Sebastes llavidus*

Table 13. EFH coastal pelagic species likely occupying the action area.

Common Name	Scientific Name
Market Squid	*Latigo opalescens*
Norther Anchovy	*Engraulis mordax*
Jack Mackerel	*Trachurus symmetricus*
Pacific Mackerel	*Scomber japonicas*
Pacific Sardine	*Sardinops sagax*

Table 14. EFH Pacific salmon species occupying the action area.

Common Name	Scientific Name
Chinook Salmon	*Oncorhynchus tshawytscha*
Coho Salmon	*Oncorhynchus kisutch*
Pink Salmon	*Oncorhynchus gorbuscha*

3.2 Adverse Effects on Essential Fish Habitat

The proposed action will temporarily diminish water quality, disturb benthic habitat and bottom sediments, and re-suspend contaminated sediments contemporaneously with pulses of turbidity.

While the action increases the overall depth of the Blair Waterway by 6 feet it does not change the functional characteristics of the habitat conditions within the waterway. The disturbance is expected to short lived and benefit species at the Saltchuk disposal site over the long-term.

3.3 Essential Fish Habitat Conservation Recommendations

NMFS determined that the following conservation recommendations are necessary to avoid, minimize, mitigate, or otherwise offset the impact of the proposed action on EFH:

1. Require vessel operators to operate at the lowest safe maneuvering speeds and power settings when maneuvering in waters close to the shoreline;
2. Allow no overflow from the barge or hopper;
3. When using a mechanical dredge increase cycle time and reduce bucket deployment;
4. Always use equipment that generates the least amount of sedimentation, siltation, and turbidity;
5. When using a clamshell bucket, dredge in complete passes;
6. Sample and monitor noise levels in real-time during dredging activities. If noise levels surpass accepted thresholds for aquatic organisms implement alternative methodology to reduce noise;
7. Incentivize development of peer-reviewed studies that identify how noise generated from dredging impacts aquatic organisms and EFH; and
8. Restore eelgrass and nearshore habitat along the Northwest shoreline and throughout Commencement Bay nearshore areas.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in Section 3.2, above, for Pacific coast salmon, Pacific coast groundfish, and coastal pelagic species.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Corps must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the federal agency have agreed to use alternative time frames for the federal agency response. The response must include a description of the measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this Opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this Opinion are the Corps. Individual copies of this Opinion were provided to the Corps. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this Opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, if applicable, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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United States Department of the Interior
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In Reply Refer To:
2022-0002215
xRef: 01EWFW00-2020-I-0829

Laura Boerner
Planning, Environmental, and Cultural Resources Branch
U.S. Army Corps of Engineers, Seattle District
4735 E. Marginal Way South, Building 1202
Seattle, Washington 98134-2388

Dear Ms. Boerner:

Subject: Tacoma Harbor Federal Navigation Channel Improvement Project

This letter is in response to your March 20, 2020, request for our concurrence with your determination, that the proposed action located in the Port of Tacoma/ Tacoma Harbor (Port), Pierce County, Washington, "may affect, but is not likely to adversely affect" listed species and designated critical habitat under the jurisdiction of the U.S. Fish and Wildlife Service (Service). We received your letter, Biological Assessment, and other materials, providing information in support of "may affect, not likely to adversely affect" determinations, on March 20, 2020. These materials included a Preliminary Design and Model Justification for the Saltchuk Beneficial Use Site (Saltchuk Site), a Draft Water Quality Monitoring and Protection Plan, and a Dredged Material Management Program (DMMP) Suitability Memo. Additional information was requested and received by the Service, in correspondence and in meetings, from May, June, and December 2020, June and December 2021, and January 2022. This consultation was completed in accordance with section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (ESA).

