Draft
Alaska Dredged Material Evaluation Framework

Photos: Courtesy of USACE – Alaska District

US Army Corps of Engineers ®

EPA United States Environmental Protection Agency

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DEFINITIONS

Acute Toxicity: Short-term toxicity to organism(s) that have been affected by the properties of a substance, such as contaminated sediment. The acute toxicity of a sediment is generally determined by quantifying the mortality of appropriately sensitive organisms that are exposed to the sediment, under either field or laboratory conditions, for a specified period.

Advanced Dredging/Advanced Maintenance: Advanced maintenance is dredging to a specified depth and/or width beyond the authorized channel dimensions in critical and fast shoaling areas to avoid frequent re- dredging, and to ensure the reliability and least overall cost of operating and maintaining the project authorized dimensions.

Aliquot: A portion or subset of a sample. An aliquot can be any size, but it must be representative of the parent sample. See also, “Field Sample.”

Apparent Effects Threshold (AET): The sediment concentration of various chemicals of concern above which statistically significant adverse biological effects (relative to an appropriate reference condition) are always expected. Theoretically, an AET can be calculated for any chemical and biological indicator.

Aquatic Disposal: Placement of dredged material in rivers, lakes, estuaries, or oceans via pipeline or surface release from hopper dredges or barges.

Beneficial Use: Placement or use of dredged material for some productive purpose.

Bioaccumulation: The accumulation of contaminants in the tissues of organisms through any route, including respiration, ingestion, or direct contact with contaminated water, sediment, or dredged material.

Bioaccumulation Trigger (BT): For bioaccumulative chemicals of concern, the sediment concentration that constitutes a “reason to believe" level that the chemical would accumulate in the tissues of target organisms. Sediments with chemical concentrations above the calculated BT require bioaccumulation testing before suitability for in-water discharge can be determined.

Bioassay: A bioassay is a test using a biological system. It involves exposing an organism to a test material and determining a response. There are two major types of bioassays differentiated by response: toxicity tests which measure an effect (e.g., acute toxicity, sublethal/chronic toxicity) and bioaccumulation tests which measure a phenomenon (e.g., the uptake of contaminants into tissues).

Bulking Factor: The ratio of the volume occupied by a given mass of dredged material in either a hopper or bin immediately after deposition by a dredging process, to the volume occupied by the same mass of sediment in situ.

Capping: The engineered placement of a covering or cap of clean material over contaminated material to isolate the contamination from the aquatic environment. A cap is typically designed to remain in place and may require periodic monitoring to ensure continued effectiveness.

Chronic: Involving a stimulus that is lingering or which continues for a long time.

Clay: Soil particle having a grain size of less than 3.9 micrometers.

Comparability: The confidence with which one data set can be compared to others and the expression of results consistent with other organizations reporting similar data. Comparability of procedures also implies using methodologies that produce results comparable in terms of precision and bias.

Composite: The combination, in a representative manner, of multiple samples from a single DMMU for a single analytical sample.

Constituents: Chemical substances, solids, liquids, organic matter, and organisms associated with or contained in or on dredged material.

Contaminant: Chemical or biological substance in a form that can be incorporated into, onto, or be ingested by and is harmful to aquatic organisms, consumers of aquatic organisms, or users of the aquatic environment.

Contaminant of Concern (COC): A chemical present in a given sediment considered to have the potential for unacceptable adverse environmental impact.

Control Sediment: A sediment essentially free of contaminants and which is used routinely to assess the acceptability of a test. Control sediment is typically the sediment from which the test organisms are collected. Test procedures are conducted with the control sediment in the same way as the reference sediment and dredged material. The purpose of the control sediment is to confirm the biological acceptability of the test conditions and to help verify the health of the organisms during the test. Excessive mortality in the control sediment indicates a problem with the test conditions or organisms and can invalidate the results of the corresponding dredged material test.

Data Quality Objectives: Quantitative statistics and qualitative descriptors which are used to interpret the degree of acceptability or utility of data to the user; include bias (systematic error), precision, accuracy, comparability, completeness, representativeness, and statistical confidence.

Detection Limit (DL): The smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration with 99% confidence. At the DL, the false positive rate (Type I error) is 1%. A DL may be used as the lowest concentration for reliably reporting a detection of a specific analyte in a specific matrix with a specific method with 99% confidence. Detection limit, or DL, is generic terminology primarily associated with the Department of Defense (DoD) Quality Systems Manual (QSM) for environmental laboratories. DL and Method Detection Limit are both determined using a procedure that is compliant with the requirements of 40 CFR 136, Appendix B.

Discharge: Consistent the definition of "discharge of dredged material" in 33 CFR 323, this term signifies any addition of dredged material into the waters of the United States, including redeposit of dredged material other than incidental fallback within waters of the United States and other exclusions included in 33 CFR 323.2(d)(2).

Dredged Material: material (sediment) dredged from a waterbody.

Dredged Material Disposal Site: Geographic areas where specific disposal activities are permitted.

Dredged Material Management Unit (DMMU): A manageable, dredgeable unit of sediment which can be differentiated by sampling, and which can be separately dredged within a larger dredging area.

EC_{50}: The median effective concentration. The concentration of a substance that causes a specified effect (generally sublethal rather than acutely lethal) in 50% of the organisms tested in a laboratory toxicity test of specified duration.

Elutriate: Water derived from mixing a known volume of sediment with site water followed by a settling period. Elutriate water is used for chemical analyses and toxicity testing.

Emergency: In the context of dredging operations, emergency is defined in 33 CFR Part 335.7 as a "situation which would result in an unacceptable hazard to life or navigation, a significant loss of property, or an immediate and unforeseen significant economic hardship if corrective action is not taken within a time period of less than the normal time needed under standard procedures."

Estimated Detection Limit (EDL): The EDL is a sample- and analyte-specific detection limit that is based on the signal-to-noise ratio present in the sample for each analyte at the time of analysis.

Evaluation: The process of judging data in order to reach a decision.

Field Sample: Sediment sample collected from a specific vertical and horizontal location to be combined and homogenized for the creation of a composite sample. See also, "aliquot."

Fill Material: Material placed in waters of the United States where the material has the effect of: (1) Replacing any portion of a water of the United States with dry land; or (2) Changing the bottom elevation of any portion of a water of the United States. Examples of such fill material include, but are not limited to rock, sand, soil, clay, plastics, construction debris, wood chips, overburden from mining or other excavation activities, and materials used to create any structure or infrastructure in the waters of the United States. The term fill material does not include trash or garbage. Quoted in whole from 33 CFR 232.2.

Freshwater Sediment: Sediments in which the sediment pore water contains less than or equal to 0.5 parts per thousand salinity.

Gravel: A loose mixture of pebbles and rock fragments coarser than sand. Specifically, a soil particle having a grain size of greater than 2,000 micrometers.

Habitat: The specific area or environment in which a particular type of plant or animal lives. An organism's habitat provides all of the basic requirements for the maintenance of life. Typical coastal habitats include beaches, marshes, rocky shores, bottom sediments, mudflats, and the water itself.

Heterogeneous Sediment: Sediment that is stratified into layers that have potentially different physical or chemical characteristics. Heterogeneous sediments are typically sampled with a coring device that allows for separate sampling and analysis for surface and subsurface sediment layers.

Holding Time: The length of time between sample collection and analysis that is allowed for a given analyte without compromising the validity of the results.

Homogeneous Sediment: Sediment that is well-mixed and deposited over a short time-frame. Homogenous sediments are often found in settling basins or some navigation channels where river flow slows down abruptly.

In-water Disposal: The purposeful aquatic discharge of suitable dredged material for the purposes of disposal at an approved dispersive, non-dispersive, or flow-lane location.

K_{OW}: The octanol-water partition coefficient (K_{OW}) is a measure of the equilibrium concentration of a compound between octanol and water that indicates the potential for partitioning into organic matter (i.e., a high K_{OW} indicates a compound which will preferentially partition into organic matter rather than water). K_{OW} is inversely related to the solubility of a compound in water.

LC_{50}: The median lethal concentration. The concentration of a substance that kills 50% of the organisms tested in a laboratory toxicity test of specified duration.

Leachate: Water or any other liquid that may contain dissolved (leached) soluble materials, such as organic salts and mineral salts, derived from a solid material. For example, rainwater that percolates through a confined disposal facility and picks up dissolved contaminants is considered leachate.

Leave Surface Sample: A sample from the first two feet below the dredging overdepth, which must be collected during sampling of heterogeneous sediments, to characterize the surface exposed after dredging (leave surface).

Limit of Detection (LOD): The lowest concentration empirically determined to consistently provide a response meeting identification and minimum signal requirements for a specific analyte-matrix-method combination. This is an estimation of the smallest concentration of an analyte that shall be present in order to be detected with a result at or above the DL with 99% confidence (false negative, Type II, error of 1%). The LOD is the lowest concentration for reliably reporting a non-detect of an analyte. LOD is terminology primarily associated with the DoD QSM for environmental laboratories.

Limit of Quantitation (LOQ): The smallest concentration that produces a quantitative result with known and recorded precision and bias. The LOQ shall be set at or above the concentration of the lowest non-zero initial calibration standard and within the calibration range.

Maximum Level (ML): A guideline value derived for each chemical of concern which represents the highest Apparent Effects Threshold (AET) – a chemical concentration at which biological indicators show significant effects.

Method Detection Limit (MDL): The minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results. The MDL is a type of DL that protects against false positives (Type I error) only and has a 99% confidence level. MDL is commonly used in labs, including those outside the DoD QSM program. DL and MDL are both determined using a procedure that is compliant with the requirements of 40 CFR 136, Appendix B.

Overdepth: Paid allowable overdepth dredging (depth and/or width) is a construction design method for dredging that occurs outside the required authorized dredge prism. Paid overdepth is designed to compensate for physical conditions and inaccuracies in the dredging process and to allow for efficient dredging practices.

Practical Quantitation Limit (PQL): PQL was established by the EPA's drinking water program and has been adopted by various other State and Federal programs. It is the lowest concentration of an analyte that can be measured within specified limits of precision and accuracy during routine laboratory operating conditions. PQL is similar to LOQ commonly used in the DoD QSM program.

Pathway: In the case of bioavailable contaminants, the route of exposure (e.g., water, food).

Porewater: The water that fills the area between grains of sediment (interstitial water).

Practicable: Available and capable of being done after taking into consideration cost, existing-technology, and logistics in light of overall project purposes.

QA: Quality assurance; the total integrated program for assuring the reliability of data. A system for integrating the quality planning, quality control, quality assessment, and quality improvement efforts to meet user requirements and defined standards of quality with a stated level of confidence.

QC: Quality control; the overall system of technical activities for obtaining prescribed standards of performance in the monitoring and measurement process to meet user requirements.

Reason to Believe: Subpart G of the CWA 404(b) (1) guidelines requires the use of available information to make a preliminary determination concerning the need for testing of the material proposed for dredging. This principle is commonly known as "reason to believe" and is used in Tier 1 Evaluations to determine acceptability of the material for discharge without testing. The decision to not perform additional testing based on prior information must be documented, in order to provide a reasonable assurance that the proposed discharge material is not a carrier of contaminants.

Recency: The duration of time for which chemical and biological characterization of a given dredge prism remains adequate and valid for decision-making without further testing.

Reference Sediment: A whole sediment used to assess sediment conditions exclusive of the material(s) of interest that is as similar as practicable to the grain size of the dredged material. The reference sediment serves as a point of comparison to identify potential effects of contaminants in the dredged material.

Reference Site: The location from which reference sediment is obtained.

Reporting Limit: the lowest concentration that can be reported by a laboratory (usually defined by the lowest calibration point), generally represented by the LOQ/PQL.

Representativeness: The degree to which sample data depict an existing environmental condition; a measure of the total variability associated with sampling and measuring that includes the two major error components: systematic error (bias) and random error. Sampling representativeness is accomplished through proper selection of sampling locations and sampling techniques, collection of sufficient number of samples, and use of appropriate sub-sampling and handling techniques.

Resource Agencies: State and Federal agencies tasked with regulating, researching, and conserving aquatic resources. Including, but not limited to the Alaska Department of Fish & Game, National Marine Fisheries Service, and U.S. Fish and Wildlife Service.

Salinity: Salt content, usually expressed in grams of salt per kilogram of water or parts per thousand.

Sand: Soil particles having a grain size ranging between 62.5 micrometers and 2,000 micrometers.

Screening Level (SL): A guideline value defined for most of the ADMEF chemicals of concern that identifies a concentration at or below which there is no reason to believe that dredged material discharge would result in unacceptable adverse effects.

Sediment: Material, such as sand, silt, or clay, suspended in or settled on the bottom of a water body. Sediment input to a body of water comes from natural sources, such as erosion of soils and weathering of rock, or as the result of anthropogenic activities such as forest or agricultural practices, or construction activities. The term dredged material refers to material which has been dredged from a water body, while the term sediment refers to material in a water body prior to the dredging process.

Silt: Sediment having a grain size ranging between 3.9 micrometers and 62.5 micrometers.

Sublethal (Chronic) Toxicity: Biological tests which use such factors as abnormal development, growth, and reproduction, rather than lethality, as endpoints. These tests involve all or at least an important, sensitive portion of an organism's life-history. A sublethal endpoint may result either from short-term or long-term (chronic) exposures.

Suspended Solids: Organic or inorganic particles that are suspended in water. The term includes sand, silt, and clay particles as well as other solids, such as biological material, suspended in the water column.

