

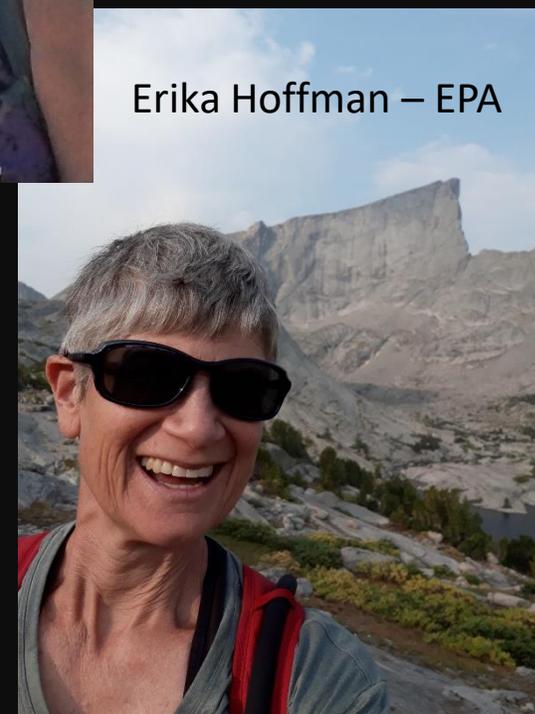
Development of Updated Monitoring Framework *and* Port Gardner Monitoring Pilot Study

Sediment Management Annual Review Meeting
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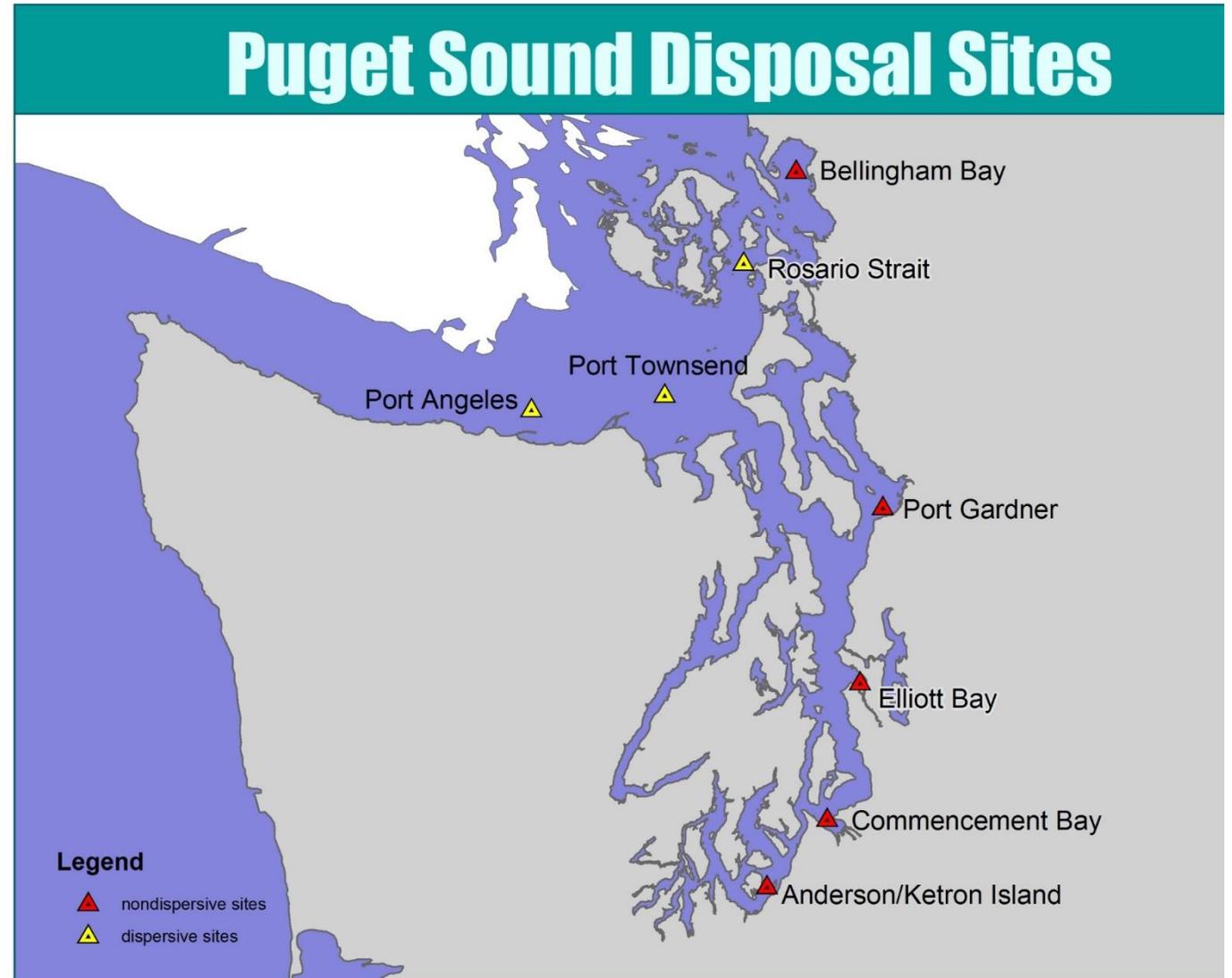


Disposal Site Monitoring Framework...

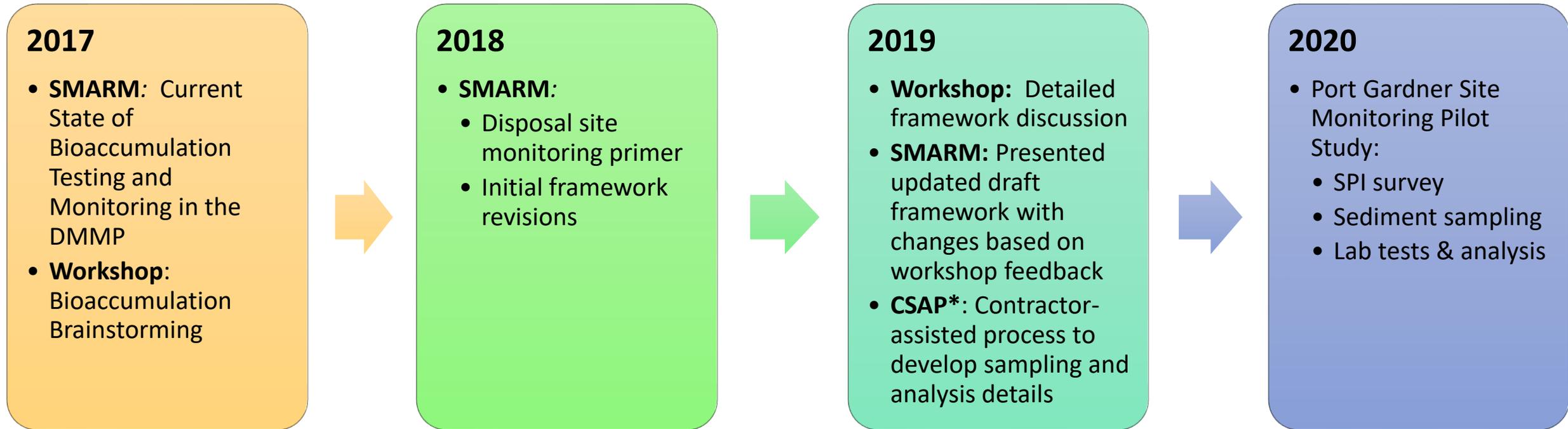
...is changing
because we've
learned a lot from
the first 30 years of
DMMP and because
science keeps
teaching us more

DMMP Monitors Non-Dispersive Disposal Sites

- The DMMP manages five NON-DISPERSIVE disposal sites in Puget Sound.
- DISPERSIVE sites are subject only to occasional bathymetric surveys to confirm that material is not accumulating.



