APPENDIX D

OVERVIEW OF DREDGED MATERIAL EVALUATION AND DISPOSAL SITE MONITORING UNDER THE DREDGED MATERIAL MANAGEMENT PROGRAM

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1 Introduction

The Dredged Material Management Program (DMMP) is an interagency approach to dredged material management in the State of Washington. The regulatory agencies comprising the DMMP include the Corps of Engineers Seattle District, Environmental Protection Agency Region 10, the Washington State Department of Natural Resources, and the Washington State Department of Ecology.

The DMMP evolved from the Puget Sound Dredged Disposal Analysis (PSDDA) program, which was implemented in 1988 (Phase I – central Puget Sound) and 1989 (Phase II – north and south Puget Sound) following a 4.5 year study and siting process. The geographic focus expanded to coastal Washington in 1995 and to the Washington side of the Columbia River in 1998. The program name was changed to the Dredged Material Management Program in acknowledgement of the broader geographical coverage.

The PSDDA study identified eight multi-user disposal sites in Puget Sound, defined a consistent and objective procedure for evaluating the suitability of dredged material for disposal at those sites, and formulated site-use management plans to monitor the effects of dredged material disposal. These management plans include an adaptive management framework, which enables the dredged material evaluation procedures to be modified based on the findings of the monitoring program. The evaluation procedures are fully documented in the DMMP Users Manual (DMMP 2013).

2 PSDDA Disposal Site Designation Process

The disposal site designation process conducted during the development of the 1988 and 1989 PSDDA environmental impact statements resulted in the selection of three dispersive sites and five non-dispersive sites throughout Puget Sound. Non-dispersive disposal sites are in areas where currents are low enough that dredged material is retained within the disposal site; dispersive sites have higher current velocities, so dredged material does not accumulate within the disposal site.

The number of sites selected balanced the need for ecologically-safe disposal with the need for economically and logistically-viable disposal options. The selection process is discussed in detail in PSDDA-FEIS (1988) for Phase I sites and PSDDA-FEIS (1989) for Phase II sites. Selection factors included:

- navigation activities;
- recreational uses;
- cultural sites;
- aquaculture facilities;
- utilities;
- scientific study areas;
- point pollution sources;
- water intakes;
- shoreline land use designations;
- political boundaries;
- location of dredging areas;
- beneficial uses of dredged material;

- fish/shellfish harvest areas;
- threatened and endangered species;
- fish/shellfish habitat;
- wetlands, mudflats and vegetated shallows;
- bathymetry;
- sediment characteristics; and
- water currents.

Information on these factors was collected, mapped, and overlain to identify areas where disposal sites would have a minimum conflict with ecological resources. In addition, attempts were made to locate disposal areas within 10 nautical miles (11.5 miles) of major dredging areas. After identifying these areas, additional constraints were included in the selection process.

For non-dispersive sites, these additional factors included the following:

- peak current speeds of less than 25 cm/sec,
- distance from shore (greater than 2,500 feet),
- site size for containment of the estimated volumes of dredged sediment to be disposed,
- distance from vulnerable biological resources (greater than 2,500 feet), and
- depth of water (where possible place site between 120 and 600 feet).

For dispersive sites, these additional factors included the following:

- current speeds in excess of 25 cm/sec,
- distance from shore not less than 1 nautical mile (1.2 miles),
- minimum water depth of 180 feet as a goal (not an absolute requirement), and
- locating sites so that the ultimate fate of the dispersed material will not have a significant adverse effect on natural resources.

3 Disposal Sites in Grays Harbor and Willapa Bay

Two multiuser dispersive disposal sites in Grays Harbor (Pt. Chehalis and South Jetty) and two in Willapa Bay (Goosepoint and Cape Shoalwater) receive material from both Federal and non-Federal dredging projects. The DMMP Users Manual is applicable to the evaluation of dredged material being placed at these sites.