Tiered Approach: A structured, hierarchical procedure for determining data needs relative to decision-making, which involves a series of tiers or levels of intensity of investigation. Typically, tiered testing involves decreased uncertainty and increased available information with successive tiers. This approach is intended to ensure the maintenance and protection of environmental quality, as well as the optimal use of resources. Specifically, least effort is required in situations where clear determinations can be made of whether (or not) unacceptable adverse impacts are likely to occur based on available information. Most effort is required where clear determinations cannot be made with available information.

Toxicity: Level of mortality or other endpoint demonstrated by a group of organisms that have been affected by the properties of a substance, such as contaminated water, sediment, or dredged material.

Toxicity Test: A bioassay which measures an effect (e.g., acute toxicity, sublethal/ chronic toxicity). Not a bioaccumulation test (see definition of bioassay).

Turbidity: An optical measure of the amount of material suspended in water. Increasing turbidity in water decreases the amount of light that penetrates the water column. Very high levels of turbidity can be harmful to aquatic life.

Water Quality Certification: A certification, pursuant to Section 401 of the Clean Water Act, which states that a proposed discharge of dredged or fill material will comply with the applicable provisions of the Clean Water Act and relevant State laws. Typically, this certification is provided by the affected State. In instances where the State lacks jurisdiction (e.g., Tribal lands and National Parks), such certification is provided by EPA or the Tribe.

Waters of the United States: Waters under jurisdiction of the CWA, as amended (40 CFR 230). Regulatory definitions and jurisdiction are subject to change and should be determined early in project planning.

Whole Sediment: The sediment and interstitial waters of a proposed dredged material or reference sediment that have had minimal manipulation. For purposes of this framework, press-sieving to remove organisms from test sediments, homogenization of test sediments, compositing of sediment samples, and additions of small amounts of water to facilitate homogenizing or compositing sediments may be necessary to conduct bioassay tests. These procedures are considered unlikely to substantially alter chemical or toxicological properties of the respective whole sediments except in the case of acid volatile sulfide measurements (EPA and USACE 1991), which are not presently required. Alternatively, wet sieving, elutriation, or freezing and thawing of sediments may alter chemical and/or toxicological properties, and sediment processed in such a manner should not be considered as whole sediment for bioassay purposes.

ACRONYMS AND ABBREVIATIONS

%R	Percent Recovery
°C	Degree Centigrade
AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADMEF	Alaska Dredged Material Evaluation Framework
ADNR	Alaska Department of Natural Resources
AET	Apparent Effects Threshold
AFDW	Ash-Free Dry-Weight
Agencies	USACE Alaska District, EPA Region 10, and ADEC
AK	Alaska
ANOVA	Analysis of Variance
AS	Alaska Statute
ASTM	American Society for Testing Materials
BCOC	Bioaccumulative Contaminants of Concern
BOD	Biological Oxygen Demand
BPJ	Best Professional Judgement
BT	Bioaccumulation Trigger
C	Control
CAS	Chemical Abstract Service
CDFATE	Computation of Mixing Zone Size or Dilution for Continuous Discharge
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIMC	Cleanups in My Community
CLP	Contract Laboratory Program
COC	Contaminant of Concern
COD	Chemical Oxygen Demand
CRM	Certified Reference Material
CS	Contaminated Site
CSL	Cleanup Screening Level
CW	Civil Works
CWA	Clean Water Act
CY	Cubic Yard
D-CORMIX	Dredging – Cornell Mixing Zone Expert System
D/F	Dioxins/Furans
DA	Department of the Army
DDD	Dichloro-diphenyl-dichloroethane
DDE	Dichloro-diphenyl-dichloroethylene
DDT	Dichloro-diphenyl-trichloroethane
DIFCD	Disposal – From a Continuous Discharge
DL	Detection Limit
DMMP	Dredged Material Management Program
DMMP UM	Dredged Material Evaluation and Disposal Procedures User Manual
DMMU	Dredged Material Management Unit
DQM	Dredging Quality Management
EC_{50}	Concentration Effecting 50% of the Population
EDL	Estimated Detection Limit
EFH	Essential Fish Habitat
EMPC	Estimated Maximum Possible Concentration
EPA	United States Environmental Protection Agency

ESA	Endangered Species Act
FDA	United States Food and Drug Administration
FPM	Floating Percentile Method
FWCA	Fish and Wildlife Coordination Act
g	Gram
GC	Gas Chromatography
GC/FPD	Gas Chromatography/Flame Photometric Detector
GC/MS	Gas Chromatography/Mass Spectrometry
GPS	Global Positioning System
HAET	Highest Apparent Effects Threshold
HARN	High Accuracy Reference Network
HASP	Health and Safety Plan
HCB	Hexachlorobenzene
HDPE	High-density Polyethylene
HPAH	High Molecular Weight Polycyclic Aromatic Hydrocarbons
HPGN	High Precision Geodetic Network
I	Initial Count
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
Ind	Individual
IP	Individual Permits
ISP	Invasive Species Partnership
ITM	Inland Testing Manual
JBER	Joint Base Elmendorf-Richardson
K_{ow}	Octanol-Water Partition Coefficient
LAET	Lowest Apparent Effect Threshold
LC_{50}	Lethal Concentration killing 50% of a Population
LCRMA	Lower Columbia River Management Area
LOA	Letter of Authorization
LOD	Limit of Detection
LOP	Letter of Permission
LOQ	Limit of Quantitation
LPAH	Low Molecular Weight Polycyclic Aromatic Hydrocarbons
LPC	Limiting Permissible Concentration
LUP	Land Use Permit
M	Mortality
MBTA	Migratory Bird Treaty Act
MDL	Method Detection Limit
MHW	Mean High Water
MIG	Mean Individual Growth
ml	Milliliters
ML	Maximum Level
MLLW	Mean Lower Low Water
MMPA	Marine Mammal Protection Act
MPRSA	Marine Protection, Research, and Sanctuaries Act
MS	Matrix Spike
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSD	Matrix Spike Duplicate
N	Normal
NA	Not Applicable
NAD	North American Datum
NAS	Nonindigenous Aquatic Species
NEPA	National Environmental Policy Act

NFG	National Functional Guidelines
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOCN	No Other Conditions Necessary
NOEC	No Observed Effect Concentration
NOS	National Ocean Service
NPDES	National Pollution Discharge Elimination System
NSRS	National Spatial Reference System
NWP	Nationwide Permit Program
O&M	Operations and Maintenance
ODMDS	Ocean Dredged Material Disposal Site
OHWM	Ordinary High-Water Mark
OTM	Ocean Testing Manual
oz.	Ounce
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated biphenyls
PCDD	Polychlorinated dibenzo-dioxins
PCDF	Polychlorinated dibenzo-furans
PeCDF	Pentachlorodibenzofuran
PFAS	Per- and Polyfluoroalkyl Substances
pH	Potential of Hydrogen
PPR	Prevention, Preparedness, and Response
ppt	Parts Per Thousand
pptr	Parts Per Trillion
PQL	Practical Quantitation Limit
PSDDA	Puget Sound Dredged Disposal Analysis
PSEP	Puget Sound Estuary Program
PSET	Portland Sediment Evaluation Team
PS-SRM	Puget Sound Standard Reference Material
QA	Quality Assurance
QC	Quality Control
QCP	Quality Control Plan
R	Reference
RCRA	Resource Conservation and Recovery Act
RD	Regulatory Division
Ref Tox	Reference Toxicant
RGP	Regional General Permit
RHA	Rivers and Harbors Act
RPD	Relative Percent Difference
RRDC	Regional Regulatory Division Chief
RSET	Regional Sediment Evaluation Team
RTK	Real-time Kinematic
SA	Spike Added
SAP	Sampling and Analysis Plan
SBH	Small Boat Harbor
SCO	Sediment Cleanup Objective
SD	Statistically Significant Difference
SEF	Sediment Evaluation Framework
SEMS	Superfund Enterprise Management System
Services	National Marine Fisheries Service and United States Fish and Wildlife Service

SIM	Selective Ion Monitoring
SL	Screening Level
SM	Standard Method
SQL	Sample Quantitation Limit
SQS	Sediment Quality Standard
SR	Sample Result
SRM	Standard Reference Material
SSR	Spiked Sample Result
STFATE	Short-Term Fate of Dredged Material Disposal in Open Water
T	Test
TBD	To Be Determined
TBT	Tributyltin
TCDD	Tetrachlorobenzodioxin
TEF	Toxicity Equivalency Factor
TEQ	Toxicity Equivalence
TIE	Toxicity Identification Evaluation
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TTL	Target Tissue Level
TVS	Total Volatile Solids
U.S.	United States
USACE	United States Army Corps of Engineers
USC	United States Code
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
W Test	Shapiro-Wilk test
WGS	World Geodetic System
WHO	World Health Organization
WOTUS	Waters of the United States
WPFPA	Watershed Protection and Flood Preservation Act
WQC	Water Quality Certification
ww	Wet Weight

1. INTRODUCTION

1.1. Overview

United States Army Corps of Engineers (USACE) and United States Environmental Protection Agency (EPA) share Federal responsibility for regulating the discharge of dredged material within waters of the United States (WOTUS) under Section 404 of the Clean Water Act (CWA). EPA regulates disposal of dredged material in ocean waters under Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA), assisted by USACE, which issues permits for dredged material disposal in ocean waters. Under Section 401 of the CWA, the State of Alaska must also certify that aquatic discharges do not violate State and Federal water quality standards.

This Alaska Dredged Material Evaluation Framework (ADMEF) provides a framework for assessing and characterizing dredge material to determine its suitability for aquatic discharge; for characterizing the post-dredge surface with respect to applicable sediment quality standards; and for ensuring that USACE Civil Works (CW) projects and Department of the Army (DA) permits comply with the CWA 404(b)(1) guidelines. The USACE Seattle District's Dredged Material Evaluation and Disposal Procedures User Manual (DMMP UM) was used as a basis for the preparation of this ADMEF. For the preparation of the ADMEF, the Alaska District of USACE, Region 10 of the EPA, and the Alaska Department of Environmental Conservation (ADEC) are the responsible agencies (Agencies).

1.2. Applicability and Limitations

Geographically, the evaluation procedures of this framework apply to dredging projects implemented or regulated by USACE Alaska District.

The ADMEF provides a framework for:

- Characterizing dredged material to determine its suitability for unconfined, aquatic discharge;
- Characterizing the post-dredge surface with respect to applicable sediment quality standards; and,
- Ensuring that USACE CW projects and DA permits comply with the CWA 404(b)(1) guidelines.

A high-level overview of the organization of the Regulatory permitting, Civil Works Planning, and Operations and Maintenance (O&M) program processes are included in Chapter 2 to orient the reader. Upland disposal of dredged material is not specifically included in the scope of the ADMEF. The ADMEF document also includes discussion of the MPRSA in Chapter 15 but is not intended as an ocean disposal framework. The ADMEF and data generated following publication of the ADMEF may also be useful for evaluating dredged material for in-water beneficial use (discussed in Chapter 14). However, beneficial use decisions involve additional resource agencies or cleanup programs and are not within the purview of this framework.

The Agencies recognize that the ADMEF is a living document and will need to be revised or updated periodically, as needed, to reflect changes made in the science and applicability. These changes may also be made through a public review process as described in Section 1.5.

This framework is aligned with programs in the continental United States (U.S.) including the Dredged Material Management Program (DMMP) in the State of Washington and the Portland Sediment Evaluation Team (PSET) in Oregon. All pertinent Federal and State laws, regulations, and guidance are considered in this ADMEF, and it is consistent with the guidelines of the National-level sediment assessment manual, i.e., Evaluation of Dredged Material Proposed For

Discharge in WOTUS Testing Manual, “Inland Testing Manual” (ITM). Nothing in this ADMEF alters or limits USACE or any other agency responsibilities or imposes mandatory requirements beyond existing statute or regulation.

The ADMEF guidance regarding sample handling, storage, analysis, and biological testing is consistent with State and Federal cleanup program guidance, which ensures consistent data quality across all relevant programs. However, this framework does not provide guidance for characterizing a contaminated site (CS) to make decisions regarding how the site will be managed. All sediment evaluations for cleanup actions under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) are to be coordinated through the appropriate State and Federal cleanup programs (see Section 1.3.6.).

1.3. Regulatory Basis for Sediment Evaluation

Several State and Federal agencies have regulatory authority governing the management of dredged material in the State of Alaska. USACE and EPA share Federal responsibility for regulating dredged material within WOTUS under Section 404 of the CWA and disposal of dredged material in ocean waters under MPRSA. Under Section 401 of the CWA, ADEC must certify that aquatic discharges do not violate State and Federal water quality standards. Alaska Department of Natural Resources (ADNR) Division of Mining, Land and Water manages Alaska State-owned waters, consisting of shorelands, tidelands, and submerged lands upon which dredged material discharge sites reside and may require additional coordination.

Figure 1-1 depicts vertical and horizontal data associated with regulatory jurisdiction of the CWA and MPRSA while **Figure 1-2** depicts the CWA and MPRSA jurisdictions as it relates to geographical features. The ordinary high-water mark (OHWM; non-tidally influenced areas) or mean high water (MHW; tidally influenced areas) is the boundary where State-owned waters begin. State submerged lands overlap with the State’s territorial sea that extend from mean lower low water (MLLW), or the “baseline of the territorial sea,” out to 3 nautical miles. These areas are under the jurisdiction of the CWA. CWA Section 404 regulates the dredging and discharge of material within inland and estuarine waters and the dredging and the discharge of fill within the territorial sea. Dredged material transported for the purposes of disposal beyond the baseline of the territorial sea, which is either MLLW or a closing line, is evaluated under Section 103 of MPRSA, also known as the Ocean Dumping Act. Closing lines are lines depicted across river mouths and bay openings on official U.S. Nautical Charts, e.g., regional National Oceanic and Atmospheric Administration [NOAA] nautical charts.