DMMP has been developing a new approach to site monitoring for the last 4 years:



- Original plan described in 1988/89: *PSDDA Management Plan Technical Appendix*
- Last major update was 2007: *Updated Environmental Monitoring Plan*
- Minor tweaks along the way as part of SMARM process (e.g. volume triggers; target coordinates; debris management)

*CSAP = Conceptual Sampling and Analysis Plan

Original PSDDA Monitoring Framework

Question	Hypothesis	Monitored Variable	Interpretive Guideline	Action Item (When exceedances noted) ¹
1. Does the deposited dredged material stay on site?	1. Dredged material remains within the site boundary	Sediment Vertical Profiling System (SVPS) Onsite and Offsite	Dredged material layer is greater than 3 cm at the perimeter stations.	Further assessment is required to determine full extent of dredged material deposit.
	2. Chemical concentrations do not measurably increase over time due to dredged material disposal at offsite stations.	Sediment Chemistry Offsite	Washington State Sediment Quality Standards and Temporal analysis	Post-disposal benchmark station chemistry is analyzed and compared with appropriate baseline benchmark station data.
2. Are the biological effects conditions for site management [PSDDA-defined Site Condition II] exceeded at the site due to dredged material disposal? (PSDDA 1988b)	3. Sediment chemical concentrations at the onsite monitoring stations do not exceed the chemical concentrations associated with PSDDA Site Condition II guidelines due to dredged material disposal.	Sediment Chemistry Onsite	Onsite chemical concentrations are compared to DMMP maximum levels.	PSDDA agencies may seek adjustments of disposal guidelines <u>and</u> compare post-disposal benchmark chemistry with appropriate baseline benchmark station data.
	4. Sediment toxicity at the onsite stations does not exceed the PSDDA Site Condition II biological response guidelines due to dredged material disposal.	Sediment Bioassays Onsite	DMMP Bioassay Guidelines (Section 401 Water Quality Certification)	Benchmark station bioassays are performed (if archived after monitoring) and compared with baseline benchmark bioassay data.
3. Are unacceptable adverse effects due to dredged material disposal occurring to biological resources off site?	5. No significant increase due to dredged material disposal has occurred in the chemical body burden of benthic infauna species collected down current of the disposal site.	Tissue Chemistry Transect	Guideline values Metals: 3x the baseline concentrations Organics: 5x the baseline concentrations	Compare post-disposal benchmark tissue chemistry with baseline benchmark tissue chemistry data.
	6. No significant decrease due to dredged material disposal has occurred in the abundance of dominant benthic infaunal species collected down current of the disposal site.	Infaunal Community Structure Transect	Guideline values Abundance of major taxa < ½ baseline macrobenthic infauna abundances.	Compare post-disposal benchmark benthic data with baseline benchmark data.

- 3 Questions
- 6 hypotheses
- On-site evaluation: emphasis on benthic toxicity (3 samples)
- Off-site evaluation: emphasis on benthic community structure/tissue analysis

Draft Framework as shown at SMARM 2019

DMMP Proposed Monitoring Framework

DRAFT

2/20/2019

	Question	Hypothesis	Monitored Variable		Interpretive Guideline	Verification/Management	
On Site	1. Does the deposited dredged material stay on site?	A. Dredged material remains within the site boundary	SPI Data Analysis <ul style="list-style-type: none"> Depth and extent of deposited dredged material On and off-site 		If >3 cm thickness of recent DM beyond any perimeter station, Hyp A is rejected.	<ul style="list-style-type: none"> Further evaluation of any offsite material (go to Q4) Consider changes to disposal management practices 	
	2. Are the biological effects conditions for site management [PSDDA-defined Site Condition II] exceeded at the site due to dredged material disposal? (PSDDA 1988b)	B. Sediment toxicity at onsite stations does not exceed the PSDDA Site Condition II biological response guidelines due to dredged material disposal.	Sediment Chemistry <ul style="list-style-type: none"> # samples TBD (> 3) Samples from top 10 cm of recent DM 	Sediment Bioassays <ul style="list-style-type: none"> Run on all samples w/ any COC > SL 	Compare Data to DMMP Guidelines <ol style="list-style-type: none"> If any COC > SL; go to Tier 2 If Bioassay toxicity test 1-hit response or two 2-hit responses, then Hyp B is rejected. 	<ul style="list-style-type: none"> Further evaluation to compare on-site toxicity with off-site toxicity (i.e. failure due to area-wide conditions?) Consider outcome of Q3 Consider changes to disposal evaluation guidelines 	
		C. Bioaccumulation at the onsite stations does not exceed the PSDDA Site Condition II biological response guidelines due to dredged material disposal.	Lab BA tests <ul style="list-style-type: none"> With composited on-site sediments COCs TBD based on recent DM and on-site sed chem results 	Compare data to Puget Sound disposal site environs tissue data set based on lab BA or analysis of field-collected tissues. <ul style="list-style-type: none"> What interpretation of this data would lead us to reject Hyp C? 	<ul style="list-style-type: none"> Further evaluation to compare on-site toxicity with off-site toxicity (i.e. failure due to area-wide conditions?) Consider outcome of Q3 Consider changes to disposal evaluation guidelines 		
	3. Are the disposal sites compliant with Part V of the SMS?	<ul style="list-style-type: none"> This question added to 3 original monitoring questions Same samples and analyses as question 2, but different interpretation of data 	D. Sediment toxicity at onsite stations ≤ CSL due to dredged material disposal.	Sediment Chemistry <ul style="list-style-type: none"> Same samples as 2B, but compared to SMS Part 5 guidelines 	Sediment Bioassays <ul style="list-style-type: none"> Same samples as 2B, but compared to SMS Part 5 guidelines 	Compare Data to SMS Part V <ol style="list-style-type: none"> If SMS COC > CSL at 3 or more stations, consider outcome of toxicity tests. If SMS bioassay failures (any #?), then Hyp D is rejected. 	<ul style="list-style-type: none"> Further evaluation to compare on-site toxicity with off-site toxicity (i.e. failure due to area-wide conditions?) Consider changes to disposal evaluation guidelines
			E. Bioaccumulation at onsite stations ≤ CSL due to dredged material disposal.	Lab BA tests <ul style="list-style-type: none"> Same samples and testing as 2C, but compared to SMS Part 5 guidelines COCs TBD based on recent DM and on-site sed chem results 	Compare data to highest of Risk-based/RB/PQL tissue data when/where available <ul style="list-style-type: none"> If SMS BCOC failures, then Hyp E rejected 	<ul style="list-style-type: none"> Further evaluation to compare on-site toxicity with off-site toxicity (i.e. failure due to area-wide conditions?) Consider outcome of Q2 Consider changes to disposal evaluation guidelines 	
	Off Site	4. Are unacceptable adverse effects due to dredged material disposal occurring to biological resources off site?	<ul style="list-style-type: none"> Focuses on chemical/biological impacts due to detection of significant amounts of dredged material in offsite sediments ("lobe") No analysis unless Hyp A rejected 	F. No significant decrease in benthic habitat quality due to dredged material disposal.	SPI Data Analysis <ul style="list-style-type: none"> Successional Stage? OSI? BHQ? 	TBD/need help	<ul style="list-style-type: none"> Develop protocols to prevent lobe. Special studies on why lobe occurred, and how to prevent in future. If Hyp A rejected, 4F always conducted; G-H conducted per BPJ (e.g. based on extent of DM in off-site material, physical characteristics, significant reduction in benthic habitat quality)
G. Chemistry/Toxicity in "Lobe" sediments ≤ SQS				Sediment Chemistry <ul style="list-style-type: none"> From "lobe" Archive environs ("beyond lobe") 	Sediment Bioassays <ul style="list-style-type: none"> "lobe" and "beyond lobe" All tox tests run in same batch 	<ul style="list-style-type: none"> Compare "lobe" chemistry to SQS Anti-degradation: <ul style="list-style-type: none"> Compare "lobe" tox to SCO If "lobe" tox > SCO, compare to "beyond lobe" tox (Anti-Dag) 	
H. No significant increase in bioaccumulation potential in "lobe" sediments				Lab BA tests <ul style="list-style-type: none"> Using composites of "lobe" and "beyond lobe" sediments. COCs TBD based on recent DM and on-site sed chem results 	Anti-degradation: <ul style="list-style-type: none"> Compare "lobe" BA tissue chem to "beyond lobe" tissue chem (from monitoring or Special Study) (Chance help?) 		