The U.S. Army Corps of Engineers – Seattle District (Corps) requested informal consultation, pursuant to section 7(a)(2) of the ESA, for the listed species and designated critical habitat identified below:

- Bull trout (*Salvelinus confluentus*)
- Designated bull trout critical habitat
- Marbled murrelet (*Brachyramphus marmoratus*)

The Corps has determined that the action will have "no effect" on additional listed species and designated critical habitat that are known to occur in Pierce County. The determination of "no effect" to listed resources rests with the federal action agency. The Service has no regulatory or statutory authority for concurring with "no effect" determinations, and no consultation with the Service is required. We recommend that the Corps document their analyses and maintain that documentation as part of their files.

The Corps and Port propose to implement alternatives identified by a General Investigations Study and Integrated Feasibility Report and Environmental Assessment, consisting of deep draft improvements to the federal navigation system in Tacoma Harbor, Washington. The Corps and Port propose to dredge and deepen the Blair Waterway federal navigation channel (channel) and berths, from a current maximum depth of approximately -51 mean lower low water (MLLW), to new maximum depth of approximately -57 MLLW. The proposed action will also widen the existing channel, from current widths ranging from approximately 330 to 1,682 ft, to proposed widths ranging from approximately 450 ft to 1,935 ft, at specific locations (Table 1; Figure 1); expand and increase the depth of the existing channel turning basin boundary, from a diameter of approximately 1,682 ft, to a diameter of approximately 1,935 ft (Table 1; Figure 1), and a new maximum depth of -57 MLLW; establish and maintain recommended channel side-slopes at ratios of 2:1 (2H:1V); and, dispose and beneficially reuse approximately 2.8 million cubic yards (CY) of dredged material. According to the Corps, the proposed deep draft improvements will eliminate transit delays due to tidal changes, and allow larger, fully-loaded ships to more efficiently and cost effectively visit the Port. According to the Corps, 'light loading', tidal restrictions, and other operational inefficiencies created by inadequate channel depths currently limit the Port's ability to accommodate vessel shipping loads.

Table 1. Current, Federally Authorized and Proposed Widths by Channel Station (STA).

Station Along Channel	Authorized Width (feet)	Proposed Width (feet)
STA -5 to STA 0	-	865
STA 0 to STA 12	520	800
STA 12 to STA 44	520, 343	520
STA 44 to STA 52	520	520
STA 52 to STA 79	520, 330	520
STA 79 to STA 100	330	450
STA 100 to STA 116	330	525
STA 116 to STA 140	1,682	1,935

Dredging operations will produce approximately 2.8 million CY of material, and the Corps identifies approximately 2.4 million CY as suitable for open-water disposal or beneficial reuse. The Corps and Port propose to place approximately 1.8 million CY for beneficial reuse at the Saltchuk Site in Commencement Bay (located north and east of the Hylebos Waterway), a former nearshore log storage site where beneficial reuse of dredged material is proposed as a means to enhance habitat for salmonids (Port of Tacoma 2015; FWS Consultation # 2015-I-

0685). The existing DMMP Commencement Bay open-water disposal site would receive the remaining suitable dredged material, approximately 0.6 million CY (FWS Consultation # 2015-I-0724). All dredged material that is determined to be unsuitable for open-water disposal and beneficial reuse, will be transported to an approved upland disposal site (approximately 0.4 million CY). Dredging of the channel, and placement and disposal of dredged material, will require 24-hour operations, seasonally over the course of four years. The established and proposed in-water work windows are: August 16 – February 15 (DMMP Commencement Bay Site); July 16 – February 15 (All Other Dredging and Beneficial Reuse Activities).