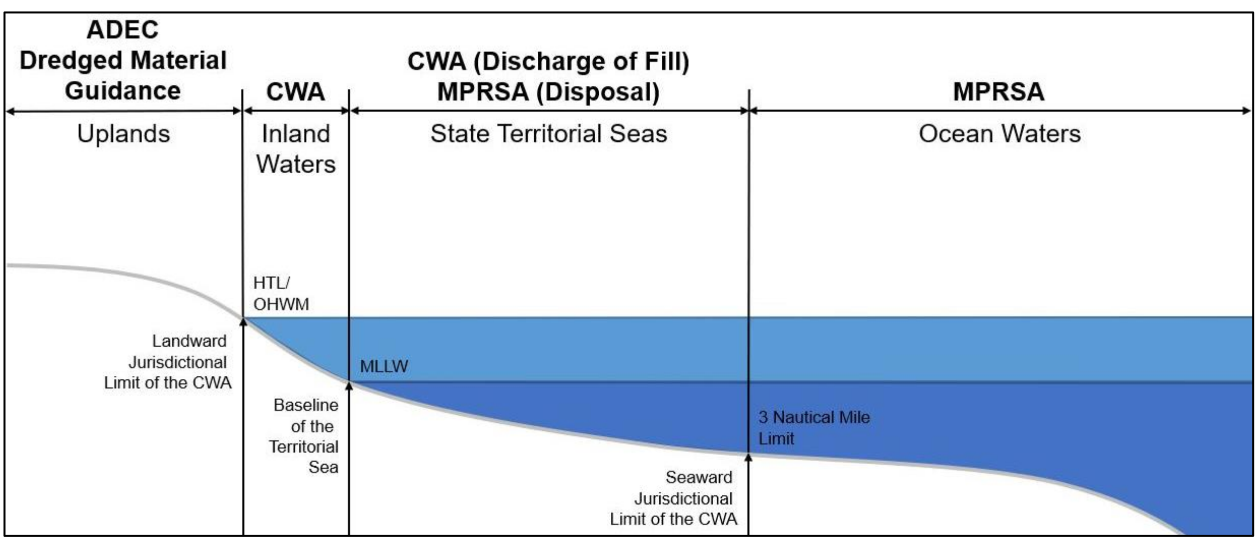

Figure 1-1. *Regulatory Jurisdictions in Relation to Vertical and Horizontal Data*

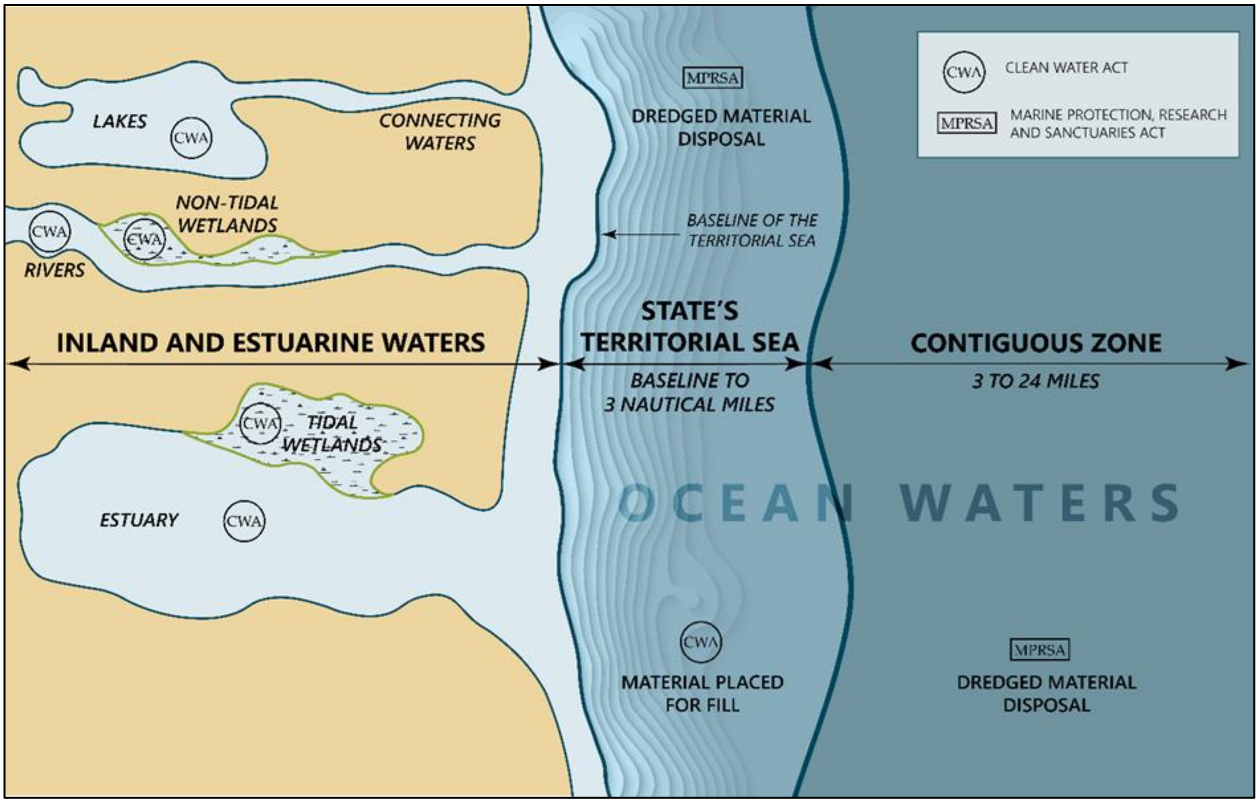

Figure 1-2. *Geographic Jurisdictions of the MPRSA and CWA Section 404(b)(1) (Engineer Manual 1110-2-5025)*

The sediment evaluations conducted under the ADMEF will assist other regulatory agencies in their assessment of potential effects to resources under their jurisdiction. The sediment evaluations can be used to support the National Marine Fisheries Service (NMFS) of the NOAA and the U.S. Fish and Wildlife Service (USFWS) analysis of potential effects to fish and wildlife species and critical habitat protected under the Federal Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA; discussed further in Section 1.3.4. and Section 1.3.5. respectively). The NMFS is also responsible for evaluating actions that may cause an adverse effect on essential fish habitat (EFH) pursuant to Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), which may be informed by these evaluations.

1.3.1. Clean Water Act

<u>Section 404</u>

The Federal Water Pollution Control Act of 1972 (amended and renamed the CWA of 1977) governs the discharge of dredged or fill material into WOTUS. The geographical limits of jurisdiction under the CWA include all WOTUS, as defined by 33 Code of Federal Regulations (CFR) 328.3. The CWA requires the EPA, in conjunction with USACE, to promulgate guidelines for the discharge of dredged or fill material to ensure that such proposed discharge will not result in unacceptable adverse environmental impacts, either individually or cumulatively, to WOTUS. The USACE and EPA also have authority under the CWA Section 404(b)(1) guidelines to identify, in advance, sites that are either suitable or unsuitable for dredged material discharge into WOTUS. USACE is responsible for authorizing all such proposed discharges and applying the guidelines to assess the least environmentally damaging practicable alternative to the proposed discharge, including alternatives that discharge into WOTUS (as defined by CWA Section 404(b)(1)).

Subpart B of the CWA 404(b)(1) guidelines (40 CFR 230.10-230.11) identifies restrictions on the discharges of dredged or fill material into WOTUS and the factual determinations that must be made in accordance with the restrictions. Subpart G of the CWA Section 404(b)(1) guidelines (40 CFR 230.60-230.61) identifies regulatory procedures for the general evaluation of discharges; Subpart G also identifies procedures for chemical, biological, and physical evaluation and testing of dredged and fill materials.

Section 401

CWA Section 401 allows States to issue a Water Quality Certification (WQC) with or without conditions, deny certification, or waive certification for any activity that results in a discharge into a water of the United States and requires a Federal permit or license. In Alaska (AK), the ADEC issues the CWA Section 401 WQC. A WQC is required by CWA Section 401 for the dredging activity itself as well as the discharge of the dredged sediments. Activities that only require a permit under Section 10 of the Rivers and Harbors Act (RHA, e.g., activities that do not result in a discharge of dredged or fill material under CWA Section 404 of the CWA) may still require a WQC if the ADEC or EPA have determined that there may be “discharges” associated with those activities. A WQC certifies that the activity complies with all applicable State and Federal water quality standards, limitations, and restrictions. Although provisional permits may be issued by Federal agencies, no work can be initiated until the WQC required by CWA Section 401 has been granted by the ADEC. Furthermore, no license or permit may be issued if certification has been denied. In many cases, the ADEC has issued programmatic WQCs for general permits (including nationwide permits) as assuming compliance with any conditions of the certifications.

1.3.2. Rivers and Harbors Act

Section 10

The RHA of 1899, codified in 33 United States Code (USC) Section 403, was designed to ensure the free flow of interstate commerce on the Nation’s aquatic “highways.” Under the RHA, any proponent who wishes to build a structure, or perform work in, above, or under navigable waters must receive a permit from USACE. Navigable waters are identified by Congress after a navigability study (this is performed by USACE in Alaska). A list of many, but not all, navigable waters in Alaska can be found on USACE website at: https://www.poa.usace.army.mil/Missions/Regulatory/Recognizing-Wetlands/Navigable-Waters/.

Most RHA Section 10 navigable waters have been defined without change for decades. Navigable waters under the RHA are defined differently than Traditional Navigable Waters under the CWA, though in many cases they overlap. Under 33 CFR 329.4 and RHA Section 10, waters are considered navigable if they are: 1) subject to the ebb and flow of the tide, and/or 2) are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. On the other hand, the CWA defines navigable waters as, “waters of the United States, including the territorial seas.” This definition is vague and does not aid in the general understanding of when the ADMEF should be used. In the ADMEF, the RHA definition for navigable waters will be used, since in most cases, if a CWA 404 permit is needed for a discharge of dredged or fill material in navigable waters, the work will also be reviewed under RHA Section 10 for potential impacts to navigation.

Section 14

Section 14 of the RHA of 1899, codified in 33 USC Section 408, established the Section 408 process to allow alterations, permanent occupation, or use of a Federally-authorized USACE

CW project including, but not limited to, Federal navigation channels, jetties, breakwaters, levees, dams, or other flood risk management projects. However, such actions cannot pose a risk to public interest and/or impair the usefulness of the Federally-authorized project. A Section 408 review would be required for a dredging project that would occur on real property of an USACE CW project; alter submerged lands occupied, used, and/or within an area subject to navigation servitude in the vicinity of a USACE CW project; or alter a Federal navigation channel subjected to RHA Section 9 or 10. For dredging operations that may impair a USACE CW project, a dredging proponent would be required to coordinate with the Regional Regulatory Division Chief (RRDC).

1.3.3. Marine Protection, Research, and Sanctuaries Act

The MPRSA of 1972 (also called the Ocean Dumping Act, 33 USC Section 1401 et seq.) governs the transportation of dredged material for the purpose of disposal into ocean waters. See Section 15 for further details.

1.3.4. Endangered Species Act

Section 7(a)1 of the ESA directs all Federal agencies to conserve endangered and threatened species and to use their authorities to further the purposes of the ESA in recovering ESA-listed species such that they can be delisted. ESA Section 7(a)2 outlines interagency cooperation procedures for Federal action agencies to consult with the USFWS and/or NMFS (Services) to ensure the actions they fund and/or permit do not jeopardize the existence of any ESA-listed species or adversely modify designated critical habitat in the action area of the project. Sediment evaluations (conducted in accordance with the ADMEF, Section 8 through Section 10) provide the Services with data to support evaluation of water quality effects at the dredging and discharge sites, and potential adverse impacts to prey species, food chain, and bioaccumulation of contaminants of concern (COCs) at the discharge site(s) or the post-dredge surface at the dredging location.

The issuance of a DA permit is a Federal undertaking and requires ESA Section 7 compliance for non-Federal dredging projects, so USACE Regulatory Division (RD) is required to consult with the Services for actions that may affect endangered species. The USACE RD project manager coordinates with the applicant/dredging proponent to provide information necessary to complete the ESA consultation and develop acceptable conservation measures.

1.3.5. Marine Mammal Protection Act

The MMPA, as amended (16 USC 1361 et seq.), was enacted in 1972 and prohibits the taking of marine mammals and imposes a complete ban on the importation of marine mammals and marine mammal products into the U.S. In areas where marine mammal occurrence is or has been observed, USACE or other regulatory permittees may be required to consult with the Services in accordance with the MMPA for potential effects to marine mammals during sediment evaluation actions (e.g., utilization of sampling equipment and/or exposure of marine mammals to COC). Consultation with the Services may result in a decision of a permittee to pursue an incidental take authorization. The MMPA and its implementing regulations include provisions for authorizing incidental take through the incidental take authorization process.

1.3.6. Comprehensive Environmental Response, Compensation, and Liability Act

The CERCLA, informally called “Superfund,” authorizes the EPA to identify and clean up CSs. Under the Superfund program, the EPA can also seek financial reimbursement for the cleanup work from the responsible parties.