Dark shading = Tier 1 Always conducted

Light shading = Tier 2 Conducted pending outcome of Tier 1

- 4 Questions
- 8 hypotheses
- On-site evaluation: emphasis on bioaccumulation added. Includes sediment chemistry & tiered bioassays.
- Off-site evaluation: dependent on presence of off-site dredged material

Status of Monitoring Framework decisions as of 2019 draft

DROPPED from original framework:

- Offsite benchmark stations
- Perimeter station sediment sampling
- Transect station sediment sampling
- Benthic community sampling
- *In situ* benthic tissue sampling
- Chemical tracking system (CTS)

ADDED to original framework:

- SPI for benthic community analysis
- More on-site sediment samples for tiered benthic toxicity testing
- Off-site/Environs area for comparison
- ISM*-like sampling for on-site and off-site lab bioaccumulation testing

*ISM = Incremental Sampling Methodology

Since then, Framework Updates

1. Clarified objectives for non-dispersive site monitoring
 2. For BCOCs, defined SMS CSL as stand-in for CWA Site Condition II
 3. Added Tier 1 analysis as part of framework
 4. Defined “significant” off-site dredged material (DM)
 5. Defined Decision Units (DU) and boundaries
 6. Planned sampling approaches
 7. Added natural background reference for bioaccumulation analyses of off-site DM
 8. Clarified Bioaccumulative CoC and Benthic CoC lists
-



Framework Updates

1. Clarified objectives for non-dispersive site monitoring

Objectives for Non-Dispersive Disposal Site Monitoring

SC2 = Site Condition 2 = “minor adverse effects” within site boundaries (Federal guideline)

CSL = Cleanup Sediment Level = sediment chemical load above which site could be considered a “cleanup” site (State guideline)

- Dredged material stays within site boundaries
- On-site DM \leq SC2, $<$ CSL
- Off-site DM \leq SC1, \leq SCO
- Management actions to prevent future non-compliance; mitigate present ones

SC1 = Site Condition 1 = “no adverse effects” outside site boundaries (Federal guideline)

SCO = Sediment Cleanup Objective = goal for sediments outside impacted areas (State guideline)

Framework Updates

2. For BCoCs, defined SMS CSL as stand-in for Site Condition 2

DMMP Guidelines (from NEPA EIS)

Washington State Standards (SMS)

Site Condition 3

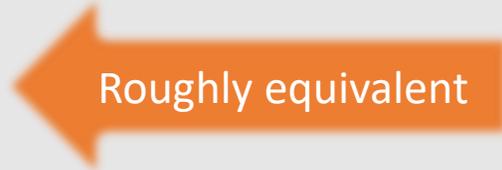


Don't go here

Cleanup Site

Cleanup Screening Level (CSL)

Site Condition 2



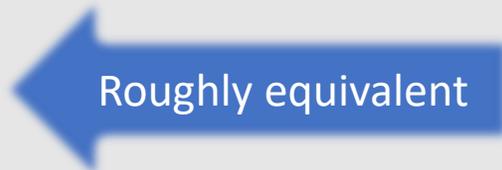
Roughly equivalent

Not cleanup site yet

Sediment Cleanup Objective (SCO)

Screening level

Site Condition 1



Roughly equivalent

Meets SCO:
Highest of: risk, natural background, or PQL

Framework Updates

3. Added Tier 1 analysis as part of framework

Added Tier 1 Analysis to framework

*Tier 1 = existing
information is
sufficient for
decision-making*

For every monitoring event, the DMMP has to juggle:

- Available budget (DNR tipping fees have not changed since 1994)
- Project materials disposed since last monitoring event (relative risk)
- Site specifics, *e.g.*:
 - Commencement Bay has most incidences of off-site drift
 - Elliott Bay environs > natural background
 - Local concerns

Existing information that may be available to help answer framework questions:

- SPI data, *e.g.*:
 - Grain size of any off-site material
 - Relative size and thickness of off-site material
- Other program data (*e.g.* PSEMP)

Framework Updates

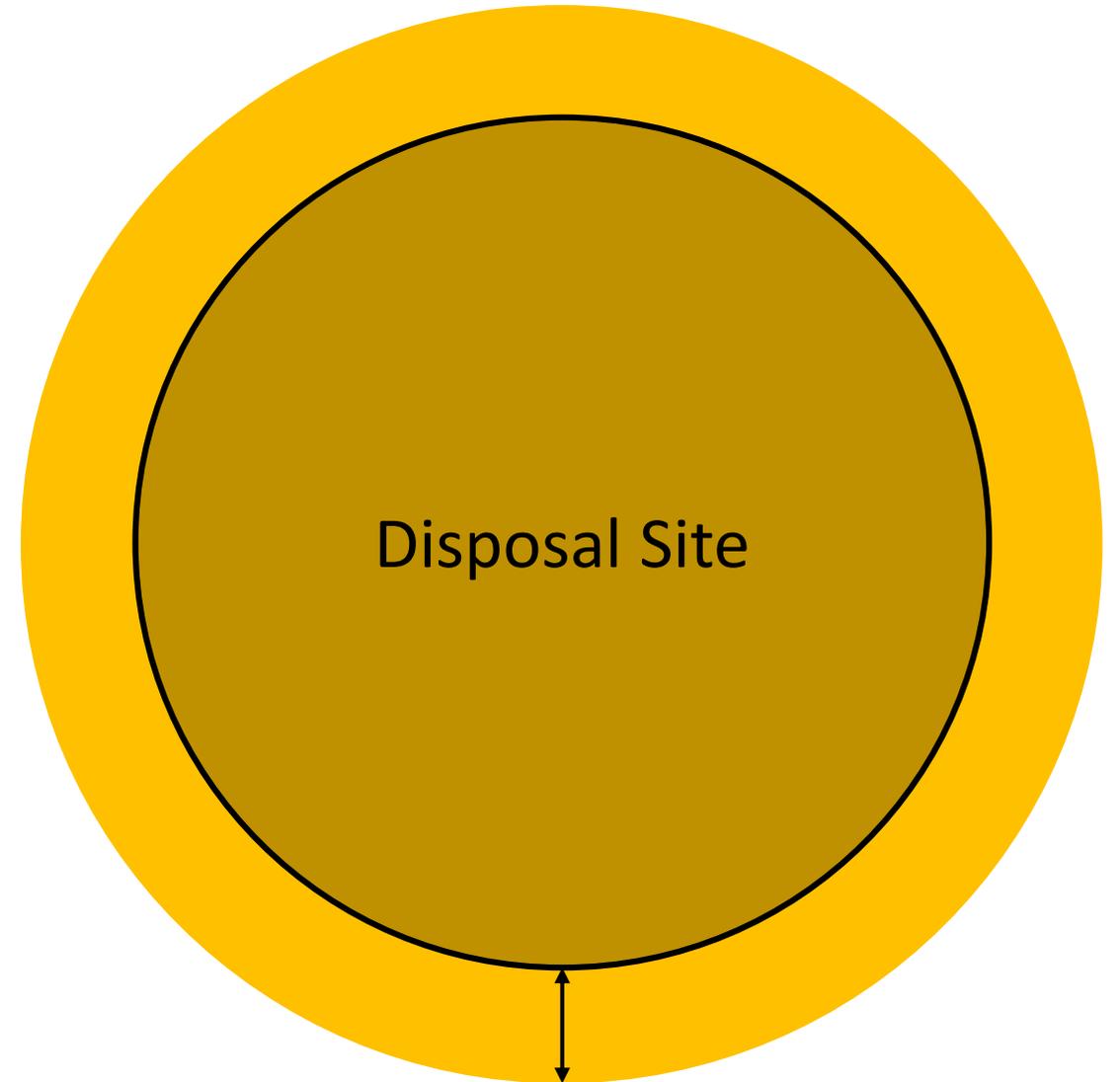
4. Defined “significant” off-site dredged material (DM)