4 Dredged Material Evaluation

All material to be dredged by the Corps or by a non-Federal entity is evaluated under the DMMP dredged material evaluation procedures (DMMP 2013) prior to dredging for suitability for open-water disposal. Only dredged material that has been determined to be suitable for unconfined, open-water disposal can be discharged at the DMMP disposal sites. The process for determining whether material is suitable for disposal at a DMMP site is described in detail in the DMMP User Manual and outlined in Figure 1. The DMMP agencies document the suitability/unsuitability of material for each proposed dredging project in a memorandum for record, which provides the DMMP agencies' evaluation of all chemical and biological testing data relative to evaluation guidelines for unconfined open-water disposal. The suitability determination is signed by all four cooperating agencies. All suitability determinations are subsequently posted on the Corps' Dredged Material Management Office website (http://www.nws.usace.army.mil/Missions/CivilWorks/Dredging.aspx).

The dredged material evaluation process involves a four-tiered approach to determine the suitability of sediments for unconfined, open-water disposal. This suitability analysis determines whether sediments to be dredged have potential to adversely affect biological resources. Dredged material with potential to adversely affect biological resources is considered unsuitable for open-water disposal and is disposed of by other means (e.g., disposal at Ecology-approved confined upland or nearshore disposal sites). A brief discussion of the tiered suitability evaluation follows.

Tier I analysis involves the review of existing sediment data and site history, including all potential sources (e.g., outfalls, spills, etc.) for sediment contamination. Section 404 of the Clean Water Act (CWA) includes provisions for exclusion from testing based on Tier 1 evaluations, as does the Inland Testing Manual guidance document. Exclusions can be made if a Tier 1 evaluation indicates that the dredged material is not considered to be a "carrier of contaminants" (40 CFR 230.60 (b)). Potential exclusion situations occur most commonly "if the dredged material is composed primarily of sand, gravel, and/or inert materials; the sediments are from locations far removed from sources of contaminants; or if the sediments are from depths deposited in preindustrial times and have not been exposed to modern sources of pollution" (ITM 1998). Testing may not be necessary "where the discharge site is adjacent to the excavation site and subject to the same sources of contaminants, and materials at the two sites are substantially similar "(40 CFR 230.60(c)). If existing data are sufficient and the sediments are geographically removed from likely sources of contamination, the DMMP agencies may deem the sediments suitable, with no further testing required.

If Tier I data are not sufficient, or there is some indication that sediments may contain contaminants (e.g., proximity to sources, spills, etc., which may affect the quality of the aquatic environment), sediments are chemically tested under Tier II for conventional parameters and chemicals of concern. Testing is conducted on dredged material management units (DMMUs), which are sized based on the potential for elevated concentrations of chemicals of concern. DMMUs are delineated such that they may be dredged independently from adjacent DMMUs.

The Tier II chemistry data are compared to established chemical guidelines to assess whether biological testing under Tier III and Tier IV is necessary. If the Tier II analysis indicates that all chemical concentrations are below the screening level (SL), then no additional biological testing is necessary. The SL is the concentration of specific chemicals below which there is no reason to believe that disposal of that material would result in unacceptable adverse biological impacts.

A maximum level (ML) has been defined for most chemicals. The ML is a concentration above which there is reason to believe that the material would be unsuitable for unconfined, open-water disposal. The dredging proponent may still choose to subject DMMUs with ML exceedances to standard biological testing using Tier III bioassays; however, a Tier IV evaluation may also be required at the discretion of the DMMP agencies. A Tier IV assessment is considered a special, non-routine evaluation that might include time-sequenced bioaccumulation or tissue analysis of organisms collected from the area to be dredged, and/or a risk assessment.

In addition to comparison to the SL and ML concentrations, the DMMP sediment evaluation process includes a bioaccumulation trigger (BT) for bioaccumulative compounds. The BT is the concentration of a chemical of concern above which there is reason to believe there is potential for that chemical to be accumulated in the tissue of target organisms. Ecological effects of sediments are typically evaluated by statistical comparison to tissue concentrations in organisms exposed to clean reference sediment. Human health effects are evaluated against DMMP guidelines for allowable tissue concentrations, which are a combination of risk-based numbers and Food and Drug Administration action levels. See the discussion in Appendix G, which addresses biomagnification effects of persistent organic pollutants in Southern Resident killer whales and Steller sea lions.