Non-Federal dredging projects that lie within the boundaries of a CERCLA site are subject to additional coordination requirements. The EPA Remedial Project Manager for each Superfund site can best advise dredging project proponents of the necessary requirements. As previously noted in Section 1.2, the ADMEF does not address CERCLA sampling and analysis requirements; a dredging project within a CERCLA site that only follows the ADMEF may be required to perform additional subsequent characterization to fulfill CERCLA requirements.

USACE policy generally prohibits Federal dredging of CERCLA sites. Exceptions to policy may be granted on a case-by-case basis with proper approval.

USACE RD Project Manager can assist project applicants/dredging proponents by helping to coordinate a pre-application meeting with the necessary State and Federal agencies to ensure that both ADMEF and CERCLA program needs are met for evaluating a proposed dredging project.

1.3.7. Other Applicable Federal and State Laws and Regulations

Numerous other State and Federal laws may pertain directly or peripherally to dredging operations and dredged material and related discharge in the State of Alaska. See Section 2 for assistance in determining which laws/permits may apply to your project.

Other Federal laws pertaining to dredging projects may include, but not limited to, the following:

- National Environmental Policy Act (NEPA)
- Fish and Wildlife Coordination Act (FWCA)
- Magnuson-Stevens Fishery Conservation and Management Act (MSA)
- National Historic Preservation Act (NHPA), Section 106
- Migratory Bird Treaty Act (MBTA)
- Watershed Protection and Flood Preservation Act (WPFPA)

State of Alaska laws/programs pertaining to dredging projects may include, but are not limited to, the following:

- Alaska Statute (AS) 46.09 – Hazard Substance Release Control
- AS 16.20.500 – Critical Habitat Areas
- 18 Alaska Administrative Code (AAC) 60 – Solid Waste Regulations
- 18 AAC 70 – Water Quality Standards
- 18 AAC 75 – Oil and Hazardous Substance Regulations

1.4. Alaska Dredged Material Evaluation Framework

The ADMEF addresses the information needed to support decisions by USACE, ADEC, and EPA under CWA Section 404 and MPRSA Section 103. Other agencies may adopt the procedures described in this ADMEF and petition to join as signatories to the framework.

1.4.1. History and Structure

USACE Alaska District does not have a regional implementation manual for dredged material evaluations under CWA Section 404 or MPRSA Section 103. USACE Alaska District has relied on a range of guidance documents to conduct dredged material evaluations including: Lower Columbia River Management Area Dredged Material Evaluation Framework (LCRMA; EPA *et al.* 1998), Puget Sound Estuary Program (PSEP; PSEP 1986), Puget Sound Dredged Disposal Analysis (PSDDA; PSDDA 1988, 1989), Sediment Evaluation Framework (SEF) for the Pacific Northwest (RSET 2018), and the DMMP UM (DMMP 2021), in addition to the ITM (EPA and

USACE 1998) and Ocean Testing Manual (OTM; EPA and USACE 1991). As with other parts of the U.S., uniqueness of an area drives the need for regional specificity in implementation guidance of Federal law. In 2019, the Agencies began the process to develop an Alaska-specific framework to create efficiencies in the sediment evaluation process. Given the proximity of USACE Seattle District and Portland District to Alaska and the longstanding implementation of USACE Seattle District's DMMP UM and USACE Portland District's SEF for the Pacific Northwest, the ADMEF is relying heavily on the processes outlined in those documents.

1.4.2. USACE Alaska District

As a responsible agency for the ADMEF, USACE RD provides a "first-stop" with respect to sediment evaluation process for dredging proponents. Dredging permit Project Managers in USACE RD implement the ADMEF and impose testing requirements to adequately characterize dredged material in coordination with the applicant/dredging proponent and the Agencies.

USACE CW environmental staff also implement the ADMEF for authorized Federal navigation projects (O&M) and planned Federal navigation projects. Federal dredging projects are subjected to analysis commensurate with DA permit applicants for non-Federal dredging.

1.4.3. U.S. Environmental Protection Agency, Region 10

As another responsible agency, the EPA will evaluate the suitability for in-water discharge of the dredged material using the guidelines set forth in the ADMEF. When a proposed Alaska dredging project is located within a CERCLA site, EPA will assist in the coordination with the EPA Remedial Project Manager for that site to ensure that the dredging project and dredged material evaluation are compatible with remedial investigations and remedies. EPA is responsible for providing CWA Section 401 WQCs in Indian Country for Tribes who do not have treatment as a State and on lands with exclusive Federal jurisdiction. As a practical matter, in Alaska this results in a very limited number of EPA CWA Section 401s. Currently in Alaska, EPA is the CWA Section 401 certifying authority only for the Metlakatla Indian Community and for the Denali National Park and Preserve.

1.4.4. Alaska Department of Environmental Conservation

The ADEC representative assists in the evaluation of dredged material using the guidelines set forth in the ADMEF and the ADEC Dredged Material Guidance (ADEC 2013). The ADEC Division of Water representative writes the State's CWA Section 401 WQC. The ADEC Division of Water representative will serve as the ADEC's initial POC for all dredging project proposals and will coordinate with other State and Federal agencies as necessary. Division of Water staff will forward all dredging proposals to the ADEC Solid Waste and Contaminated Sites programs for review.

1.4.5. How to Contact Us

ADMEF program Agencies' staff are available to answer questions, assist in the development of sediment sampling and analysis plans (SAPs), and help troubleshoot during sediment sampling and testing.

Any questions, problems or issues related to dredged material management should be directed to the ADMEF program Agencies. Agencies' ADMEF contact information is as follows:

USACE RD

Physical Address:	2204 3rd Street
	Joint Base Elmendorf-Richardson (JBER), AK 99506-0898
Mailing Address:	U.S. Army Corps of Engineers, Alaska District
	CEPOA-RD
	P.O. Box 6898
	JBER, AK 99506-0898
E-mail:	regpagemaster@usace.army.mil
Phones:	(907) 753-2717; (800) 478-2712

U.S. Environmental Protection Agency, Region 10

Physical/Mailing Address:	Alaska Operations Office
	222 West 7th Avenue
	#19
	Anchorage, AK 99513
Email:	Call to Request
Phone:	(907) 271-5083/5084; (800) 781-0983

Alaska Department of Environmental Conservation

Physical/Mailing Address:	Alaska Department of Environmental Conservation
	Division of Water
	Wastewater Discharge Authorization Program
	555 Cordova Street
	Anchorage, AK 99501
Email:	DEC-401Cert@alaska.gov
Phone:	(907) 269-6096

1.5. Public Process to Modify the ADMEF

Members of the public or agencies wishing to petition the Agencies for changes (at any time) to the ADMEF should submit their comments, either in writing or via electronic mail, to the addresses above. The subject line should include “ADMEF” to ensure the correspondence is filed appropriately. The Agencies agree to meet regularly (2-3 times per year) and will evaluate comments as they are received. Comments that are determined to be substantive and induce changes to the ADMEF will be included in the subsequent update to the document.

2. DREDGING PROJECT PERMITTING

Dredging and dredged material management in WOTUS require various permits. Evaluation of the proposed dredged material utilizing the ADMEF is an integral part of the permitting process. This section provides an overview of the permitting process and the role that the sediment evaluation plays in that process.

2.1. Regulatory Permit Overview and the ADMEF Process

Prior to dredging, all dredging proponents must obtain the appropriate permits, licenses, or approvals. Depending on the scope and complexity of the project, permits may be required from Federal, State, county, city and/or local jurisdictions. First, to determine which regulation(s) (i.e., CWA, MPRSA, or Alaska Polluted Soil) may apply to a specific dredging project, it is recommended that dredging proponents utilize the flowchart in **Figure 2-1**. Next, early coordination and communication through a pre-application consultation with USACE is recommended. This may be one or more meetings between USACE staff, an applicant, and/or the applicant's agent or consultant. USACE may invite other agency members, such as EPA or ADEC, for a CWA Section 401 WQC certification on the applicant's behalf if they deem it appropriate. Pre-coordination for dredging projects is critical for identifying potential issues prior to starting the permitting process to; identify which environmental studies and Federal, State, and local permits will be required; ask questions; and focus efforts on the critical path early on to avoid or minimize project delays.

Some general permitting guidelines for non-USACE dredging and discharge projects:

- All in-water work in WOTUS requires a DA permit, a Federal permit issued by USACE RD.
- All dredging proponents should review the ADMEF process during the planning phase for characterizing sediments to determine the appropriate level of evaluation.

For projects within Alaska, USACE RD issues DA permits under the CWA, RHA, and MPRSA authorities. ADMEF documentation is an integral piece of information used by USACE RD Project Manager when evaluating permit requests and issuing the DA permits for dredging projects.

A project sediment quality evaluation will result in an ADMEF decision document that summarizes the project characterization process and data; and provides the regulatory permitting project manager with the information needed to support a permit decision. Types of ADMEF decision documents include a Tier 1 Evaluation, a Suitability Determination, a Leave Surface Characterization, a Recency Extension, or other documents related to sediment quality evaluations (refer to Section 3.1.).

Examples of additional laws, certifications, or permits commonly required for dredging-related projects in Alaska are presented in Section 1.3., **Figure 2-2**, and **Figure 2-3**; and they provide a simplified overview of the general permitting process.

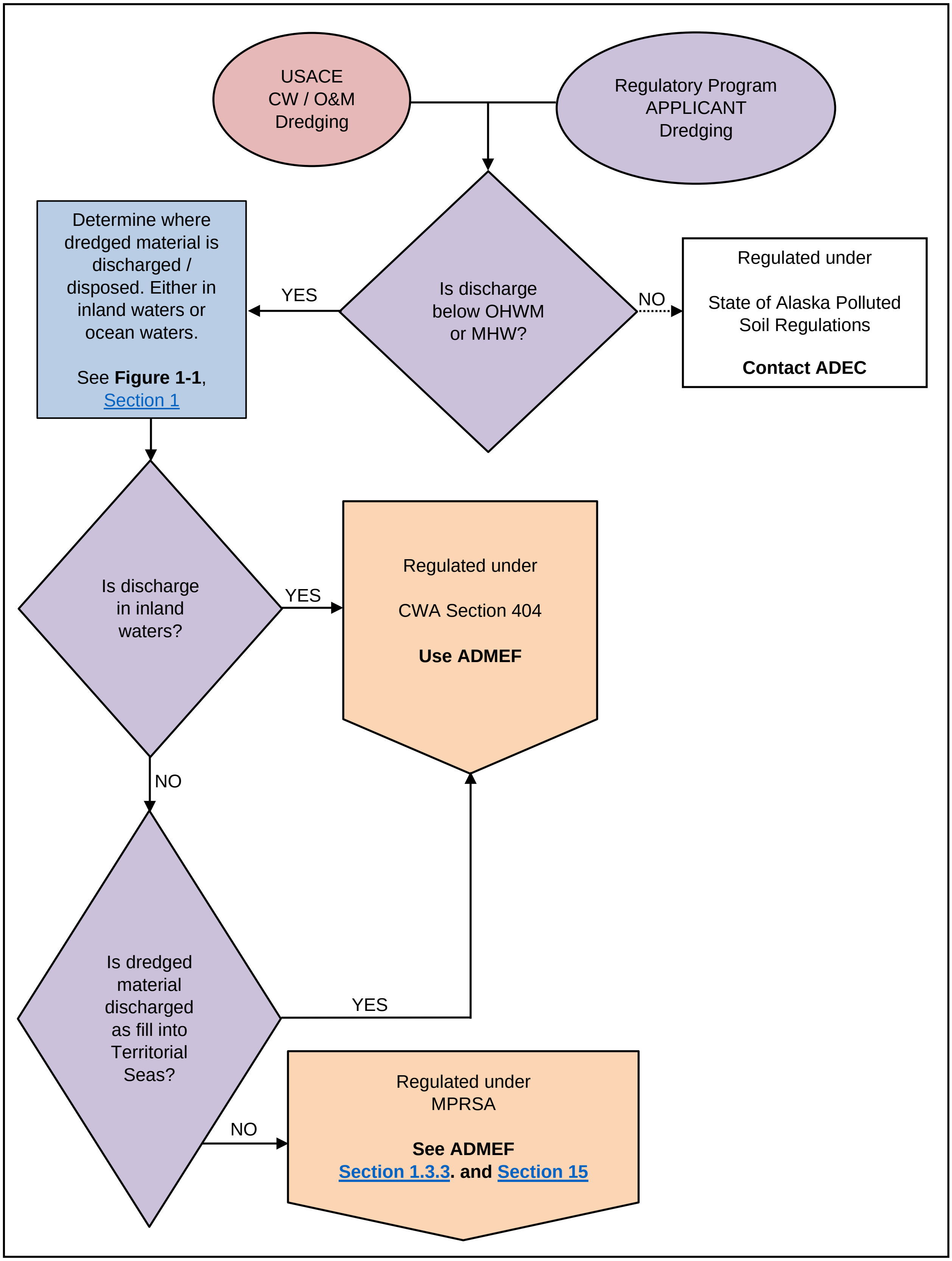

Figure 2-1. *Flowchart Determining whether Dredged Material is Regulated under CWA or MPRSA.*