Definition of “Significant” Off-site Dredged Material

- **Either** 10 cm of recent DM at site boundary
- **Or** 3 cm of recent DM identified at site perimeter

Off-site material triggers management actions to prevent future off-site disposal or drift

e.g. target zone shifts, tug travel direction, tidal limits



Site Perimeter = 0.125 nautical mile from site boundary

Framework Updates

5. Defined Decision Units (DUs) and boundaries

Decision Units

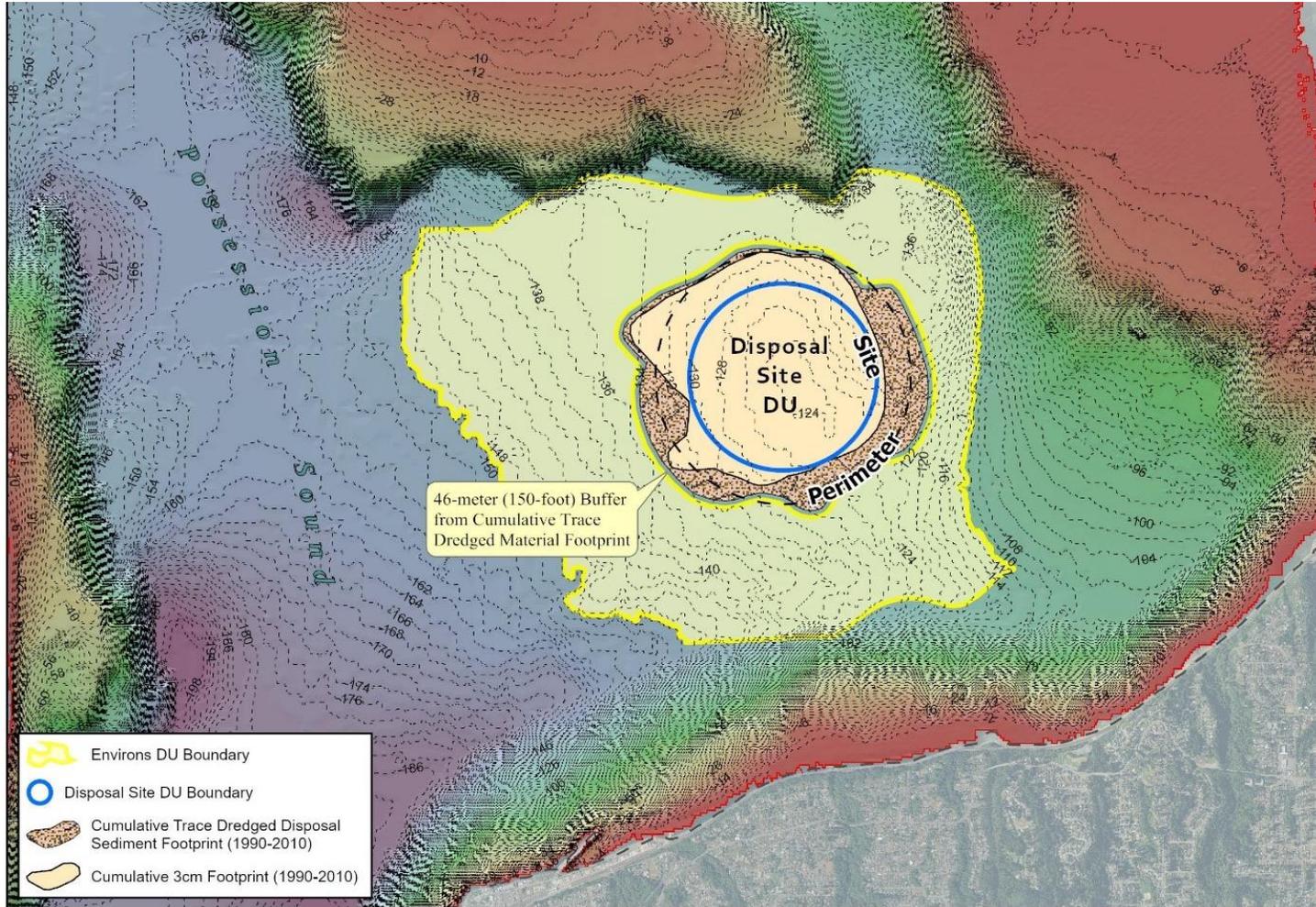


Figure 1. Proposed Environs DU and Disposal Site DU Boundaries for the Port Gardner Dredged Material Disposal Site

State Plane WA North,
Lambert Conformal Conic Projection
NAD 83 Datum
Units: Meters
2/20/2020

0 500 1,000 2,000 Meters

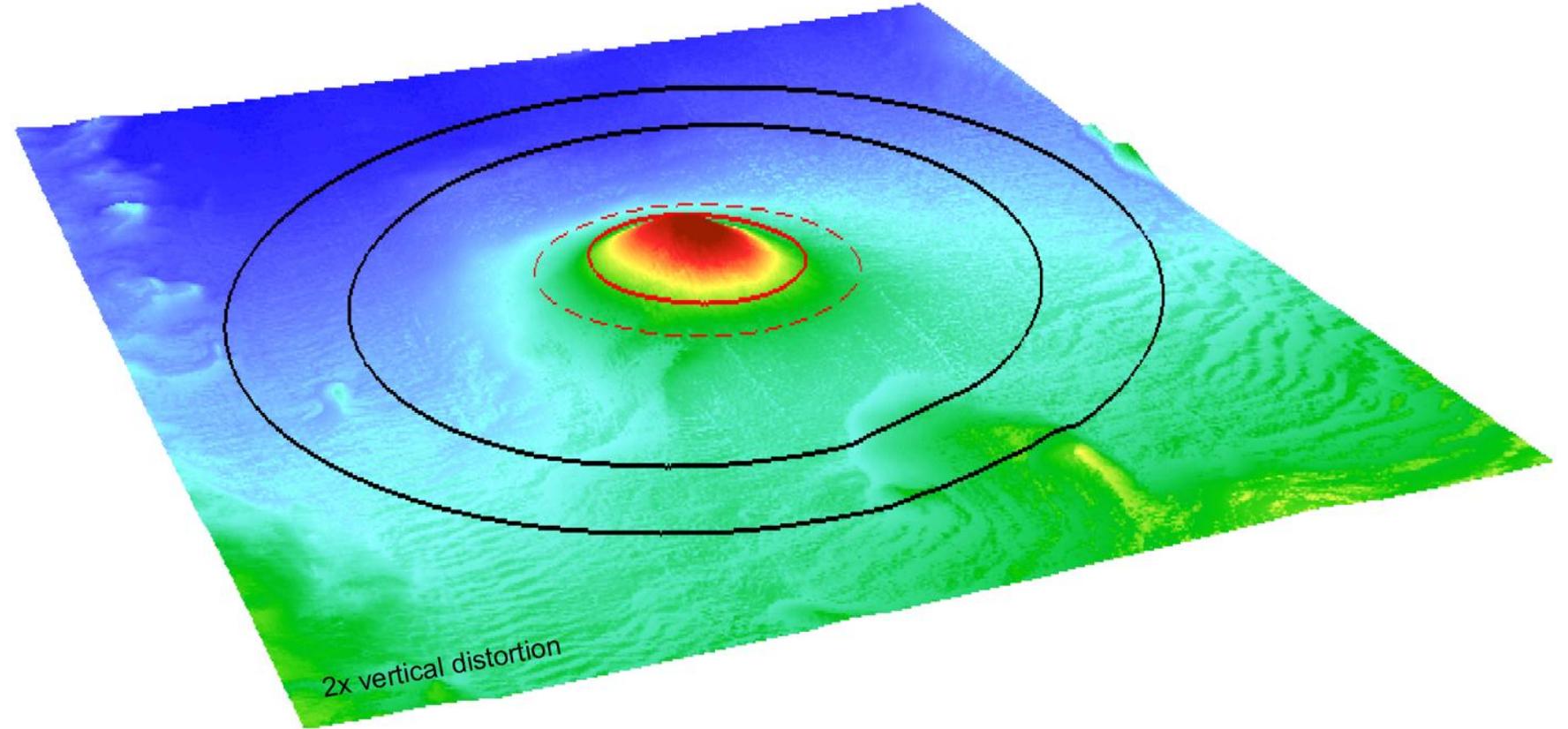
Disposal Site DU

- Material under DMMP management
- Entire area within site boundary, plus lobes of any recent off-site material >10 cm thickness