Dispersive sites are located in areas of high bottom currents where dredged material placed at the site is expected to be rapidly dispersed. Tier II chemical testing for dispersive sites is the same as non-dispersive sites. However, the interpretation guidelines for Tier III bioassays are more restrictive. The more restrictive bioassay interpretation guidelines for dispersive sites insure adherence to the Site Condition I management standard (no adverse effects on biological resources due to sediment chemicals) in effect at those sites. Site Condition II (minor adverse effects on biological resources due to sediment chemicals) is in effect at non-dispersive sites.

5 Disposal Windows

The timing of dredging activities is generally regulated by in-water work periods established to protect ESA-listed species during sensitive times in their life histories. However, three of the eight PSDDA sites have additional closure periods for the protection of other marine resources (see Table 1 below).

Table 1. DMMP Site Closure Periods (non-ESA)

Disposal Site	Disposal Site Closure Period	Reason
Port Townsend	September 1 to November 30	Fall shrimp closure
Port Angeles	September 1 to November 30	Fall shrimp closure
Bellingham Bay	November 1 to February 28	Crab/shrimp closure

6 Dredged Material Transport

Transport of the barge to and from the disposal sites is not generally a concern with regard to potential physical effects on salmon, coastal pelagic fish, and groundfish species or habitat. Concern has been expressed that windborne, spilled, or leaking dredged material entering the water column during transport could in some way delay or otherwise affect freshwater entry of returning adult salmon or have deleterious effects on pelagic and groundfish species. The negligible potential for this outcome is reviewed in the following discussion.

Mechanical dredging operations are performed to achieve an economical load that will result in some overflow of dredged material within the allowable dilution zone. The determination of an economical load is made in the field, based on the consistency of the dredged material and the safe load capacity of the transport barge. Sometimes the dredged material dewaters quickly, allowing the load to be mounded along the centerline axis of the barge. If the dredged material contains fines and high water content, mounding is not feasible and appropriate freeboard is maintained on the confinement bulkhead (sideboards) to prevent spillage. When barge capacity is reached, the deck area outside the perimeter bulkhead is inspected for accumulated sediment. Spilled sediments are flushed overboard with water in the dilution zone at the dredging site to