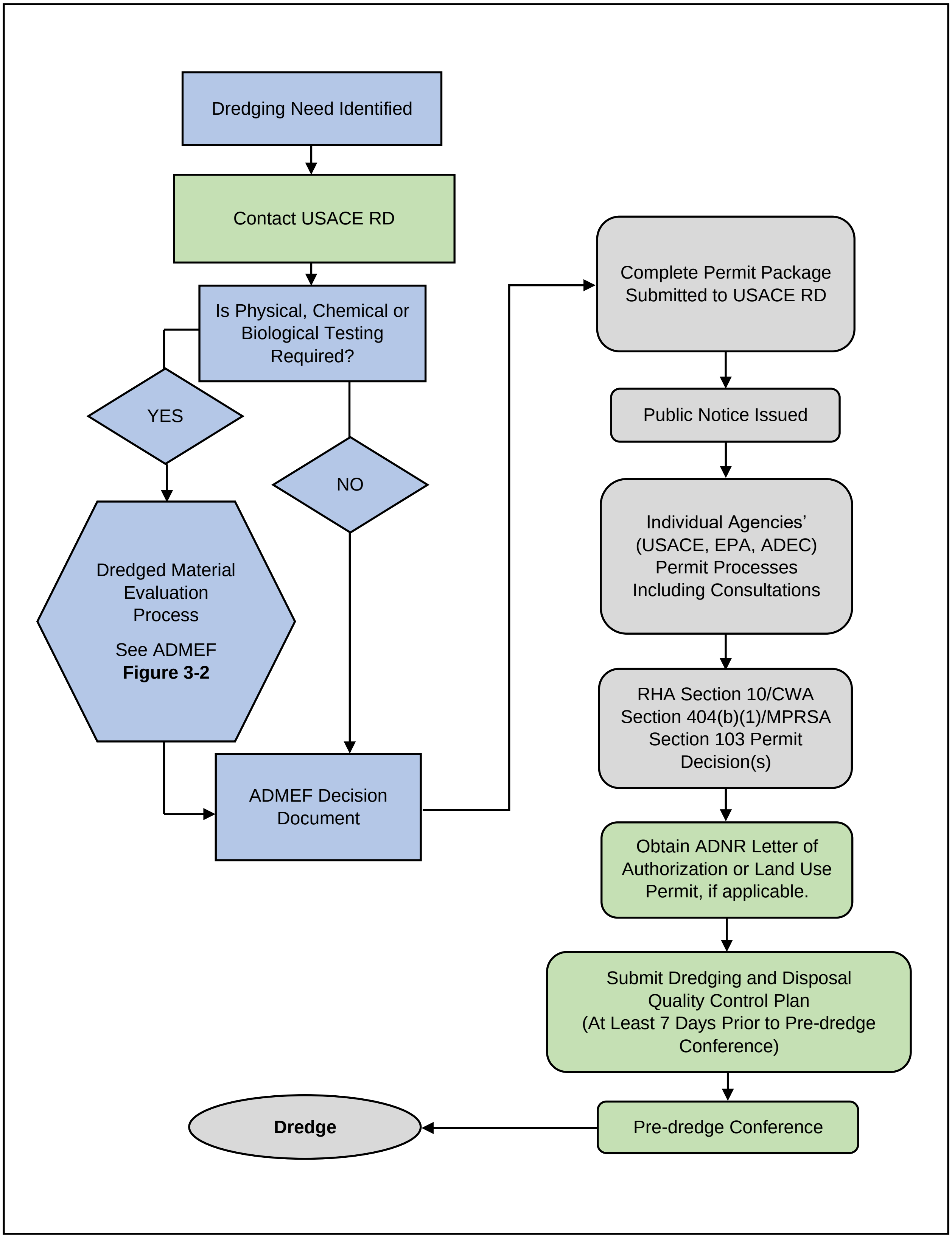

Figure 2-2. *ADMEF New Permit Regulatory Process*

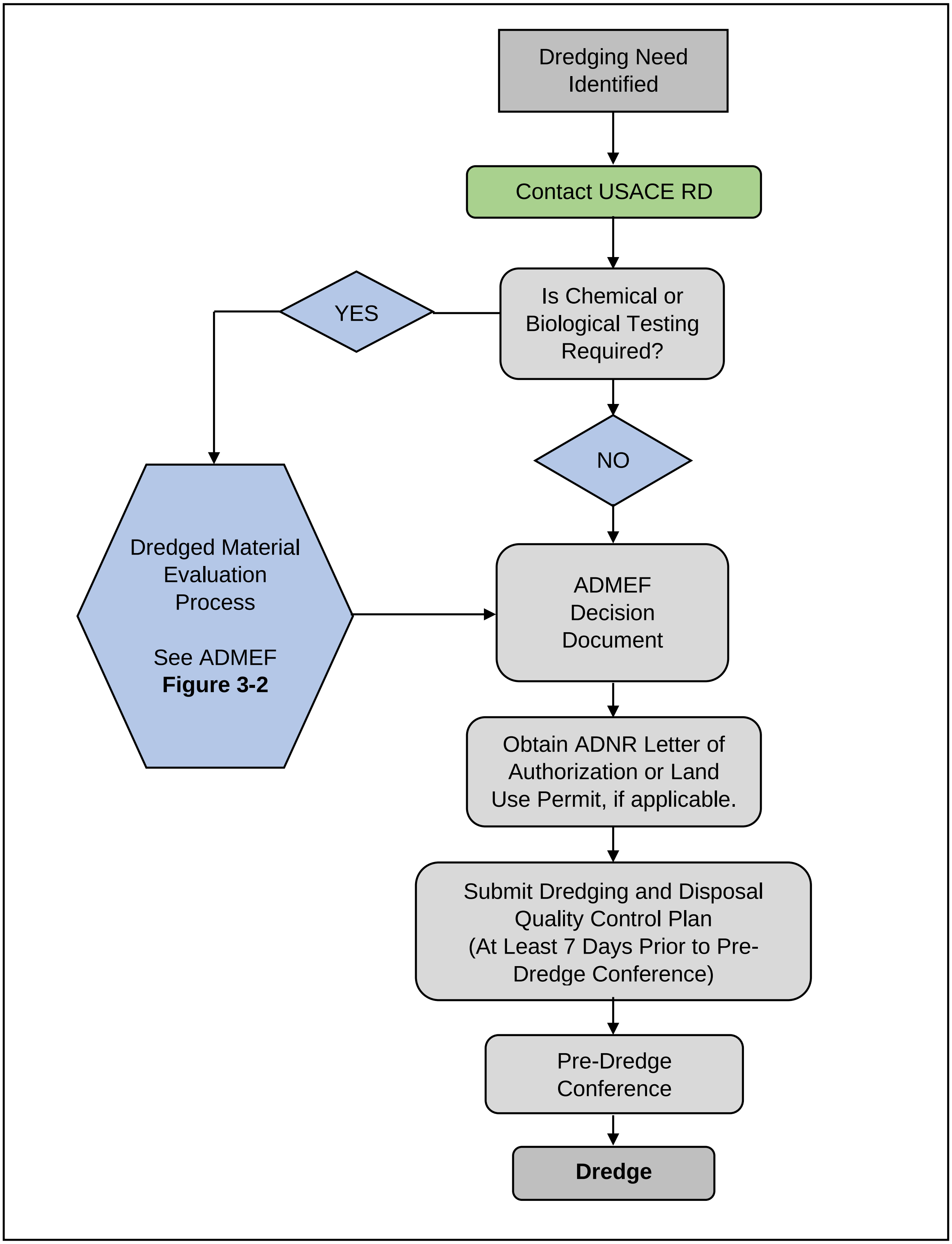

Figure 2-3. *ADMEF Regulatory Process Under an Existing Multi-Year Permit.*

2.2. Federal Permits

USACE RD permits dredging projects under two types of permits:

- Individual Permits - includes Standard Individual Permits (IPs) and Letters of Permission (LOPs)
- General Permits – includes Regional General Permits (RGP) and the Nationwide Permit Program (NWP)

Individual Permits are issued for specific projects, whereas General Permits can authorize many projects of a similar nature over a specified region. Typically, IPs undergo the greatest amount of analysis, requiring a public notice comment period as well as consideration of cumulative effects and an alternatives analysis if the project would result in a discharge of dredged or fill material. IPs can authorize project impacts under Section 404 of the CWA, Section 10 of the RHA, Section 103 of the MPRSA, or a combination of these laws. LOPs, a type of streamlined Individual Permit, can also be issued for projects that have no more than minor impacts to navigation and should not encounter appreciable opposition, such as residential piers and work in navigable waters. Although all applications qualifying as LOPs are categorically exempt from the NEPA, USACE must still comply with other laws like the ESA and CWA. LOPs can only authorize RHA Section 10 projects, while CWA Section 404 permits require additional authorization.

General Permits are intended to streamline the permitting process for projects that only have minimal individual and cumulative adverse environmental effects. Compliance with the NEPA, cumulative impact considerations, and alternatives analysis are completed programmatically for General Permits. The Alaska District RGPs can authorize specific actions State-wide or only in certain Alaska regions. Check with USACE RD for the RGPs currently in use or under review. NWPs are a type of General Permit issued across the entirety of the U.S.

USACE RD determines the type of permit and level of analysis appropriate for the project after reviewing the project impacts. Dredging and dredged material discharge projects frequently undergo USACE RD IP process due to the amount of work and material discharged. The IP process timeline can be highly unpredictable as it requires a full public interest review. A general expectation for the IP process is between 6 months to one year once a complete permit application has been accepted by USACE RD. Dredging proponents should not make assumptions regarding the timeframes for approval and should contact USACE RD (Section 1.4.5.) early in the planning process.

Section 2.1. outlined the typical regulatory permitting process with an emphasis on interactions with USACE RD.

2.3. State Permits

Prior to or concurrent with USACE RD DA permit process, dredging proponents would be required to obtain permits/approvals from local jurisdictions and/or State agencies.

Typical permits/approvals required in the State of Alaska may include, but not limited to:

- ADEC CWA Section 401 WQC
- ADNR Letter of Authorization (LOA) or Land Use Permit (LUP)
- Regional Floodplain Development Permit
- Alaska Department of Fish and Game (ADF&G) Fish Habitat Permit
- ADF&G Special Area Permit

These permits may not be coordinated by USACE RD project manager. The LOA or LUP (issued by ADNR) is required if the proposed project involves dredging of, placing fill material on, or altering of shorelines, tidelands, and submerged lands. When an individual CWA Section 401 certification is needed, the permit applicant must request (apply) for a WQC, and USACE cannot issue the CWA Section 404 permit prior to issuance of the WQC. USACE RD must check with ADNR during project planning and complete the LOA or LUP application and supplemental questionnaire for the use of marine waters including submerged lands/tidelands as required. This process should be initiated when coordination with USACE RD begins.

2.4. Sediment Quality Evaluation Timeline Considerations

When should dredging proponents conduct the sediment quality evaluation?

Proponents of dredging projects are encouraged to identify the need for a sediment quality evaluation early in the dredging project planning process. There are several advantages to this approach:

- Streamlines ESA Section 7 consultation – The Services commonly need the sediment quality evaluation to complete the ESA consultation.
- Streamlines CWA Section 401 State water quality certification – ADEC typically requires the sediment quality evaluation prior to completing their review and issuance of the WQC.
- Prevents delays in the DA permit evaluation – The sediment quality evaluation may require modifications to the initially conceived project plan prior to permit issuance. For example, the dredged material discharge site and/or dredging methods may change because of the sediment quality evaluation. Also, post-dredge surface management may be necessary. These changes may lead to permit processing delay or denial.
- Provides information needed for an informed public interest review – Conducting the sediment quality evaluation prior to release of the public notice ensures that reviewing entities have a better understanding of the project and avoids the need to potentially reissue the public notice should the sediment evaluation result in modification of the proposed project.

How much time is required for the ADMEF sediment quality evaluation process?

The time required for the ADMEF's sediment quality evaluation can vary significantly depending on the complexity of the proposed dredging project, whether biological testing is triggered, the need for CERCLA coordination, and/or any sampling or analytical issues encountered. A typical project that requires characterization may require anywhere from 4 months to a year or more to complete all the steps, which include developing a sampling plan, collecting samples, lab analysis, data interpretation, data report preparation, and preparation of the ADMEF decision document. Section 3 outlines this process in more detail.

USACE is the lead ADMEF decision document preparation agency for both Federal and non-Federal dredging projects. The partner agencies support the analysis, conduct reviews, and sign the decision document to indicate concurrence. Federal dredging proponents should begin considering sediment quality as soon as the need for dredging is identified to facilitate the integration of the ADMEF decision document into the overall project schedule, NEPA document preparation, WQC, and other requirements. For DA permit applicants, obtaining the DA permit and the ADMEF decision document are two separate but interdependent processes. The dredging proponent will need to coordinate with USACE RD for both a permit and USACE RD decision document (not to be confused with ADMEF decision documents described in Section 3.1.).

2.5. Special Types of Dredging and Permitting / Sediment Evaluation Considerations

2.5.1. Non-Federal Dredging Projects

Dredging of areas that have not previously been dredged will always require a new DA permit. Maintenance dredging, defined as dredging to maintain existing channels, harbors, berthing areas, etc., must also have a permit in effect to cover the planned work. If there is an existing DA permit, check the expiration date and permitted volume. Unless all projected dredging can be completed before the DA permit expires, a new permit (or extension of an existing permit) is required.

If a new permit is not required, the dredging proponent should check the recency date (expiration) and permitted volume of the ADMEF decision document. If dredging cannot be completed prior to expiration of the applicable decision document, the Agencies should be contacted for guidance. A new ADMEF decision document may be needed, which could require additional sampling and testing, or an extension of the recency period may be granted. The dredging proponent should also check the status of other regulatory permits for their work to ensure they are still in effect.