Environs DU

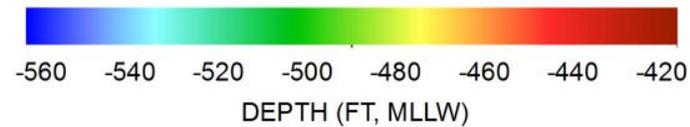
- Compared to Site DU
- Boundary based on bathymetry and grain size to “best meet intent of comparison with Site DU”
- Inner boundary 150 ft from any previously mapped offsite material

Commencement Bay DMMP Disposal Site
2013 Multibeam survey



Different
Site

Different
Perspective



-  DISPOSAL ZONE (1800' DIAMETER) & TARGET AREA (1200' DIAMETER)
-  SITE BOUNDARY AND SITE PERIMETER

Framework Updates

6. Planned sampling approaches

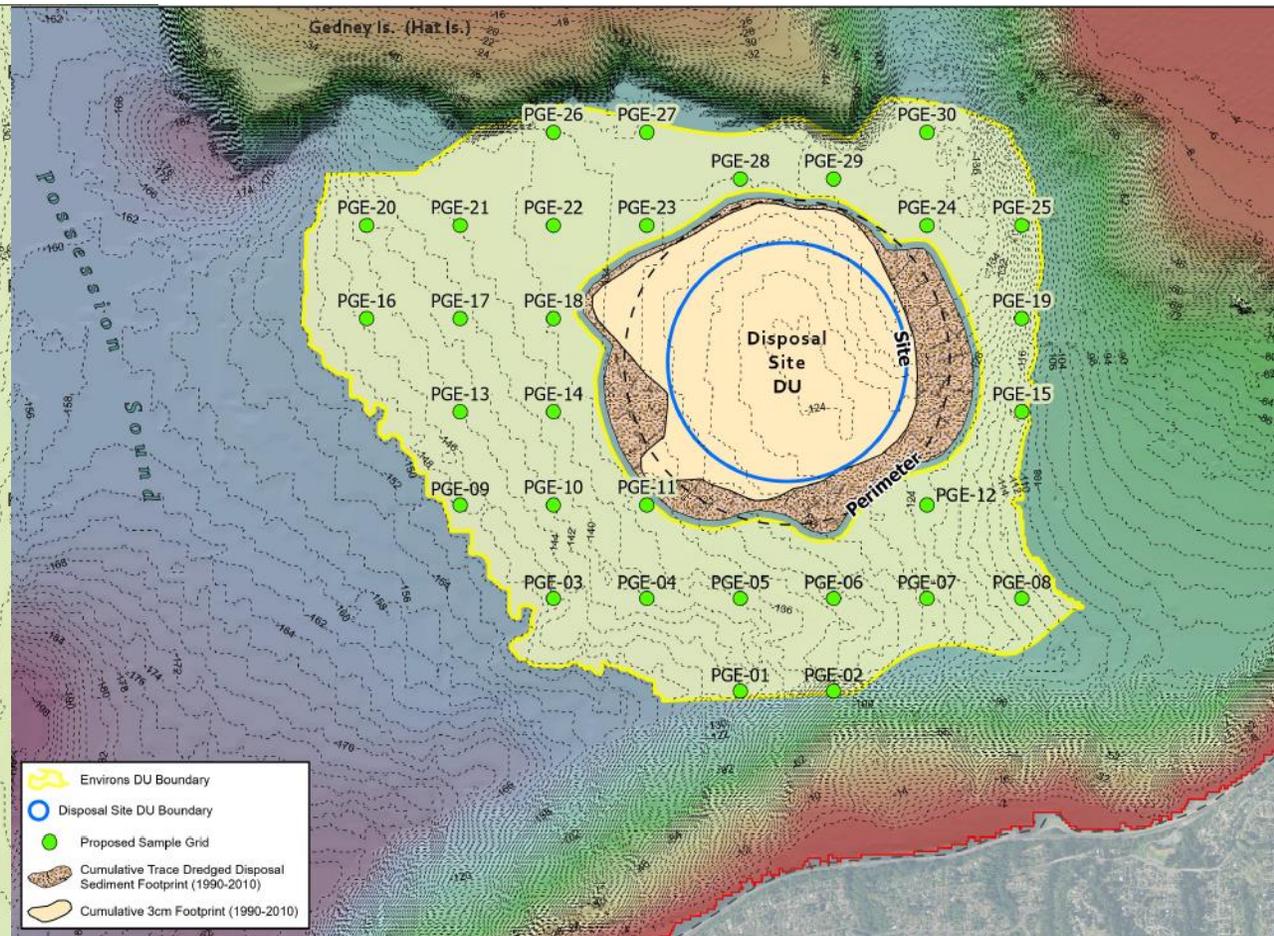
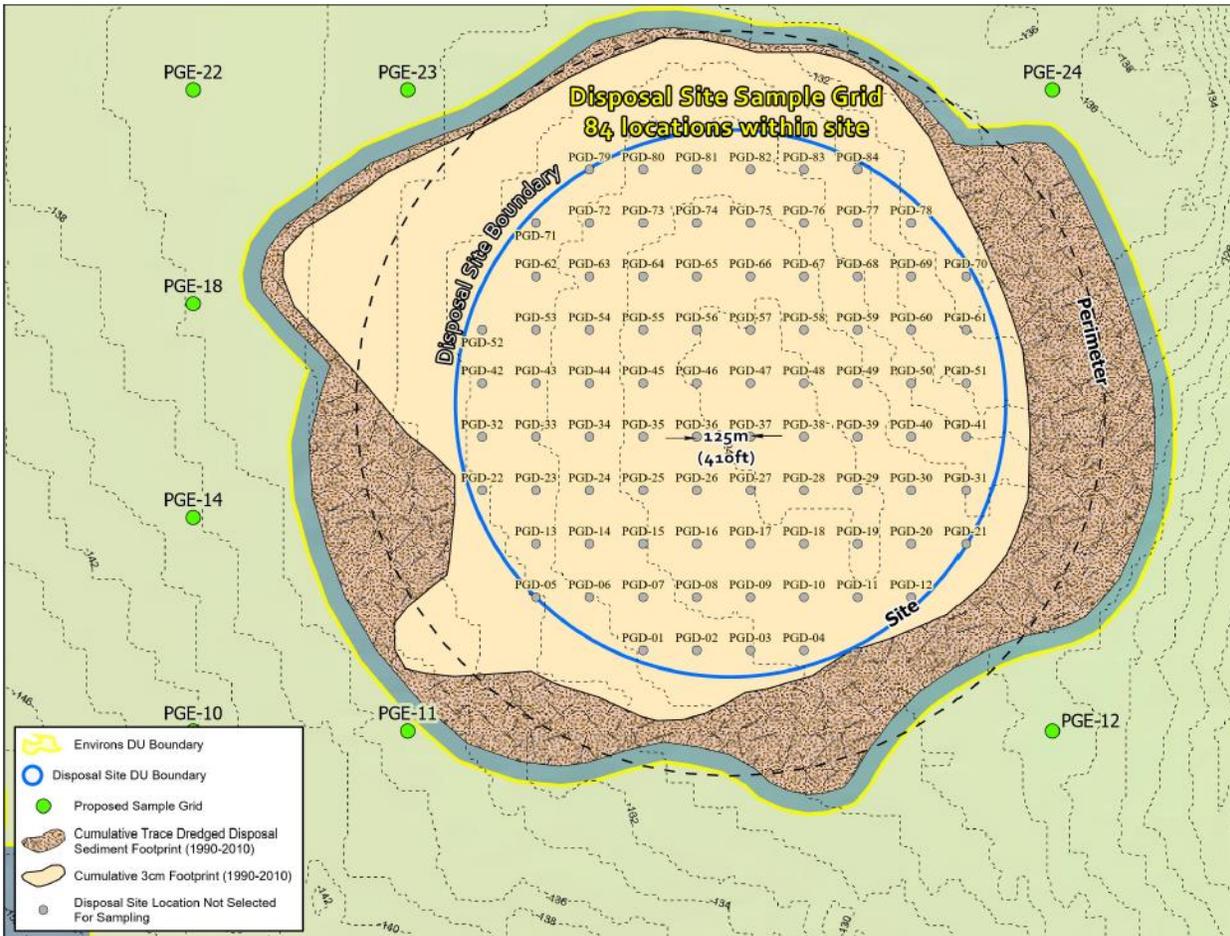
Sampling Station Grids