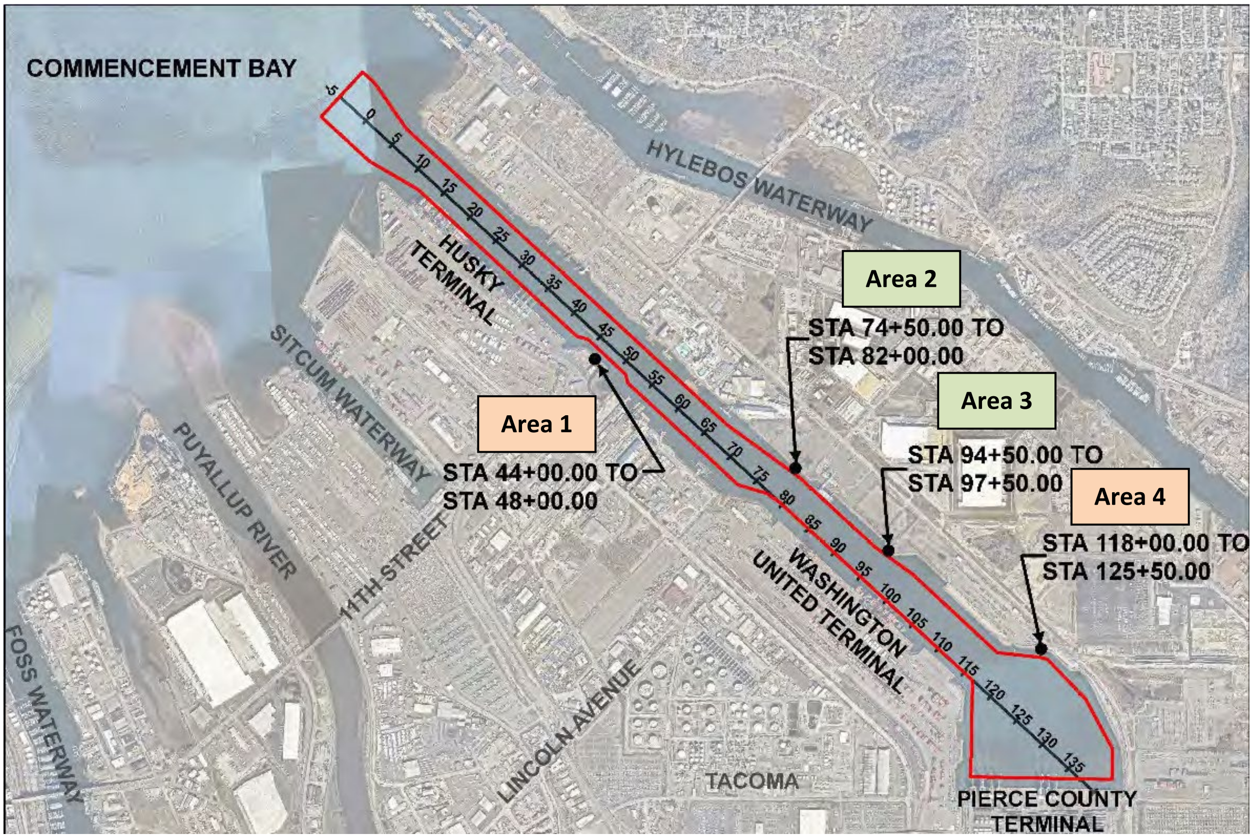

Figure 1. Side Slope Stabilization Areas by Channel Station (STA).

The proposed action will establish and maintain recommended channel side-slopes at ratios of 2:1 (2H:1V). The Corps and Port expect and propose to implement engineered slope stabilization and strengthening (armored slope rock toe and/or secant pile wall), at four locations (Figure 1; Areas 1, 2, 3, and 4), along approximately eight percent of the channel (i.e., measured by channel length). For Areas 1 and 4, the proposed action would include approximately 1,150 linear ft of armored slope rock toe (400 ft and 750 ft, respectively); for Areas 2 and 3, the proposed action would include approximately 1,050 linear ft of secant pile wall (750 ft and 300 ft, respectively). The proposed slope stabilization and strengthening would augment existing engineered channel side-slopes, to protect and maintain existing water-dependent uses and properties, including property or properties owned and administered by the Puyallup Tribe of Indians (Area 2).

Methods of construction and required equipment include but are not limited to the following: conventional and environmental clam shell buckets, excavators, and dredging equipment, operating from fixed locations and barges; tugs, skiffs, and workboats; bottom-dump barges; drill rigs and/ or augers; and vibratory pile driving equipment. All open-water disposal and beneficial reuse of dredged material will comply with a current, valid Site Use Authorization(s) approved by the DMMP.