2.5.2. Federal (USACE) Dredging Projects

USACE maintenance dredging of Federal channels and dredging incident to new construction of USACE CW projects do not require a DA permit. However, USACE must still comply with the substantive requirements of the CWA, RHA, and the MPRSA, including the sediment evaluation procedures provided in this framework and other State guidelines. USACE is required to obtain a CWA Section 401 WQC from the ADEC when triggered by in-water discharge. If USACE is preparing a NEPA document concurrently with a CWA Section 401 WQC request, a joint public notice may be issued by USACE, and the public is directed to the ADEC for comments specifically on the Section 401 WQC. If USACE is not preparing a NEPA document for the proposed project and has no other reason to issue a public notice, ADEC will issue an independent public notice for the WQC.

Regular (annual or nearly annual) dredging projects are subject to the NEPA only if there is a substantive change in the project description, discovery of an insufficient analysis or undisclosed impacts, change in the environmental setting, or change of the status of a resource. Annual maintenance dredging contracts are generally multi-year contracts, and any required testing is conducted between contract cycles to prevent a change in condition. Testing is generally conducted if there has been a known change in condition that would suggest COCs concentrations may be higher than previously measured levels, the State water quality agency requires testing prior to the issuance of a WQC, or characterization of project-specific sediment has become inadequate and invalid for decision making without further testing in accordance with recency guidelines. A Tier 1 document is prepared and circulated to stakeholders (at a minimum the EPA and ADEC) to gain consensus on the need to test. USACE Alaska District has adopted the DMMP UM recency guidelines as its guidance for the duration sediment chemical and biological data will be adequate and valid (Section 5.2).

Non-annual dredging needs are identified by periodic project condition surveys, which precipitates the funding request. Funding levels are generally known by February of each year and construction contract award is targeted for approximately two years after planning funding is received. Environmental analysis under the NEPA is generally required for non-annual projects due to the long (10-40 years) interval between dredging iterations. Data needs are identified soon after planning funding is received, initiating coordination and data collection. A Tier 1 document is prepared and circulated to stakeholders (at a minimum the EPA and ADEC) to determine the need for testing. The NEPA coordination must be completed, and environmental clearances must be obtained prior to contract award. After contract award, contractor plans are submitted for a 30-day government review, and this includes a review for compliance with environmental requirements.

2.5.3. Beneficial Use of Dredged Material

The ADMEF program does not issue beneficial use determinations for dredged material. However, the data generated by the ADMEF sediment quality evaluation process may be utilized to make final beneficial use determinations. Material proposed for beneficial use in WOTUS is required to meet the ADMEF guidelines for aquatic discharge and/or other applicable sediment evaluation standards. Resource agencies or landowners/managers may have additional requirements for sediment characteristics (e.g., grain size), especially for in-water beneficial use or habitat creation projects.

Dredging proponents considering beneficial use projects are encouraged to coordinate with USACE RD and with other resource agencies early in the dredged material evaluation process. For more information on beneficial uses of dredged material, see EPA's Beneficial Use of Dredged Material page (https://www.epa.gov/cwa-404/beneficial-use-dredged-material-under-cwa-section-404), and USACE/EPA technical website, Beneficial Uses of Dredged Material (https://budm.el.erdc.dren.mil/). If the sediment proposed for beneficial use is State-owned, contact ADNR early to determine if additional considerations apply. Section 14 of this Framework includes more detail on the beneficial use of dredged material.

2.6. How To Get Help

For assistance with implementing the ADMEF, please contact USACE RD. See Section 1.4.5. for contact information.

3. CHARACTERIZING YOUR DREDGING PROJECT

Permits for dredging and the discharge of dredged material are integral to project ADMEF decision document(s). Changes in volume, dredge prism, dredge method, or discharge site(s) after ADMEF evaluation and agency coordination may result in delayed permitting, additional sediment testing, construction contract issues, or permit enforcement actions. Taking the time to plan a project carefully before proceeding to sediment characterization can save considerable time and costs from rework.

3.1. Types of ADMEF Decision Documents

USACE is the lead agency for the ADMEF decision document preparation for both Federal and non-Federal dredging projects. The Agencies provide technical support, adequacy review, and concurrence of the ADMEF decision documents. Completed ADMEF decision documents are posted to the USACE Alaska District website after concurrence. The major types of ADMEF decision documents prepared by the ADMEF Agencies are as follows:

- **Tier 1 Evaluation**: A Tier 1 document is written for projects that do not proceed past the Tier 1 analysis and documents the outcome of that evaluation. More information on Tier 1 Evaluations is provided in Section 4. In Alaska projects, including small projects, Tier 1 information is reviewed, and if through Agency coordination it is determined that sufficient information exists to make a decision, then additional sediment characterization may not be warranted. The type of ADMEF decision document that will be necessary for a project is largely determined by the type(s) of discharge proposed.
- **Suitability Determination**: The standard type of ADMEF decision document intended for projects with in-water discharge where some level of Tier 2 (Section 8) and/or Tier 3 (Section 9 and Section 10) testing was completed. This document typically also addresses the post-dredge leave surface (Section 12) and other project-specific issues such as debris management (Section 13.5). Detailed information regarding the evaluation procedures necessary for a Suitability Determination are included throughout this ADMEF.
- **Leave Surface Characterization**: Prepared for projects for which in-water discharge is not proposed and the sampling is only conducted to determine that the post-dredging sediment surface will not be more degraded than the existing sediment surface. See Section 12 for more information on leave surface evaluations.
- **Recency Determination**: Prepared for projects for which existing sediment testing results are evaluated to verify that they are “recent” enough to be representative of the project. More information can be found in Section 5.2.
- **Volume Revision**: Documents changes in project volume and if/how the previous project documentation applies to the new volume. More information can be found in Section 13.6.
- **Special/Supplemental Determination**: The least common type of decision document; an example would be a supplement to an original Suitability Determination due to the availability of new or changed information.

3.2. Evaluating Discharge Options

Before embarking on the dredged material evaluation process, the dredging proponent should identify discharge location(s) for the dredged material, because testing and suitability decisions are unique to each location. Possible discharge options will depend on the location of the project, but the three general categories are as follows:

1. Upland Disposal (subject to State of Alaska Polluted Soil Regulations and ADEC Dredged Material Guidance [ADEC 2013]).
2. Aquatic Discharge in WOTUS (subject to regulation under the CWA). Aquatic discharge can include disposal in Inland Waters (those waters within a closing line or baseline) or the placement of fill to create any structure or infrastructure in WOTUS.
3. Disposal in ocean waters subject to MPRSA (see Section 15).

3.3. The Dredged Material Evaluation Process

The main questions evaluated by the ADMEF are:

- What is the regulatory jurisdiction for the project based on geographic location of the proposed discharge site(s), and what is the intent of the proposed discharge activity (placement as fill, beneficial use, or disposal)?
- Is proposed dredged material suitable for in-water discharge? If in-water discharge, is discharge at an existing discharge site?
- Is proposed dredged material suitable for in-water beneficial use (Section 14)? In general, material proposed for beneficial use needs to meet not only the CWA guidelines for beneficial use, but the State of Alaska requirements such as 18 AAC 70, Alaska Water Quality Standards (ADEC 2013). For Federal beneficial use, the material must be used for authorized purposes. The data generated by the dredged material evaluation process is available to evaluate beneficial use, but the ADMEF does not provide the final determination of project material suitability (EPA and USACE 2007). Resource agencies or landowners/managers may require more stringent comparisons, especially for in-water beneficial use or habitat creation projects.
- Will the proposed dredged material potentially be disposed in an upland location (e.g., landfill) or beneficially reused in an upland area (Section 14)? Upland disposal of dredged material is not specifically included in the scope of the ADMEF. Material disposal will be regulated under the State of Alaska Polluted Soil Regulations (18 AAC 60.025) according to the ADEC Dredged Material Guidance (ADEC 2013). If the background concentrations are equal to or greater than those within the dredged material, no solid waste authorization will be required.
- Will the post-dredge surface maintain and protect existing water uses and the level of water quality necessary for those existing uses?

To answer these questions, the ADMEF uses a four-tiered approach to characterize sediment for discharge into WOTUS (**Figure 3-1**):

Tier 1: Site history and evaluation to document potential past and present sources of contamination of dredged material proposed for in-water discharge (Section 4).

Tier 2: Chemical testing of the dredged material for all COCs and conventional sediment parameters listed in Section 8 and identified during the Tier 1 Evaluation.

Tier 3: Bioassay, and if needed, bioaccumulation testing when Tier 2 chemical testing indicates the potential for unacceptable adverse environmental (Section 9) or human health effects (Section 10).

Tier 4: Special, non-routine evaluations performed when Tier 2 and Tier 3 evaluations are unable to determine the suitability of dredged material for open-water discharge (Section 11).

Every project is subject to a Tier 1 Evaluation, which is a review of existing information including historical and ongoing sources of contamination, land use, and any previously collected data (Section 4). In Alaska, a Suitability Determination can often be made using only Tier 1 information. For other projects, Tier 1 informs the characterization required in subsequent tiers. If additional information is needed to make a decision, the project moves to Tier 2 chemical testing. Tier 3 biological testing is invoked if COCs are present at concentrations that are of potential concern for human health or the environment, generally indicated by exceedance of Tier 2 screening levels (SLs). Time can be saved by compressing Tiers 2 and 3; that is, by conducting concurrent chemical and biological testing in situations where there is reason to believe Tier 2 SLs will be exceeded. Tier 4 testing is rarely required by the Agencies or pursued by dredging proponents. If Tier 4 testing is needed, it is project-specific and designed in coordination with the Agencies.

It is always the dredging proponent's decision to proceed to the next tier for further testing; the option of disposing of material in an appropriate upland location rather than pursuing further testing for in-water discharge is always available. The dredged material evaluation process is required for every dredging cycle. In some cases, this process will be as simple as checking to see if an existing Suitability Determination covers the proposed dredging, as might be the case for frequent, routine maintenance dredging. In other cases, Tier 2 and Tier 3 testing may be required. Regardless of the project, coordination with the Agencies needs to be conducted and documented.

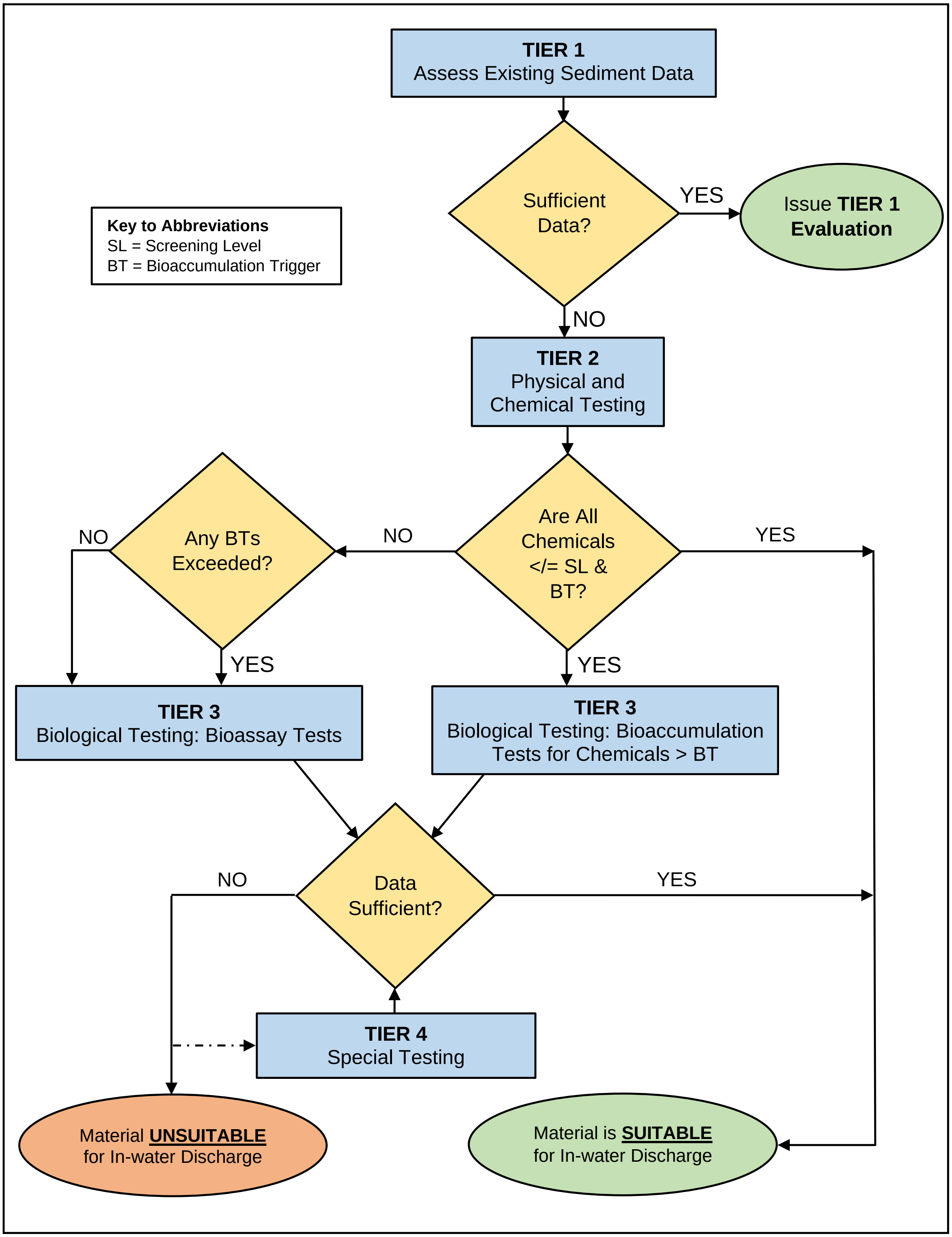

Figure 3-1. *The Basic Tier Sequence of Dredged Material Evaluation for Discharge under CWA Section 404 (Adapted from Figure 3-2 of the DMMP UM; DMMP 2021).*