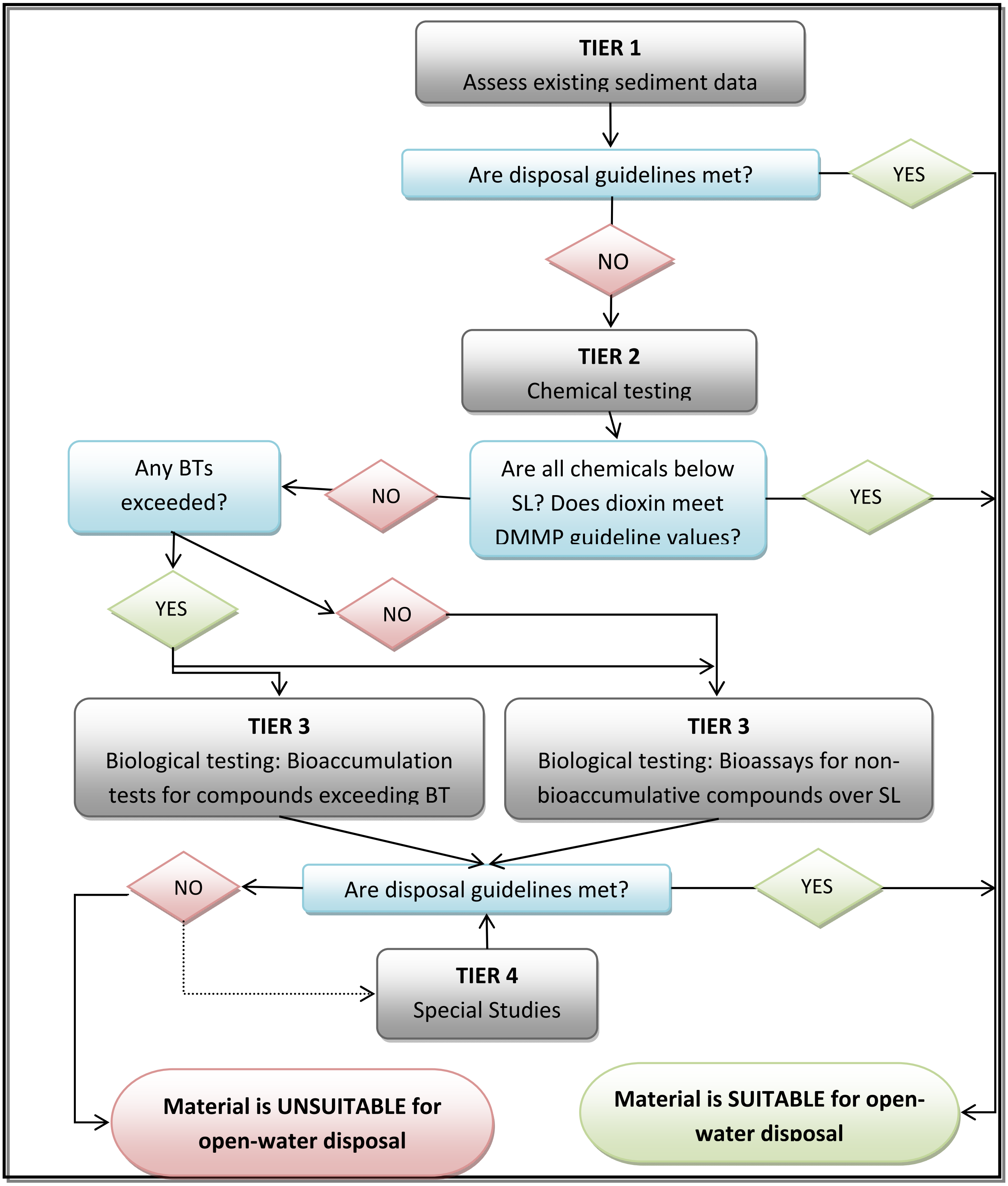


Figure 1. Tiered Testing Decision Diagram (DMMP 2013)

provide safe access for the dredge crew and to prevent the materials from being lost overboard in transit from the dredging site to the disposal site.

The potential for effect from windborne sediments is minimal. The type of sediments that can typically be mounded on a barge (and thus would be most exposed to wind) are either more granular (contain little fine or organic material, would be relatively inert, and pass quickly through the water column) or are very cohesive (clay). More claylike sediments generally contain a high moisture content, which would resist windborne transport. The amount of time between loading and discharge of dredged materials at the disposal site is relatively short (hours), which gives finer material little time to dry (become less cohesive) during the transport process. Thus, potential for windborne transport of these types of materials is minimal.

The potential for sloughing or leaking of dredged material from barges during the transport of material to the disposal sites is minimized by the design of modern barges (sideboards on the deck and seals on the bottom dump doors) and the typical operation practices of the contractors (loading practices and deck cleaning for crew safety and access, as required, prior to leaving the dilution zone). If any significant leaking is noted, the contractor must correct the situation before leaving the dredging dilution zone. Thus, the potential for significant sloughing or leaking of dredged material is minimal.

Although there is always potential for a fuel spill, this possibility is extremely small. The number of trips and distance traveled by the tugs and barges is minimal compared to the vast number of commercial vessels sailing on Puget Sound. However, as with any commercial vessel operation, procedures are in place for vessel maintenance and prevention of spills, and for emergency response should a spill occur.

The incremental effect of the noise generated by the tug hauling the barge to and from the disposal sites is considered to be insignificant. Loading sandy or smaller-grained material onto a barge generates relatively low sound levels, based on the observations of work crews--a search of the literature failed to find any reference to the impulse noise generated by the loading of sand into a barge. Similarly, no reference could be found of the noise levels caused by the opening of a center-dump barge under the water surface to release the load of sediment. Intuitively, it would seem that the noise would be relatively less than other activities in dredging areas, such as the sound of the tug engines, and is thus a negligible addition to the ambient noise levels surrounding the disposal area. Furthermore, the disposal operation is short-lived (less than one minute), and is unlikely to occur while a killer whale is in the vicinity. Therefore, this potential noise effect is considered to be discountable.

7 Fate of Dredged Material Placed at Disposal Sites

7.1 Dispersive Sites

Dredged material disposed at the dispersive sites is dispersed relatively quickly by the strong currents at these locations. Disposal occurs from a barge as the barge is being towed through (over) the disposal site. The disposal sites were sized using the assumption that a barge is towed at an average speed of 3 knots and the load is completely dumped in 10 minutes. Dispersive site disposal zones (the area on the surface where dredged material is released) were sized based on the predicted horizontal spread of a single dump of dredged material.