The Corps has provided sufficient information, to determine the effects of the proposed action and to conclude whether the proposed action would adversely affect federally listed species and/or designated critical habitat. Our concurrence is based on information provided by the federal action agency, best available science, and complete and successful implementation of the conservation measures included by the federal action agency.

Status of the Species – Bull Trout and Designated Bull Trout Critical Habitat

The closest population of bull trout is in the Puyallup River, which enters Commencement Bay through the Puyallup Waterway. Anadromous and fluvial bull trout use the lower reaches of the Puyallup, Carbon, and White Rivers for foraging, migration, and overwintering, and anadromous bull trout seasonally use Commencement Bay and nearshore marine waters of Puget Sound for foraging and migration. Use of the nearshore marine waters is highest in the spring, and bull trout have been documented in Commencement Bay during the months of April, May, and June. A number of studies have investigated seasonal distribution of bull trout and utilization of nearshore marine habitats in the Puget Sound. These studies document far-ranging patterns of bull trout movement, and opportunistic feeding where prey is abundant and concentrated.

Low numbers of native char have been documented during sampling efforts conducted by the Puyallup Tribe of Indians and others (Ratte and Salo 1985). Three bull trout were captured in beach seines, between the Hylebos Waterway and Brown’s Point, during a 16-year study from 1980 through 1995; beach seining was conducted between February and August, and one bull trout was caught in each of three years. In 2006, a bull trout was radio tracked leaving the Puyallup River on June 28, migrated to Brown’s Point on July 2, and was back in the Puyallup River on July 7. Numerous sampling efforts also show that juvenile Chinook salmon (*Oncorhynchus tshawytscha*), a prey species for bull trout, use the Blair Waterway in relatively low numbers (Duker et al. 1989). These and other studies or sampling efforts indicate that bull trout do utilize Commencement Bay, and are highly migratory during their time in nearshore marine waters. Based on the geographic location and baseline environmental conditions, we expect that bull trout use Commencement Bay in low numbers.

The urban and industrial waterfronts in Tacoma, inclusive of the action area, are highly altered. Vertical seawalls, bulkheads, angular bank armor, and large overwater structures extend along the entire length of the waterfronts. Sediment and water quality are degraded and natural forms of habitat complexity are almost completely absent. All of the baseline environmental conditions are either at risk or not properly functioning.

The final revised rule designating bull trout critical habitat (75 FR 63898 [October 18, 2010]) identifies nine Primary Constituent Elements (PCEs) essential for the conservation of the species. The 2010 designation uses the term PCE. The new critical habitat regulations (81 FR 7214) replace this term with physical or biological features (PBFs). This shift in terminology does not change the approach used in conducting our analyses, whether the original designation identified PCEs, PBFs, or essential features. In this letter, the term PCE is synonymous with PBF or essential features of critical habitat.

In marine nearshore areas, the inshore extent of designated bull trout critical habitat is the mean higher high-water line; designated critical habitat extends offshore to depths of -10 meters (-33 ft) MLLW (75 FR 63935 [October 18, 2010]). Marine nearshore areas contain only a subset of the identified PCEs for bull trout (PCEs 2, 3, 4, and 8) (75 FR 63932 [October 18, 2010]):

> (***PCE #2***) Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.
>
> (***PCE #3***) An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.
>
> (***PCE #4***) Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.
>
> (***PCE #8***) Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

Within the action area, baseline environmental conditions include dredged and artificially over-deepened marine waters (in excess of -33 ft MLLW), vertical seawalls, bulkheads, angular bank armor, and large overwater structures along the entire length of the Blair Waterway. Sediment and water quality are degraded and natural forms of habitat complexity are almost completely absent. All of the baseline environmental conditions and current PCE functions are severely degraded.

Status of the Species – Marbled Murrelet

Marbled murrelets forage in the nearshore marine waters of Puget Sound and have been documented off Brown's Point. Based on survey data, marbled murrelet densities in southern Puget Sound are lower than in northern Puget Sound, the Straits, and the outer Washington coast. Although marbled murrelets are periodically documented along the waterfronts of Commencement Bay, there are few or no records of marbled murrelets foraging in the industrial waterways.