The dredged material evaluation process consists of the following steps (**Figure 3-2**):

1. Dredging proponent contacts USACE RD and then defines and submits a conceptual dredging plan (Section 3.4.) and site history (Section 4.1) for development of the Tier 1 Evaluation.
2. Tier 1 Evaluation:
   a) For projects disposing of dredged material in ocean waters under MPRSA, criteria described in 40 CFR 227.13(b) are evaluated to determine whether the sediments may be excluded from testing and documentation of the consistency with the exclusionary criteria is prepared. This documentation will be included in the required submittal to the EPA by USACE for concurrence to dispose of dredged material in ocean waters under Section 103 of the MPRSA.
   b) For discharge under Section 404 of the CWA, USACE drafts a Suitability Determination based on the Tier 1 Evaluation alone and consults with EPA and ADEC. Upon concurrence of the determination, no additional testing is required.
   c) Determination that inadequate information is available, and a Tier 2 evaluation is required.
3. If a Tier 2 evaluation, and potentially a Tier 3 evaluation, is determined to be needed, the dredging proponent (with consultant assistance as needed) determines project-specific sampling and analysis requirements, as stipulated in this framework. Since a Tier 4 evaluation is uncommon it is not included in these steps.
4. Dredging proponent develops a SAP for sediment evaluation (Section 5 and Section 6).
5. Dredging proponent submits a SAP to USACE RD.
6. Dredging proponent may be required to address USACE RD comments and re-submit the SAP.
7. USACE RD will coordinate the review and send SAP approval letter(s) or email message(s) to the dredging proponent.
8. A pre-sampling conference call between the Agencies and sampling team may be scheduled prior to the beginning of sampling.
9. Dredging proponent conducts field sampling and laboratory testing.
10. Dredging proponent submits a Sediment Characterization Report (Section 6.6) to the Agencies for review.
11. Dredging proponent may be required to address comments and re-submit the Sediment Characterization Report if it does not meet ADMEF requirements.
12. USACE RD drafts and the Agencies review and sign a Suitability Determination.

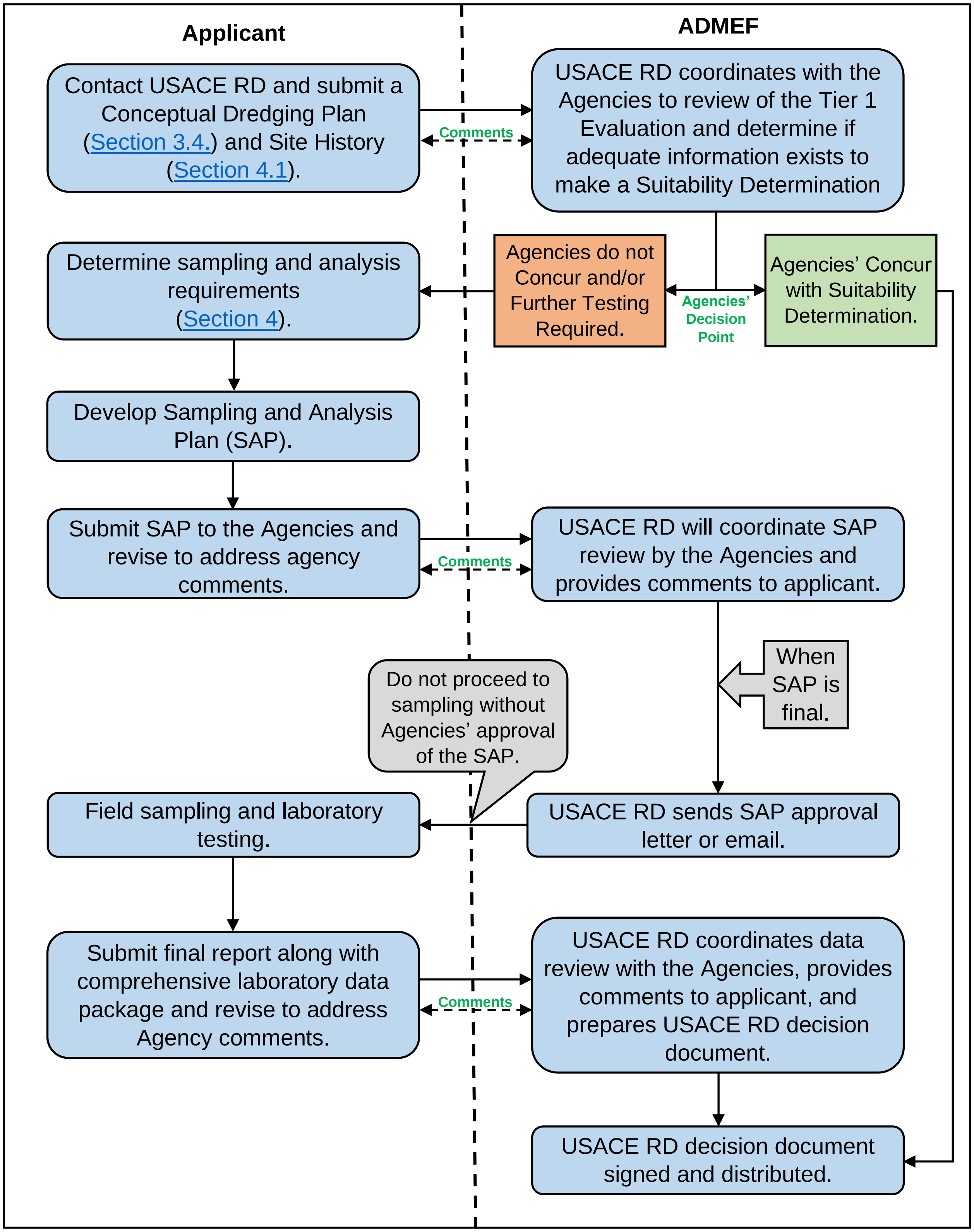

Figure 3-2. *Dredged Material Evaluation Process.*

3.4. Developing a Conceptual Dredging Plan

Defining the project is one of the most important steps in sediment evaluation. The requirements for a complete USACE RD permit application are defined in 33 CFR 325.1(d). Similar information is required to conduct the Tier 1 Evaluation. A conceptual dredging plan is the ideal tool to provide a complete project description; the plan should include:

1. Project location, including site description/characteristics for the area(s) to be dredged and description/characteristics of the proposed discharge site(s), including potential fill and beneficial use sites, background information about the recency of dredging, project depth, and geology. Additionally, if known, possible contamination sites that potentially affects the waters and sediment of the project area need to be noted.
2. A current hydrographic survey showing project drawings, sketches, and plans with the dredging project dimensions clearly labeled: length, width, depth, advanced maintenance (if planned), overdepth limit, side slope and box cut material, and anticipated sloughing material.
3. Drawings, sketches, or plans showing the site and plans for discharge of the dredged material.
4. Figures showing existing storm drainages and outfalls, and special aquatic sites (e.g., wetlands, eelgrass beds, ponds, lakes) relative to the project footprint.
5. Type, composition, and volume of the material to be dredged.
6. Site characteristics that could affect movement of contaminants (e.g., vessel traffic [prop wash, hull displacement, and wakes], river flows, tidal and wave action, bar scalping, and proximity to other dredged sites or channels).
7. Method(s) of dredging.
8. Method(s) of transportation and discharge of the material.

The physical geometry and volume of sediments proposed for dredging must be determined from a pre-dredge/pre-sampling bathymetric survey. The total dredging volume calculation should include the material within the authorized project prism, advanced maintenance material (if proposed), overdepth material, material dredged from side slopes and box cuts, and sediments anticipated to slough from under piers and wharves (Tavolaro *et al.* 2007). For habitat restoration projects, terrestrial topographic surveys and proposed cut-fill lines, waterline (OHWM or high tide line), and wetland boundaries should be included in the project design drawings. This information will be used to establish dredged material management units (DMMUs) across the dredging projects. These terms are discussed in Section 5.

Before starting the dredged material evaluation process, the dredging footprint, design depth, overdepth and other characteristics of the dredging project must be determined. While construction-level detail is not required at this point in the process, a realistic conceptual dredging plan will aid in the development of a SAP (if needed) and avoid permitting delays and construction issues further along in the process.

If sampling and testing are anticipated, the conceptual dredging plan should also consider the ramification of various testing outcomes. This topic is addressed in more detail in Section 5.

3.5. Determining Volume of Material to be Dredged

For each project, whether for a new project or recurring project, such as maintenance dredging, the physical geometry and volume of sediments proposed for dredging should be determined from a pre-dredge/pre-sampling bathymetric survey. The dredging volume calculation should include side slopes, overdepth, any advance maintenance depth, and sediments anticipated to slough from under piers and wharves. Dredging contracts routinely include "overdepth" material that is often one to two feet below the required dredging depth. Overdepth volume will be included in the calculation of the requirements for sampling and analysis. Likewise, volume attributed to advance maintenance depth for projects in critical and fast shoaling areas will be included in the calculation for purposes of the sampling and analysis.

Volume estimates are incorporated into the project permits, WQC, and other applicable coordination documents. Exceedances of permitted volumes may result in fines or work stoppages. Thus, it is important to develop an accurate volume estimate of material to be dredged. To reduce the incidence of permit violations, the following guidelines should be followed:

1. Pre-sampling surveys should be taken as close in time as possible to the sampling event to get the best possible bathymetric data for volume estimates.
2. Pre-sampling volume estimates must include allowable overdepth for the entire dredging prism, including side slopes and any proposed advance maintenance.
3. When a box cut is proposed along a pier face, sloughing from under the pier should be anticipated in all cases. The dredging proponent should ensure that all necessary geotechnical or under-pier survey data be provided to the contractor estimating the dredged material volume.
4. It is highly recommended that pre-sampling estimates of in-situ volume be increased by an uncertainty factor to account for the error inherent in the estimation process:

    - Uncertainty in the pre-sampling bathymetric data
    - Uncertainty from the volume estimation process
    - Shoaling that occurs between the pre-sampling survey and the time of dredging
    - Failure to include overdepth material, side slopes or "non-pay" volume

    Sampling and testing requirements will be based on an adjusted volume. The uncertainty factor for the adjustment must be identified in the SAP along with a technical justification for its selection. It should be noted that the uncertainty factor applies only to estimates of in-situ volume and is not meant to address bulking of sediments during dredging. For clarification on how to analyze and determine the uncertainty factor for adjusted volume, refer to DMMP 1996: Dredged Material Volume Estimates.
5. Up to 2 feet of additional shoaling is permitted between the time of sampling and dredging without the need for additional characterization. It is the dredging proponent's responsibility to identify the need for a volume adjustment as a result of post-sampling shoaling. Volume adjustments should be made prior to issuing the public notice if possible. If significant shoaling occurs after the public notice has been issued, written requests for permit revisions must be made to the Agencies as early as possible and before dredging commences.
6. Some areas experience unpredictable shoaling rates. This could be due to any number of factors, including but not limited to, climate conditions such as ice formations and/or frequency as well as intensity of winter storms. Since sampling and testing are required prior to dredging, not all the sediment to be dredged may

have been deposited at the time of sampling. In such instances, an estimate needs to be made of the additional sedimentation expected between the time of sampling and time of dredging. Known sedimentation rates for the area, records from previous dredging events, extrapolation from existing conditions, and best professional judgement (BPJ) can be used to estimate the volume of sediments likely to be dredged. The rationale for calculating the contingency volume should be included in the sampling plan. Sampling and testing requirements must include this contingency volume.

7. Volumes would be confirmed from post-dredge bathymetric surveys.

3.6. Issue Resolution for ADMEF Decision Documents

There should be early and frequent communication between the USACE RD project manager and dredging proponent. Communication throughout the process may be able to highlight and resolve issues as they arise, particularly before the Suitability Determination is finalized, if possible. If conflicts cannot be avoided, the preferred method of resolving project-specific issues is for the dredging proponent to communicate promptly with ADMEF agency staff to identify issues and work toward their resolution prior to finalization of a ADMEF determination. In order to facilitate this process, the USACE RD project manager assigned to a project will communicate in advance with the dredging proponent to ensure that the dredging proponent understands the determination being made and the rationale for agency decision-making. Issues identified by the dredging proponent or disagreement with the determination should be brought to the USACE RD project manager's attention prior to the Suitability Determination being signed. ADMEF staff and managers will commit to do their best to resolve issues raised by the dredging proponent in a timely fashion.

In the event that a project-specific solution cannot be reached or the dredging proponent disagrees with the ADMEF agency staff's determination, the dredging proponent has the option of elevating the issue incrementally. The dispute could be elevated from the staff level to first-tier management level, and potentially onto senior-level management if necessary.

4. TIER 1: EVALUATION/SITE HISTORY

Tier 1 is a comprehensive analysis of all readily available existing information on the proposed dredging project, including a site history with all previously collected physical, chemical, and biological data. The type and amount of information required for a Tier 1 Evaluation will vary according to the size and complexity of the project and the history of the dredging site and associated sources. **Every dredging project is subject to Tier 1 analysis**; a necessary step to describe the site history and establish the framework for evaluation and subsequent tiers.