Based on modeling conducted as part of the PSDDA site selection process (Phase I PSDDA DSSTA, pages II-29 to II-46), a disposal event based on a single 1,500 cy bottom-dump barge disposal in 400 feet of water with a current speed of 50 cm/sec (1 knot) would result in a horizontal spread of 2,000 feet down current of the dump spot, and 1,000 feet to either side. For the dispersive sites, 3,000-foot diameter disposal zones were established. Based on the projected spread, the disposal site dimensions were set at 6,000 feet diameter for the Rosario Strait site, and 7,000 feet diameter for the Port Townsend and Port Angeles sites.

7.2 Non-Dispersive Sites

Dredged material disposal at the non-dispersive sites takes place within a 600-foot radius target area. Disposal occurs from the barge as the barge is being towed through the disposal site at the minimum speed necessary to maintain control. All dredged material disposal tugs are required to record and report when and where the doors on the barge are opened and closed to ensure that all disposal occurs within the target area. In addition, the DNR keeps a record of all track lines that each barge travels during disposal events.

The behavior of discharged material at non-dispersive sites was modeled as part of the original site selection process (PSDDA-DSSTA 1989). The models showed that material disposed from a bottom-dump barge settled on the bottom inside the disposal site boundary within a 1,000-foot radius of the drop point. The depth of the deposits estimated from a single 1,500 cy barge load of dredged material varies from about 0.8 cm in the center of the disposal mound, to about 0.1 cm near the edges of the mound.

7.3 Disposal Dynamics

As part of the PSDDA site selection analysis, the Corps conducted extensive numerical modeling simulations using the Disposal from an Instantaneous Dump (DIFID) model (Trawle and Johnson 1986). The model evaluated the fate and dispersal of dredged material of varying composition discharged from barges into waters of varying depth and current speed (PSDDA-MPR 1988, 1989). A schematic representation of a discharge event is presented in Figure 2.

Changes in the form and behavior of an instantaneous discharge of dredged material from a barge during its descent through the water column are described by the U.S. Army Corps of Engineers (USACE 1986) and Pequegnat (1983). The descent from an instantaneous discharge from a moving split-hull barge can be divided into three phases according to the physical forces that act on the material as it descends through the water column to the bottom. These phases are convective descent, dynamic collapse, and passive diffusion.

<u>Convective Descent</u>

During convective descent, the discharged material descends through the water column as a dense, well-defined fluid-like jet. The consistency and behavior of the jet depends on the characteristics of the dredged material, moisture content, cohesiveness, size composition (e.g., silt, clay, sand, gravel), and the equipment used to dredge the material (clamshell, cutterhead, hopper/drag-arm). Material previously discharged at PSDDA sites has been of highly variable character, and a wide range of dredged material type can be expected in future disposal activities. Dredging within Puget Sound is almost entirely performed using clamshell dredges and requires use of bottom-dump barges, which release the consolidated dredged material below the water surface. Clamshell dredges keep the dredged material relatively consolidated and minimize the percent moisture content.

Moisture content is the primary factor that will determine the amount of dredged material that will initially reach the bottom, the amount of time it takes to initially reach the bottom, the area of the bottom it covers, the direct and immediate potential impact on the pelagic water column and bottom, and the effects of the environment on the dredged material (resuspension and transport). Where the initial moisture content is low, as with clamshell dredging, the transit time of the material to the bottom is sufficiently brief that the influence of any currents in transporting the material laterally is minimal (Pequegnat 1983). In modeling conducted by the Corps (PSDDA-FEIS 1988, 1989), transit time of the material to the bottom in 400 feet of water is on the order of 30 seconds after the discharge is initiated.

As the material descends to the bottom, large volumes of water are entrained in the jet, which expands the diameter of the jet as it approaches the bottom. USACE (1986) estimated that the diameter of the jet as it makes contact with the bottom in 400 feet of water would be approximately 250 feet. As a result of several factors, including turbulent shear, some material is separated as it descends, and settles to the bottom at a slower rate. This rate is determined by material density (size fractionation). Lateral transport of this material has been a concern in the discharge of sediments that contain contaminants. However, this is not a critical issue for the present analysis because the material discharged at DMMP sites will have been evaluated thoroughly for suitability for disposal. To be suitable, the sediments must not contain unacceptable concentrations of chemicals of concern.