The urban and industrial waterfronts in Tacoma, inclusive of the action area, are highly altered. Vertical seawalls, bulkheads, angular bank armor, and large overwater structures extend along the entire length of the waterfronts. Sediment and water quality are degraded and natural forms of habitat complexity are almost completely absent. All of the baseline environmental conditions are either at risk or not properly functioning. Foraging opportunities for marbled murrelets are extremely poor within and along the entire Blair Waterway, and we expect that marbled murrelets use the action area infrequently and in very low numbers.

Temporary Exposures and Effects to Bull Trout

Construction of the proposed deep draft improvements will be completed during a time of year (July 16 to February 15) when few, if any, bull trout are present in the action area. Typically, anadromous bull trout return to their natal waters to spawn and overwinter during these months. During these same months, there are no seasonally abundant prey resources that are likely to attract bull trout to the action area.

Construction will result in temporary impacts to water quality, including temporary increases in turbidity and water column contaminant concentrations. We assume, with effective implementation of the Water Quality Monitoring and Protection Plan, and with adherence to DMMP requirements, these effects to water quality will be intermittent, limited in physical extent, duration, and intensity, and will not cause or contribute to any measurable increase to the extent of existing sediment contamination. The proposed action will permanently remove approximately 0.4 million CY of contaminated sediment and other sources of degraded water quality (e.g., creosote treated wood and wood structures).

Temporary exposures resulting in injury or mortality are extremely unlikely and therefore considered discountable. Sound levels sufficient to disrupt normal behaviors (i.e., the ability to successfully feed, move, and/or shelter) will be intermittent and limited in duration, will be laterally constrained by existing landforms, and will not extend to the higher functioning habitats in close proximity (including the mouth of the Puyallup River). The Service concludes that the foreseeable temporary exposures and effects are unlikely to elicit anything more than a mild behavioral response. The effects of the action, temporary and permanent, will not prevent bull trout from successfully foraging and migrating in the action area, and are considered insignificant.

Effects to the PCEs of Designated Bull Trout Critical Habitat, Habitat and Prey

With full and successful implementation of the conservation measures included as part of the proposed action, we expect that the foreseeable effects of the action will not measurably degrade or diminish habitat functions or prey resources in the action area. Therefore, the foreseeable effects of the action are considered insignificant.

Construction of the proposed deep draft improvements, inclusive of the proposed permanent features (i.e., a widened and deepened channel, engineered slope stabilization and strengthening), will result in impacts to habitat that supports bull trout and their prey. However, these impacts will be limited in physical extent and will not measurably degrade habitat functions, including prey production and availability.

The proposed action will not cause or contribute to any measurable increase to the current extent of existing sediment contamination. Instead, the proposed action will permanently remove approximately 0.4 million CY of contaminated sediment and other sources of degraded water quality (e.g., creosote treated wood and wood structures).

The placement and beneficial reuse of approximately 1.8 million CY of clean dredged material at the Saltchuk Site in Commencement Bay, will provide and enhance approximately 50 acres of shallow subtidal and intertidal nearshore marine habitat. Current depths (-55 to -5 MLLW), will be raised to -20 MLLW (approximately 36 acres), to -10 MLLW (approximately 12 acres), and to -5 MLLW (approximately 3 acres). The proposed action will thereby provide measurable benefits to bull trout and their prey.

(***PCE #2***) Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

- The Blair Waterway retains and provides little or no existing function as migration habitat. Baseline environmental conditions include dredged and artificially over-deepened marine waters (in excess of -33 ft MLLW), vertical seawalls, bulkheads, angular bank armor, and large overwater structures along its entire length. The Blair Waterway exists today as a 'dead-end' channel, and does not connect in a functional way to the Puyallup Waterway, Puyallup River, or to adjacent higher-functioning nearshore marine waters (e.g., north and east of the Hylebos Waterway).