Disposal Site DU

- Sample independence not required
- Grid spacing of 125 m

Environs DU

- Sample independence required
- Grid spacing of 500 m



Site DU Sampling

20 random stations selected from within entire DU

For lab bioaccumulation tests, one super-composite of all 20 randomly-selected locations

For benthic toxicity evaluation, a subset of 5 randomly-selected locations, each sampled and tested separately (tiered chemistry/bioassays)

If significant offsite lobe, at least one sample taken from offsite area

Hypothetical Example

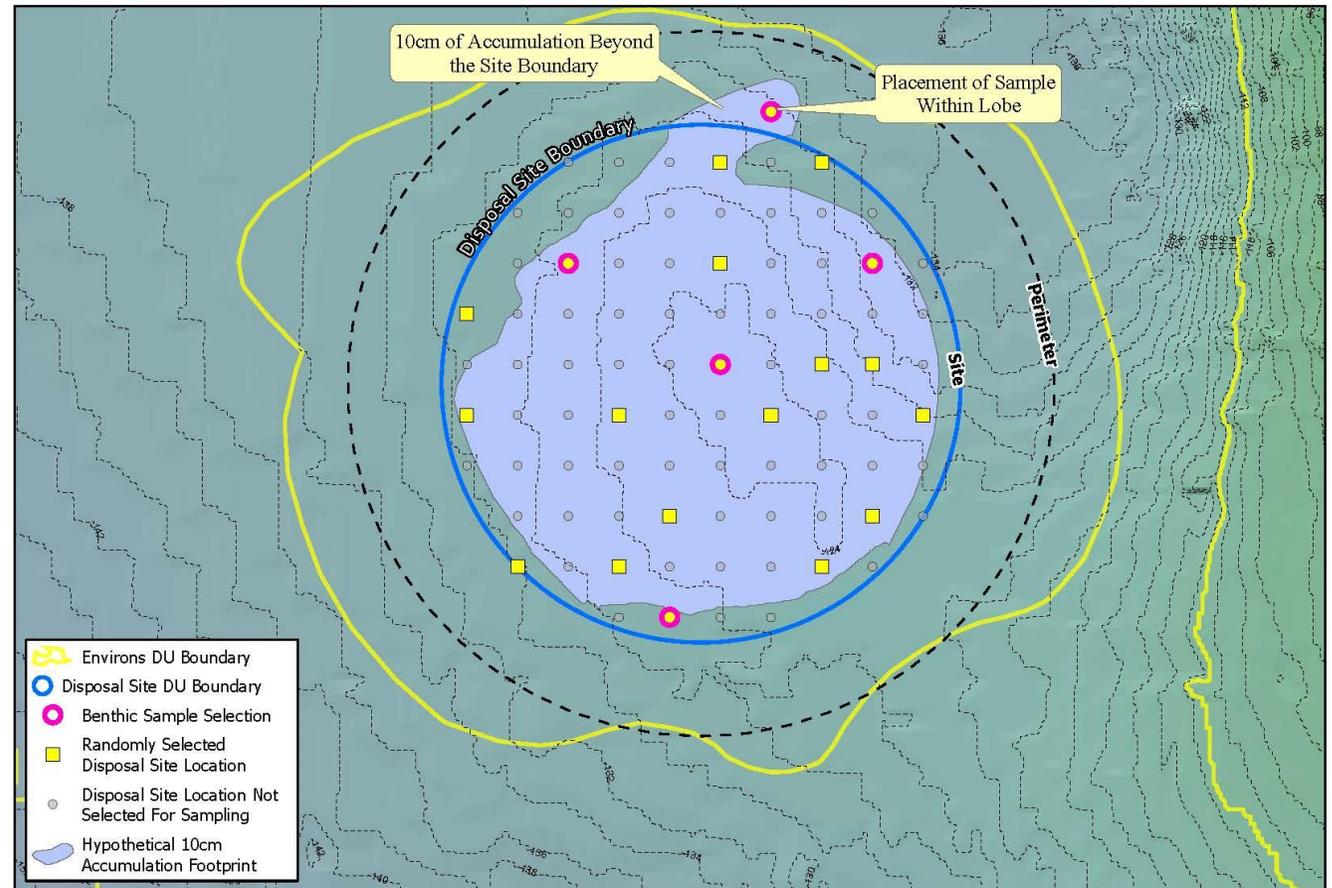


Figure 6. Hypothetical 10cm Accumulation Scenario and Modified Sample Grid

State Plane WA North,
Lambert Conformal Conic Projection
NAD 83 Datum
Units: Meters
2/19/2020

Environs DU Sampling

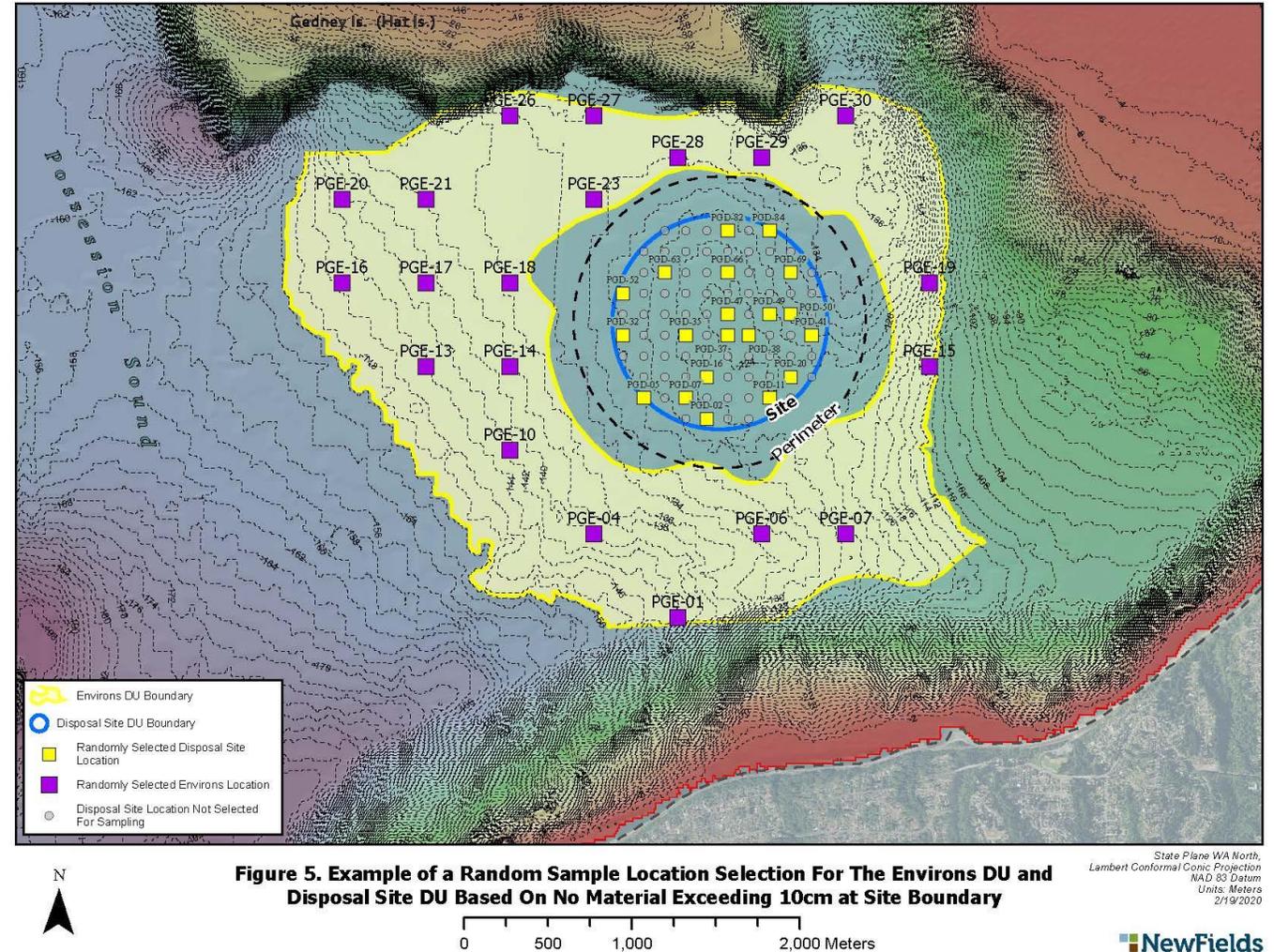
20 random stations selected from within entire DU