Dynamic Collapse

The dynamic collapse phase occurs as the material collides with the bottom or when the material encounters a water layer with greater ambient density (thermocline or pycnocline). As the jet material collapses, the material spreads out in all directions as a density/momentum-driven surge.

For dispersive sites, the models showed that material impacts the bottom within the disposal site boundary. An estimated 90% of material is deposited within a 1,500-foot radius of the disposal location. The initial depths of the deposits on the bottom were calculated to vary from 2.2 to 0.73 cm in water depths of 200 to 400 feet.

For non-dispersive sites, the models showed that material settled to the bottom inside the disposal site boundary within a 1,000-foot radius of the drop point. The depth of the deposits on the bottom varies from about 0.8 cm in the center of the disposal mound, to about 0.1 cm near the edges of the mound.

The concentration of suspended solids, as well as the extent and duration of their presence in the water column, is of concern because of potential effects on biota. As expected, effects caused by suspended solids depend on the type of material discharged and environmental conditions. The material to be discharged is loaded into bottom-dump barges with a clamshell dredge, which maximizes the cohesiveness of the material compared to other dredging methods. As such, the material tends to clump when discharged. This minimizes loss from the jet to the surrounding water and resuspension once it contacts the bottom. Various estimates have been made to characterize the loss of material to surrounding waters (USACE 1986). Studies have generally concluded that from 1 to 5% of the disposed material is lost from the jet to the water column during descent. However, monitoring has demonstrated that this material settles rather quickly (within 1 hour).

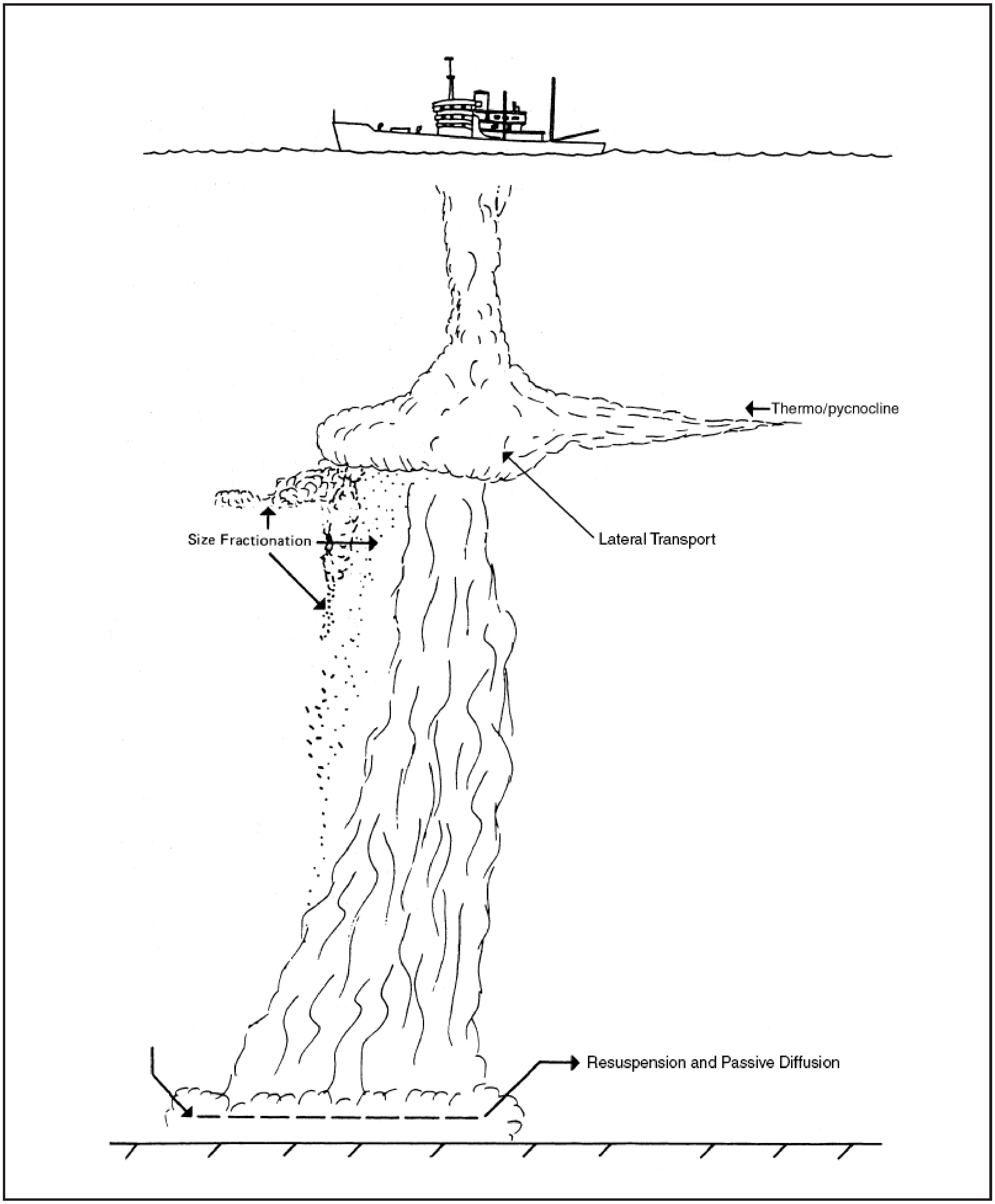
Resuspension and Transport of Disposed Material by Currents