- The proposed action will present a temporarily impediment or barrier within migration habitat; i.e., temporary impacts to water quality, including impacts that may elicit mild behavioral responses (e.g., avoidance). However, the proposed action will not preclude bull trout movement through the action area, either during or after construction, and any measurable effects will be temporary. Migration habitat will not be permanently altered, destroyed, or degraded.

- Foreseeable effects to the current function of this PCE are therefore considered insignificant.

(***PCE #3***) An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

- The Blair Waterway does not support significant bull trout prey resources. The Blair Waterway exists today as a 'dead-end' channel, and does not connect in a functional way to the Puyallup Waterway, Puyallup River, or to adjacent higher-functioning nearshore marine waters (e.g., north and east of the Hylebos Waterway). Limited potential spawning habitats for marine forage fish are present, but outside the dredge prism and will not be affected. Use of the action area by juvenile salmonids is limited, and construction of the proposed deep draft improvements includes specific measures to avoid and minimize impacts to these prey resources.

- Placement and beneficial reuse of clean dredged material at the Saltchuk Site will provide and enhance approximately 50 acres of shallow subtidal and intertidal nearshore marine habitat. Current depths will be raised to -20 MLLW and shallower. The proposed action will thereby provide measurable benefits to bull trout and their prey.

- Foreseeable effects to the current function of this PCE are therefore considered insignificant.

(***PCE #4***) Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.

- Natural forms of habitat complexity are almost completely absent from the Blair Waterway. Baseline environmental conditions include dredged and artificially over-deepened marine waters (in excess of -33 ft MLLW), vertical seawalls, bulkheads, angular bank armor, and large overwater structures along its entire length. Sediment and water quality are degraded, and the Blair Waterway exists today as a 'dead-end' channel.

- The Blair Waterway was previously approved for the removal of 2.1 million CY of dredged material, to achieve the current depth of -51 ft MLLW (Corps 2001). Since 2008, six maintenance dredging actions have been approved for the Blair Waterway (FWS Consultation #s 2008-I-0607, 2009-I-0160, 2009-I-0285, 2011-I-0390, 2015-I-0365, and 2016-I-0060). Since 2008, six actions installing, maintaining, or repairing bank armor have been approved for the Blair Waterway (FWS Consultation #s 2008-I-0587, 2009-I-0285, 2011-I-0078, 2011-I-0294, 2012-I-0272, and 2013-I-0449). In summary, these actions have continued to maintain the Blair Waterway's degraded state.

- Features and indicators corresponding to PCE #4 are almost completely absent (Table 2). The proposed action will affect no significant change to the features and indicators of complex marine shoreline habitat or habitat forming processes (Table 2).

Table 2. Features and Indicators Corresponding to PCE #4; Baseline and Expected Conditions.

Feature / Indicator	Baseline Condition	Expected Condition	Net Change
Large Wood	Not present	Not present	No change
Side Channels	Not present	Not present	No change
Pools	Not present	Not present	No change
Undercut Banks	Not present	Not present	No change
Unembedded Substrates	Not present	Not present	No change
Variety of:			
Depths	Minimal	Minimal	No change
Gradients	Minimal	Minimal	No change
Velocities	Minimal	Minimal	No change
Complex Structure	Minimal	Minimal	No change

- Placement and beneficial reuse of clean dredged material at the Saltchuk Site will provide and enhance approximately 50 acres of shallow subtidal and intertidal nearshore marine habitat. Current depths will be raised to -20 MLLW and shallower. The proposed action will thereby provide measurable benefits to bull trout and their prey.

- Foreseeable effects to the current function of this PCE are therefore considered insignificant.

(***PCE #8***) Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

- Construction will result in temporary impacts to water quality, including temporary increases in turbidity and water column contaminant concentrations. We assume, with effective implementation of the Water Quality Monitoring and Protection Plan, and with adherence to DMMP requirements, these effects to water quality will be intermittent, limited in physical extent, duration, and intensity, and will not cause or contribute to any measurable increase to the extent of existing sediment contamination. The proposed action will permanently remove approximately 0.4 million CY of contaminated sediment and other sources of degraded water quality (e.g., creosote treated wood and wood structures).