For lab bioaccumulation tests, one super-composite of all 20 randomly-selected locations

Sediment BCoCs compared to Site DU

Tissue BCoC levels from lab bioaccumulation tests compared to Site DU

Hypothetical Example

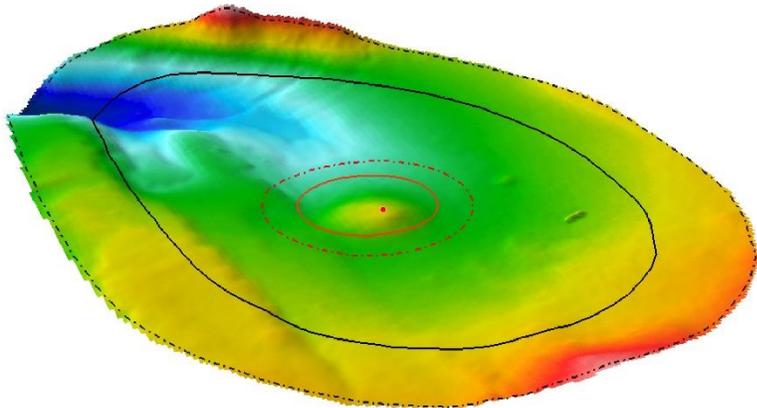


Framework Updates

7. Added natural background (NB) reference for bioaccumulation analyses of off-site DM

Bioaccumulation Reference Areas: off-site vs on-site

Elliott Bay DMMP Disposal Site
2013 Multibeam Survey



-420 -335 -250 -165 -80
Depth (ft MLLW)

DISPOSAL ZONE & TARGET AREA
SITE BOUNDARY & SITE PERIMETER

Site DU = entire site + any off-site lobe

Environs DU = comparison for ON-SITE portion of Site DU

Natural background DU = comparison for OFF-SITE portion of Site DU

IF Environs \cong NB, then Environs DU can be comparison for both on-and off-site portions of Site DU

Natural Background DU Sampling

IF:

- Significant offsite lobe of DM
- BCoCs in Environs DU > natural background (NB)

THEN:

- Need natural background reference (equivalent to SCO)
- Carr Inlet identified as appropriate NB reference site
- composite sample of 20 randomly-selected from sampling grid (NB DU)

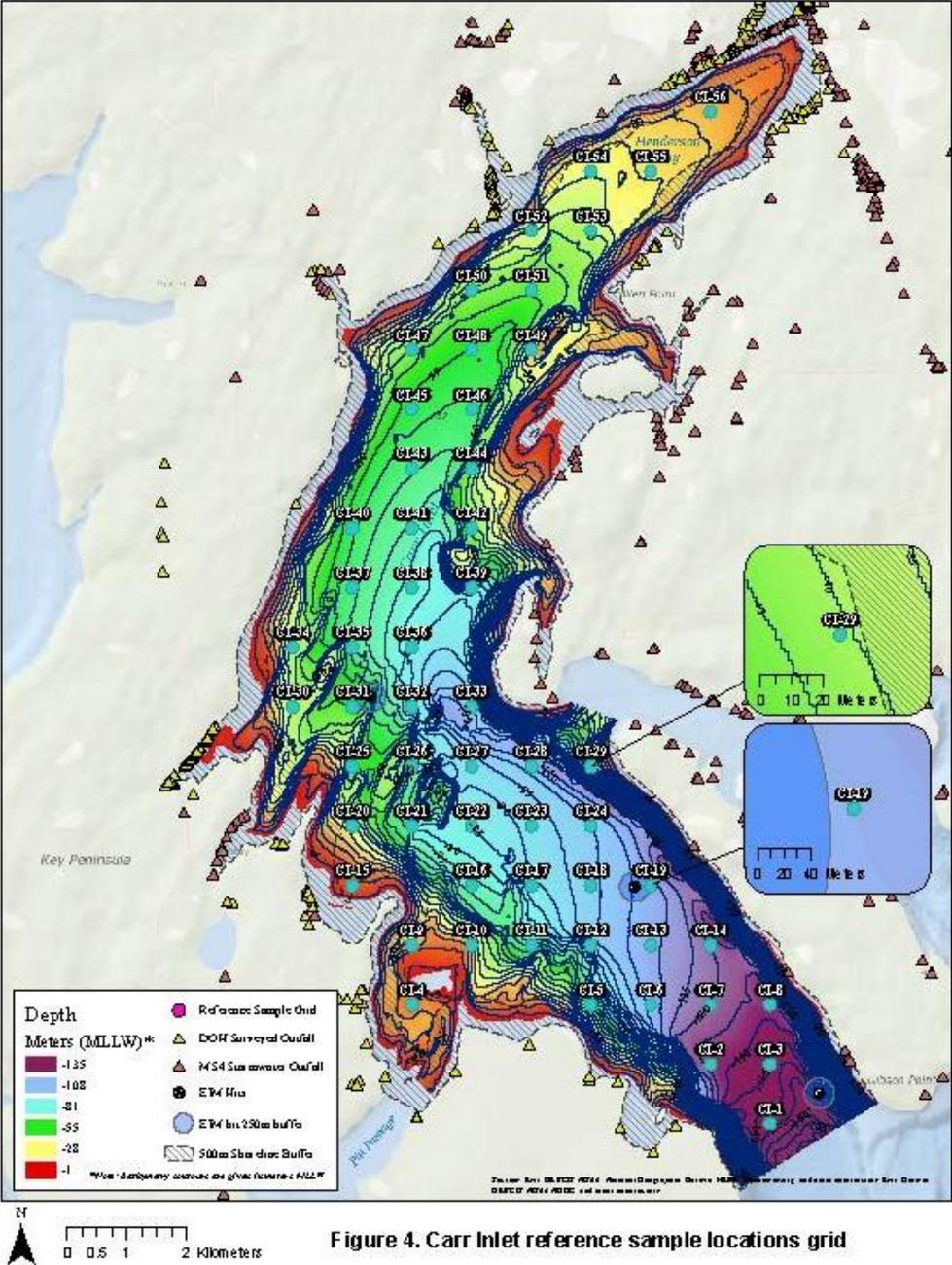


Figure 4. Carr Inlet reference sample locations grid

Framework Updates

8. Clarified Bioaccumulative CoC and
Benthic CoC lists

Different chemical analyses for benthic and bioaccumulation samples

Benthic COC list (for 5 on-site samples)

- Conventionals
- Metals
- SVOCs/Pesticides
- PCB Aroclors

Bioaccumulative COC list (for Site and Environs DU composites)