This process is not a major factor at non-dispersive sites because current velocities at the sites are too slow to initiate movement of the material. The dispersive sites are located in areas where bottom currents are swift enough to completely disperse discharged dredged material out of the disposal site. For example, the three dispersive sites in Puget Sound have mean current speeds greater than 40 cm/sec. Several field studies were performed and numerical models were created to evaluate the transport of dredged material from PSDDA dispersive sites, based on current speeds. These studies/models indicated that at all three sites a small amount of dredged material would initially accumulate on the bottom after a discharge event, but then complete erosion of the material would likely occur over a single flood or ebb tide.

Bathymetric monitoring of the Rosario Strait site in 1991, 1994, 1999, and 2009 confirmed that dredged material is rapidly dispersed and no accumulation of dredged material has occurred at that site since the 1989 baseline survey. The other two dispersive sites in Puget Sound have not been monitored since their baseline surveys because of the relatively low site use and low volumes of material disposed at these sites over the past 26 years.

Transport of dredged materials by currents can occur over relatively large distances at the dispersive sites. The direction and distance of transport varies for each site and depends on the stage of the tide during which the material is disposed. PSDDA-DSSTA (1989) evaluated far-field dispersion using a variety of methods including observation of Lagrangian drifters and numerical simulations (Crean 1983). The studies predicted wide dispersal of the material because of the strong currents at the sites.

A fate and transport study (USACE and WDNR 2012) of the PSDDA dispersive sites confirmed the prediction of wide dispersal of material made during the siting study. Acoustic Doppler Current Profiler (ADCP) surveys at the Rosario Strait, Port Angeles, and Port Townsend sites confirmed currents stronger than 100 cm/s at each of the sites. Dispersal of material at the Port Angeles and Port Townsend sites is predominantly in the east-west direction, parallel to the Strait of Juan de Fuca. Peak currents at the Rosario Strait site exceed 180 cm/s, making this site the most dispersive of the three. Material placed at the Rosario Strait site is transported predominantly to the south, with smaller amounts of material moving to the north and east.



SOURCE: Adapted from Pequegnat 1983.

Figure 2. Schematic representation of the fate of dredged material released from a bottom dump barge.

8 Monitoring of Disposal Sites in Puget Sound

Disposal-site monitoring is conducted periodically to ensure that site management objectives are being met. A brief description of monitoring at dispersive and non-dispersive sites follows. Details of the DMMP monitoring program are included in DNR (2007).