- Foreseeable effects to the current function of this PCE are therefore considered insignificant.

Exposures and Effects to Marbled Murrelet

Construction will result in temporary impacts to water quality, including temporary increases in turbidity and water column contaminant concentrations. These effects to water quality will be intermittent, limited in physical extent, duration, and intensity, and will not cause or contribute to any measurable increase to the extent of existing sediment contamination. The proposed action will permanently remove approximately 0.4 million CY of contaminated sediment and other sources of degraded water quality (e.g., creosote treated wood and wood structures).

Placement and beneficial reuse of clean dredged material at the Saltchuk Site will provide and enhance approximately 50 acres of shallow subtidal and intertidal nearshore marine habitat. Current depths will be raised to -20 MLLW and shallower. The proposed action will thereby provide measurable benefits to marbled murrelet prey.

Temporary exposures resulting in injury or mortality are extremely unlikely and therefore considered discountable. Sound levels sufficient to disrupt normal behaviors (i.e., the ability to successfully feed, move, and/or shelter) will be intermittent and limited in duration, will be laterally constrained by existing landforms, and will not extend to the higher functioning habitats in close proximity. The Service concludes that the foreseeable temporary exposures and effects are unlikely to elicit anything more than a mild behavioral response. The effects of the action, temporary and permanent, will not prevent marbled murrelets from successfully foraging and loafing in the action area, and are considered insignificant.

Conclusion

This concludes consultation pursuant to the regulations implementing the ESA (50 CFR 402.13). Our review and concurrence with your effect determinations is based on implementation of the project as described. It is the responsibility of the federal action agency to ensure that the projects they authorize or carry out are in compliance with the regulatory permit and ESA. If a permittee or the federal action agency deviates from the measures outlined in a permit or project description, the federal action agency has the obligation to reinitiate consultation and comply with section 7(d).

This project should be re-analyzed and re-initiation may be necessary if 1) new information reveals effects of the action that may affect listed species or critical habitat in a manner, or to an extent, not considered in this consultation, 2) if the action is subsequently modified in a manner that causes an effect to a listed species or critical habitat that was not considered in this consultation, and/or 3) a new species is listed or critical habitat is designated that may be affected by this project.

This letter constitutes a complete response by the Service to your request for informal consultation. A record of this consultation is on file at the Washington Fish and Wildlife Office, in Lacey, Washington. If you have any questions about this letter or our shared responsibilities under the ESA, please contact Ryan McReynolds (ryan_mcreynolds@fws.gov) or Assistant Field Supervisor Curtis Tanner (curtis_tanner@fws.gov).

Sincerely,

for Brad Thompson, State Supervisor
Washington Fish and Wildlife Office

cc:
Corps, Seattle, WA (K. Whitlock)
Corps, Seattle, WA (F. Goetz)

Literature Cited

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DEPARTMENT OF THE ARMY
U.S ARMY CORPS OF ENGINEERS, SEATTLE DISTRICT
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March 15, 2022

Planning, Environmental and Cultural Resources Branch

Kim W. Kratz
Assistant Regional Administrator
Oregon Washington Coastal Office
National Marine Fisheries Service
1201 Northeast Lloyd Boulevard, Suite 1100
Portland, Oregon 97232

Dear Mr. Kratz:

This letter responds to the February 16, 2022, Essential Fish Habitat (EFH) Conservation Recommendations accompanying the National Marine Fisheries Service (NMFS) Biological Opinion (BiOp) on the effects of the U.S. Army Corps of Engineers' (Corps) Proposed Tacoma Harbor Navigation Improvement Project in the Blair Waterway of Tacoma Harbor, Pierce County, Washington (HUC 171100190204; WCRO-2020-00645). That document was in response to the Corps' Biological Assessment, same subject, submitted in March 2020 pursuant to Section 7 of the Endangered Species Act, as amended.