- Conventionals
- Select Metals
- Bulk TBT
- Select SVOCs/Pesticides
- PCB Aroclors
- PCB congeners
- Dioxin/Furan congeners
- PBDEs

And...the Latest

Still a work in progress – PG Pilot results and workshops will inform framework modifications as needed

- (back to) 3 Questions
- (back to) 6 hypotheses
- On-site evaluation: benthic toxicity (5 samples; tiered bioassays) and bioaccumulation (20-sample composite)
- Off-site evaluation: emphasis on physical assessments and bioaccumulation

QUESTION	HYPOTHESIS	METRIC	METHOD	HYPOTHESIS ACCEPTANCE CRITERIA
1. Does the deposited dredged material stay on site?	A. Dredged material stays within site boundaries.	SPI quantitative assessment	SPI survey of site and surrounding area	≤ 10 cm at (or beyond) site boundary AND ≤ 3 cm at or beyond site perimeter
		SPI qualitative assessment	Successional Stage/ Apparent Redox Potential Discontinuity and other SPI parameters	Benthic community shows expected levels of recovery based on historical data
2. Does deposited dredged material cause unacceptable ^{1,2} adverse impacts to biological conditions on site?	B. No long-term adverse effect on on-site benthic biological resources and habitat as defined by SMS and SCII	Sediment chemistry	5 individual samples from stratified random grid within the Disposal Site DU 0-10 cm samples analyzed for benthic DMMP COC list	All COCs ≤ DMMP SL
		Sediment bioassays (Tiered)	Run on all samples with any COC > SL	No bioassay toxicity test exhibits a 1-hit response or two 2-hit responses
		Tier 1 analysis	Review of SPI, project data and other relevant data	Sufficient evidence of no adverse effects > SCII
	C. No long-term adverse bioaccumulative risk to on-site resources as defined by SCII and SMS SQS	Laboratory bioaccumulation tests (Tiered)	20 subsamples from stratified random grid within the Disposal Site DU composited into a single sample analyzed for sediment chemistry and bioaccumulation 20 subsamples from Environs DU composited into a single sample and analyzed for sediment chemistry and bioaccumulation. Sediment and Tissue analyses for all relevant DMMP List 1 BCOCs	No BCOCs from DU-exposed tissues are significantly higher than the highest of: <ul style="list-style-type: none"> • Risk-based values (including relevant TTLs) • Environs DU tissue data • PQLs if available
3. Does deposited dredged material cause unacceptable ^{1,2} adverse impacts to biological conditions off site?	D. No significant decrease in off-site benthic habitat quality due to dredged material disposal.	SPI qualitative assessment	Successional Stage/ Apparent Redox Potential Discontinuity and other SPI parameters	Nearby off-site benthic community shows background levels of habitat quality
	E. No adverse effect to off-site benthic biological resources and habitat as defined by SMS SQS and SCI	Sediment chemistry	Individual grab samples from off-site stations with ≥10 cm of DM Analyze for full DMMP COC list	All COCs in off-site DM ≤ SMS SQS
		Sediment bioassays (Tiered)	Run on all discrete off-site samples with any COC > SQS	No bioassay toxicity test exhibits a 1-hit response or two 2-hit responses
	F. No bioaccumulative risk to off-site resources as defined by SMS SQS and SCI.	Tier 1 analysis	Review of SPI, project data and other relevant data	Sufficient evidence of no adverse effects > SMS SQS
		Laboratory bioaccumulation tests	Disposal Site DU expanded to include off-site areas with ≥10 cm of dredged material 20 subsamples from stratified random grid within expanded Disposal Site DU composited into a single sample and analyzed for chemistry and bioaccumulation. 20 subsamples from known natural background reference area (Environs DU if applicable, Carr Inlet, or other) composited into a single sample and analyzed for chemistry and bioaccumulation.	No BCOCs from expanded DU-exposed tissues are significantly higher than the highest of: <ul style="list-style-type: none"> • Risk-based values (including relevant TTLs) • Natural background DU tissue data • PQLs if available

¹ per Washington State Sediment Management Standards (SMS) and
² Clean Water Act, 404(b)1 - Site Condition II (SCII)

¹ per Washington State Sediment Management Standards (SMS) and
² Clean Water Act, 404(b)1 - Site Condition I (SCI)

QUESTION	HYPOTHESIS	METRIC	METHOD	HYPOTHESIS ACCEPTANCE CRITERIA
1. Does the deposited dredged material stay on site?	A. Dredged material stays within site boundaries.	SPI quantitative assessment	SPI survey of site and surrounding area	≤ 10 cm at(or beyond) site boundary AND ≤ 3 cm at or beyond site perimeter
2. Does deposited dredged material cause unacceptable ^{1,2} adverse impacts to biological conditions on site? <i>¹ per Washington State Sediment Management Standards (SMS) and ² Clean Water Act, 404(b)1 - Site Condition II (SCII)</i>	B. No long-term adverse effect on on-site benthic biological resources and habitat as defined by SMS and SCII	SPI qualitative assessment	Successional Stage/Apparent Redox Potential Discontinuity and other SPI parameters	Benthic community shows expected levels of recovery based on historical data
		Sediment chemistry	5 individual samples from stratified random grid within the Disposal Site DU 0-10 cm samples analyzed for benthic DMMP COC list	All COCs ≤ DMMP SL
		Sediment bioassays (Tiered)	Run on all samples with any COC > SL	No bioassay toxicity test exhibits a 1-hit response or two 2-hit responses
	C. No long-term adverse bioaccumulative risk to on-site resources as defined by SCII and SMS SQS	Tier 1 analysis	Review of SPI, project data and other relevant data	Sufficient evidence of no adverse effects > SCII
		Laboratory bioaccumulation tests (Tiered)	20 subsamples from stratified random grid within the Disposal Site DU composited into a single sample analyzed for sediment chemistry and bioaccumulation 20 subsamples from Environs DU composited into a single sample and analyzed for sediment chemistry and bioaccumulation. Sediment and Tissue analyses for all relevant DMMP List 1 BCOCs	No BCOCs from DU-exposed tissues are significantly higher than the highest of: <ul style="list-style-type: none"> Risk-based values (including relevant TTLs) Environs DU tissue data PQLs if available
3. Does deposited dredged material cause unacceptable ^{1,2} adverse impacts to biological conditions off site? <i>¹ per Washington State Sediment Management Standards (SMS) and ² Clean Water Act, 404(b)1 - Site Condition I (SCI)</i>	D. No significant decrease in off-site benthic habitat quality due to dredged material disposal.	SPI qualitative assessment	Successional Stage/Apparent Redox Potential Discontinuity and other SPI parameters	Nearby off-site benthic community shows background levels of habitat quality
	E. No adverse effect to off-site benthic biological resources and habitat as defined by SMS SQS and SCI	Sediment chemistry	Individual grab samples from off-site stations with ≥10 cm of DM Analyze for full DMMP COC list	All COCs in off-site DM ≤ SMS SQS
		Sediment bioassays (Tiered)	Run on all discrete off-site samples with any COC > SQS	No bioassay toxicity test exhibits a 1-hit response or two 2-hit responses
	F. No bioaccumulative risk to off-site resources as defined by SMS SQS and SCI.	Tier 1 analysis	Review of SPI, project data and other relevant data	Sufficient evidence of no adverse effects > SMS SQS
		Laboratory bioaccumulation tests	Disposal Site DU expanded to include off-site areas with ≥10 cm of dredged material 20 subsamples from stratified random grid within expanded Disposal Site DU composited into a single sample and analyzed for chemistry and bioaccumulation. 20 subsamples from known natural background reference area (Environs DU if applicable, Carr Inlet, or other) composited into a single sample and analyzed for chemistry and bioaccumulation.	No BCOCs from expanded DU-exposed tissues are significantly higher than the highest of: <ul style="list-style-type: none"> Risk-based values (including relevant TTLs) Natural background DU tissue data PQLs if available



Questions?