8.1 Dispersive Sites

Dispersive sites are located in areas of high bottom currents where dredged material placed at the site is expected to be rapidly transported offsite. This precludes practical monitoring for chemically-induced biological effects. Consequently, the suitability guidelines for bioassays are more stringent for dispersive sites, and these sites are only monitored for physical conditions. Post-disposal hydrographic surveys are periodically conducted to determine whether material is remaining at the site or dispersing. The surveys consist of precision vertical soundings within the target perimeter. The baseline and post-disposal soundings are compared to determine whether dredged material is mounding within the target area. Baseline studies of the dispersive sites were performed in 1989 (PTI 1989). Three post-disposal bathymetric surveys conducted at the Rosario Strait disposal site in 1991, 1994, and 1999 demonstrated that no accretion of material within the disposal site had occurred.

8.2 Non-Dispersive Sites

Monitoring for non-dispersive sites consists of more rigorous evaluations to determine if the deposited material remains onsite; if the site conditions are being met; and if biological resources are being affected off-site. Monitoring data form the basis for the annual review of the dredged material evaluation procedures and site management plans. The frequency of post-disposal monitoring events varies by site and disposal volume. Monitoring involves the collection of physical, chemical and biological data at and near the site. Three types of post-disposal monitoring events are distinguished in the PSDDA monitoring framework:

- Full Monitoring - Mapping of the disposal site is accomplished through the use of sediment profile imagery (SPI), which determines the depth and spread of dredged material. Box core benthic samples and SPI photos are used to provide quantitative and qualitative information on benthic infaunal conditions onsite and offsite. Chemical monitoring is used to evaluate the concentrations of chemicals of concern present on and off the site, and whether or not they are present in concentrations that could cause unacceptable adverse impacts. Biological monitoring includes toxicity bioassays to assess onsite-dredged material. Additionally, offsite benthic communities are evaluated by a comparison of baseline data and post-disposal data along a gradient to determine whether unacceptable impacts from dredged material disposal are occurring. Monitoring parameters include sediment chemistry, sediment bioassays, infaunal tissue chemistry, and infaunal abundance.
- Partial Monitoring - for material with no or few SL exceedances, less rigorous site monitoring occurs. Partial monitoring includes bathymetric mapping of the site and use of SPI to determine the depth of dredged material and sediment dispersal. SPI is also used to provide information on general benthic conditions onsite and offsite. Partial monitoring includes collection of sediment at and near the site for analysis of chemicals of concern. No quantitative biological information (box cores) is collected during partial monitoring events.

- Tiered Monitoring – Only a portion of the samples are analyzed to verify that deposited material is staying on-site and that site conditions are met. If analysis of samples indicates that there may be unacceptable impacts offsite, the archived samples are analyzed to determine whether biological resources are being affected.

8.3 Monitoring History

To date, the DMMP agencies have conducted post-disposal monitoring surveys and special studies at all five of the PSDDA nondispersive sites and all three PSDDA dispersive sites, including the following:

- 7 full monitoring events (Port Gardner – 1990, 2006; Elliott Bay – 1992, 2000; Commencement Bay – 2001, 2007; and Anderson/Ketron Island – 2005)
- 5 tiered full monitoring events (Port Gardner – 1994, 2010; Elliott Bay – 2002; Commencement Bay – 1995, 2003)
- 3 partial monitoring events (Elliott Bay – 1990, 2013 and Bellingham Bay – 1993)
- 2 tiered partial monitoring events (Commencement Bay – 1996, 2004)
- 7 special studies (side-scan surveys at Bellingham Bay – 1993 and Elliott Bay – 1995, 2014; standalone SPI surveys at Commencement Bay – 1998, 2013; on-site chemical testing at Elliott Bay – 2005; SPI and phenol study at Commencement Bay – 2005);
- 11 bathymetric surveys (Commencement Bay – 2001, 2004, 2006, 2007, 2013; Rosario Strait – 1991, 1993, 1999, 2009; Elliott Bay – 2013; and Anderson-Ketron – 2014)
- Fate and Transport Study (2011) at PSDDA dispersive sites (Port Angeles, Port Townsend, Rosario Strait); Fate and Transport study at the Anderson-Ketron Island site (2014)

Based on PSDDA site monitoring data to date (including physical mapping, onsite and offsite chemistry, sediment toxicity, offsite infaunal bioaccumulation, and offsite benthic community structure data), dredged material disposal is not causing adverse impacts at or adjacent to the disposal sites. The DMMP evaluation procedures, as evidenced by 25 years of monitoring results, appear to have adequately protected the environmental conditions at all the disposal sites.

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