The Corps is providing a detailed response to NMFS' EFH conservation recommendations within 30 days of their receipt, as provided in 50 CFR 600.920(k)(1). The conservation recommendations from NMFS are stated below, followed by an explanatory response to each. Section 3 of the BiOp contains eight EFH conservation recommendations. In response to your request to identify the number of conservation recommendations accepted, the Corps accepts recommendations one through five (a-e) in full, number six (f) in part, and numbers seven and eight (g-h) in full as allowed under existing Corps programs and authorities. Our detailed responses indicate the acceptance status of each recommendation.

EFH Conservation Recommendations:

a. Require vessel operators to operate at the lowest safe maneuvering speeds and power settings when maneuvering in waters close to the shoreline.
b. Allow no overflow from the barge or hopper.
c. When using a mechanical dredge increase cycle time and reduce bucket deployment.

d. Always use equipment that generates the least amount of sedimentation, siltation, and turbidity.
e. When using a clamshell bucket, dredge in complete passes.

   EFH Recommendations (a) - (e) Response: Accepted. These recommendations are generally standard practices within the Corps' dredging protocols and described in the specifications of dredging contracts. The Corps will include these recommendations in the applicable dredging contract(s).

f. Sample and monitor noise levels in real-time during dredging activities. If noise levels surpass accepted thresholds for aquatic organisms implement alternative methodology to reduce noise.

   EFH Recommendation (f) Response: Accepted as follows. Underwater noise will be monitored as described in Term and Condition 2 of the BiOp. Alternative methodologies to reduce noise during mechanical (clamshell) dredging are not feasible; however, mechanical dredging generates less noise than hydraulic dredging. Available measures to minimize noise will already be implemented, such as using a clamshell bucket and recommendations listed above under a and c.

g. Incentivize development of peer-reviewed studies that identify how noise generated from dredging impacts aquatic organisms and EFH.

   EFH Recommendation (g) Response: Accepted. Studies of dredging effects, including those from noise, are performed by the Corps' Engineer Research and Development Center (ERDC) under the Dredging Operations and Environmental Research Program (DOER; https://doer.el.erdc.dren.mil). DOER supports the Corps' Operation and Maintenance Navigation Program. Research is designed to balance operational and environmental initiatives and to meet complex economic, engineering, and environmental challenges of dredging and disposal in support of the navigation mission. Research will continue under these and other applicable Corps programs and authorities. Results are disseminated to Corps technical staff through webinars, newsletters, and the online ERDC library, which is also available to the public at the link above. A portion of DOER and ERDC research result in peer-reviewed journal publications (https://erdc-library.erdc.dren.mil/jspui/). Navigation programs receive research information from technical staff, engineering regulations, and the annual Corps national dredging meeting, as appropriate.

h. Restore eelgrass and nearshore habitat along the Northwest shoreline and throughout Commencement Bay nearshore areas.

   EFH Recommendation (h) Response: Accepted. This project does not have an ecosystem restoration component, but the Corps has included beneficial use of dredged material at Saltchuk in the Recommended Plan that, once constructed, would be expected to improve nearshore habitat conditions along the northwest shoreline of Commencement Bay. Planting eelgrass is not part of dredged material placement at Saltchuk. However, the project will raise substrate to elevations suitable for potential eelgrass colonization (+5 to -10 feet mean lower low water). In addition, this may encourage others to further pursue habitat restoration actions in and near Saltchuk. The Port of Tacoma (Port), for instance, has expressed plans to perform habitat restoration adjacent to Saltchuk. Port actions are still being developed, but initial designs include tidal marsh benches, removal of shoreline structures, and riparian habitat improvements.

Thank you for your attention to this matter. If you have any questions or need additional information, please contact Ms. Katie Whitlock at 206-764-3576 or Kaitlin.E.Whitlock@usace.army.mil.

Sincerely,

Laura A. Boerner, LG, LHG
Chief, Planning, Environmental & Cultural Resources Branch