A Tier 1 Evaluation is necessary to inform the entire sediment evaluation process. It's not necessarily a long or complex process, but it is vital to determining all further steps for a given sediment evaluation. Providing the Tier 1 information is the responsibility of the dredging proponent and needs to be included in the project SAP if a Tier 2, 3, or 4 evaluation is required. Tier 1 requirements include a complete project description and site history with a compilation of existing information. Tier 1 Evaluation can often be performed early in the process. Suggested Tier 1 timing for common project types are:

- USACE CW projects: the Tier 1 Evaluation can generally be completed within the first 6 months of the planning charrette, or identification of the need for dredging.
- USACE O&M projects: the Tier 1 Evaluation can generally be completed within 3 months of project kickoff, pursuant to a review of historical documents (NEPA, feasibility studies, bathymetric surveys, project history documents).
- DA Permit projects: Tier 1 Evaluation can and should be performed during the pre-application phase, prior to the submission of a USACE RD permit application.

For a Tier 1 Evaluation, the two major components that the dredging proponent (or its consultants) need to provide to the Agencies are as follows:

- Conceptual Dredging Plan (see Sections 3.4.).
- Site History (see Section 4.1.).

4.1. Site History

The history of a project area plays a pivotal role in project evaluation and, if necessary, the SAP development. The purpose of the site history is to document potential past and present sources of dredged material contamination. A site history characterizes known activity at the dredging site and adjacent properties and provides a comprehensive description of watershed activities that may contribute to elevated levels of COCs, e.g., anthropogenic or geological. It identifies past activities and describes the type of contamination that may have resulted from those activities.

The following outline identifies the type of information that may be necessary in a site history for a large, complex site. Smaller projects in areas of lower concern will require less information. For most projects, site histories do not need to extend beyond 2 to 3 pages. A reasonable effort should be made to obtain relevant data. It is recognized that certain types of data may not be readily available, but efforts made to obtain it should be documented. Previous characterization and dredging in the area should be referenced and summarized to the extent possible. Emphasis should be placed on activities that have occurred since the last dredging cycle if dredging is not a one-time event. The site history should identify whether the proposed dredging project is within or adjacent to a past, existing, or proposed EPA or ADEC-listed CERCLA, Resource Conservation and Recovery Act (RCRA), or State CS and the appropriate site manager (if known). In addition to any in-water CS and locations of waste left in place, this should include upland sites in parcels adjacent to the in-water work area.

The site history should include, but is not limited to, the following information as applicable to the specific project's dredging site:

1. A map showing the site's location, layout, storm drainage, outfalls, and special aquatic sites such as eelgrass or wetlands.
2. Current site use.
3. Industrial processes at or near the site. Include any hazardous substances used/generated; like mining activities within the watershed, log transfer facilities or log rafting areas, nearby aquaculture operations, and fish processing activities that may have occurred at or near the proposed dredge site or upland areas that may drain to the site.
4. Outfall information, such as: type, volume, National Pollution Discharge Elimination System (NPDES) data.
5. State contaminated, CERCLA or RCRA site information (including site manager if known), as well as those on adjacent upland areas (e.g., location of caps, sheet pile containment, use restrictions).
6. Spill events.
7. History of site ownership and land uses.
8. Adjacent property uses, especially those up-gradient or up-current/upstream.
9. Site characteristics that could affect movement of contaminants (e.g., prop wash, vessel traffic, etc.).
10. Results of any previous sampling and testing on and around the project site.
11. Presence or absence of invasive species (Section 4.2).
12. Evidence of the presence/absence of debris, whether natural or anthropogenic, in the dredge prism based on previous rounds of dredging or other lines of evidence.
13. Geologic history, e.g., how the material came to be in its present location and elevation.
14. Sediment sources and deposition rate.
15. Hydrodynamic energy exposure.

4.1.1. Sources of Information

A large variety of information sources may be used for site histories. Potential sources include:

1. Current and previous property owners.
2. Aerial photographs (past and present).
3. Real estate and Sanborn Fire Insurance maps.
4. Zoning, topographic, water resource, and soil maps.
5. Bathymetric surveys and nautical charts.
6. Bore logs or geotechnical reports from proximal construction projects (e.g., pile driving, breakwaters, docks, etc).
7. Hydraulic data including tidal predictions, wave height information, and current velocity.

8. Marine traffic data (Automated Information System) to identify traffic patterns and informal anchoring locations.
9. Agency records such as NPDES permit files, contaminated site lists (State and Federal), CERCLA construction completion, and long-term monitoring reports, aquatic leases, previous permits, databases, etc.
10. Land use records.
11. Knowledgeable persons at or near the site (e.g., Tribes, managers, employees, adjacent property owners, harbor masters).
12. City atlases.
13. Agency environmental databases:
    - EPA Superfund Enterprise Management System (SEMS) Database: https://enviro.epa.gov/envirofacts/sems/search
    - EPA Cleanups in My Community (CIMC) Database: https://www.epa.gov/cleanups/cleanups-my-community
    - ADEC Contaminated Sites Database: https://dec.alaska.gov/Applications/SPAR/PublicMVC/CSP/Search/
    - ADEC Prevention Preparedness and Response (PPR) Spills Database: https://dec.alaska.gov/Applications/SPAR/PublicMVC/PERP/SpillSearch

Not all the above listed sources are needed for every project, and the type and number of sources consulted will vary. Smaller projects and those with less complicated source histories will generally require less documentation but should always include enough information to enable the Agencies to adequately address sampling and testing requirements. Dredging proponents can contact USACE RD to determine the level of effort required for their specific project. USACE RD will coordinate with the other Agencies as necessary to determine project-specific requirements.

4.1.2. Testing Exclusions Based on Tier 1 Analysis

Section 404 of the CWA includes provisions for exclusion from testing based on Tier 1 Evaluations (40 CFR 230.60), as does the ITM guidance document (EPA and USACE 1998). Additionally, the MPRSA includes exclusion provisions in 40 CFR 227.13 (see Section 15). A project may be given a rank of very low and be excluded from testing under any of the following conditions:

- Based on the site history information review (Tier 1), the proposed dredged material is sufficiently removed from potential sources of sediment contamination, either geospatially or vertically (in the case of native sediment[1]), and bioaccumulative compounds are not likely present at levels of concern based on review of historical data and comparison to ADMEF SLs and bioaccumulation triggers (BTs). An exception to this is where sediment at depth may be contaminated by groundwater.
- The site is subject to strong current and/or tidal energy and contains coarse-grained

[1] Native sediment is defined as previously un-dredged sediment that has been assessed as unimpacted by anthropogenic activities and sources. Naturally occurring metals may still need to be characterized in the native sediment to determine discharge status.

sediment with at least 80% sand/gravel retained in a No. 230 sieve and total organic carbon (TOC) content of less than 0.5%. Grain size and/or TOC analysis may be necessary in some cases to demonstrate that the dredged material meets the numerical guidelines. In other cases, photographic evidence of grain size (e.g., a photo of a gravel or sand bar obstructing navigation) may be sufficient to rank a project “very low” without having the dredging proponent analyze for grain size or TOC.

- The discharge site is adjacent to the dredged site and subject to the same sources of contaminants, the materials at the two sites are substantially similar, and the material when dissolved or suspended can be controlled to prevent the carrying of pollutants to less contaminated areas (40 CFR 230.60(c)).
- It is a small project where there is low potential risk of unacceptable adverse effects resulting at the discharge site from the discharge of dredged material. This is to balance the cost of testing against the environmental risks posed by discharge of a very small volume of dredged material. As a result, a small volume of sediment to be removed at a dredging site may require no testing or reduced testing.

  Qualifiers for being considered a small project include (1) no unjustified intentional partitioning of a dredging project to reduce or avoid testing requirements; (2) project volumes are defined in as large a context as possible, recognizing that multiple small discharges can cumulatively affect the discharge site. One example of this latter qualifier is recurring maintenance dredging of a small harbor where the "project volume" for dredging is projected over a period of analysis. In this instance, a multi-year authorization could potentially be acquired to streamline the effort for each individual dredge event.

All testing exclusions are project-specific and may be subject to other regulatory authorities and guidelines.

4.1.3. Tier 1 Suitability Determinations

The possible outcomes of a Tier 1 Evaluation are:

1. For projects disposing of dredged material in ocean waters under MPRSA, exclusionary criteria are evaluated to determine whether the sediments may be exempted from testing under 40 CFR 227.13(b). Documentation of the consistency with the exclusionary criteria is prepared and will be included in the required submittal to EPA for concurrence to dispose the dredged material in ocean waters under Section 103 of the MPRSA (see Section 15).
2. USACE drafts a Suitability Determination based on the Tier 1 Evaluation alone and consults with EPA and ADEC. Upon concurrence of the determination, no additional testing is required.
3. Determination that inadequate information is available, and a Tier 2 evaluation is required.

Given the provisions in Section 4.1.2., the Agencies may issue Suitability Determinations based on a Tier 1 Evaluation alone.

4.2. Invasive Species

The project area must be checked against online resources for the known or suspected presence of invasive species. The following websites may be helpful to check for documented presence of invasive species of concern:

1. ADF&G Invasive Species:

   https://www.ADF&G.alaska.gov/index.cfm?ADF&G=invasive.main
2. ADNR Invasive Plants and Agricultural Pest Management:

   http://plants.alaska.gov/invasives/index.htm
3. AK Invasive Species Partnership (ISP):

   https://alaskainvasives.org/
4. University of Alaska Anchorage – Alaska Natural Heritage Program site for invasive plants:

   https://aknhp.uaa.alaska.edu/apps/akepic
5. U.S. Geological Survey (USGS) Nonindigenous Aquatic Species (NAS) – includes nationwide distribution maps for many NAS:

   https://nas.er.usgs.gov/
6. USFWS Alaska Region Invasive Species:

   https://fws.gov/initiative/invasive-species-alaska

This list is not exhaustive; other sources of information may exist. Sources used should be cited. The result of this check must be documented in the decision document or, if testing is required, in the SAP. If the project is located within an area known or suspected of harboring invasive species, then dredging proponents are encouraged to contact ADF&G as early as possible in the project planning stages to obtain further guidance. Depending on the project location, design, and invasive species involvement, transportation of dredged material may be prohibited or restricted and could significantly impact projects. The SAP also needs to include sampling equipment cleaning procedures to prevent the transfer of invasive species from sampling efforts (see Section 7.4.2.).

5. DEVELOPING SAMPLING AND ANALYSIS REQUIREMENTS

Once a Tier 1 Evaluation is completed and it is determined that additional project characterization is needed, the steps listed below are followed to determine the requirements for the Tier 2 characterization of project sediments:

1. Determine the rank for the project.
2. Determine the volume of material to be dredged and frequency of dredging (if not already done).
3. Determine required number of DMMUs and field samples.
4. Refine the conceptual dredging plan.
5. Determine DMMU distribution to reflect the conceptual dredging plan by allocating the required number of field samples and presenting a compositing scheme for combining field samples to represent each DMMU.
6. Determine if any non-standard COCs are required.

These steps must be documented in the SAP developed for review by the Agencies.

NOTE: If the proposed project is within an EPA CERCLA or RCRA site or an ADEC CS, the dredging proponent should coordinate with the relevant agency early since additional sampling requirements may be required.

5.1. Determine Project Rank

A dredging area, or a specific project, is typically assigned one of five possible ranks: *high*, *moderate*, *low-moderate*, *low,* or *very low* (**Table 5-1**). These ranks represent the Agencies' BPJ of the level of concern or potential risk associated with site sediments, typically based on a potential for adverse biological effects or elevated concentrations of COC. The lower the rank, the less the concern of contamination. Thus, lower ranks have less intense sampling and testing requirements required to adequately characterize the dredged material. The ranking system is based on two factors:

1. The available information on the sediment physical composition and chemical and biological-response characteristics.
2. The number, kinds, and proximity of potential existing and historical contamination sources.

For dredging projects with sufficient historical data, the assigned ranking is based on the available physical, chemical, and biological data for project sediments. For projects lacking sufficient historical data, the number, kinds, and proximity of contamination sources are the major factors driving the assigned rank.

5.1.1. General Rankings

Certain geographic areas and use activities are assigned a general rank based upon the nature and extent of possible sources of COCs that could impact project sediments. In the absence of sediment quality data to the contrary, industrialized areas (as well as areas located within EPA CERCLA/RCRA or ADEC CS boundaries; see databases listed in Section 4.1.1.) are initially ranked *high*. Areas with potential sources of COCs but limited shoreline industrial development are initially ranked *moderate.* Areas that are geographically removed from potential sources of COCs are ranked *low-moderate*, *low,* or *very low* based off the information available and used in the Tier 1 analysis.

Table 5-1 defines the general ranking guidelines used to determine an initial project ranking.

Table 5-1. *General Dredged Material Ranking Guidelines*

Rank	Guidelines
Very Low (VL)	Typical locations include gravel bars, mainstem channels, and coastal inlets subject to the ebb and flood of tide. General characteristics of Very Low-ranked sites include: • Project is sufficiently removed from potential sources of sediment contamination either geospatially or vertically (in the case of native sediment). • There are no known or suspected CSs within the watershed. • Bioaccumulative compounds are not likely present at levels of concern based on review of historical data and comparison to ADMEF BTs. • The site is subject to strong current and/or tidal energy and contains coarse-grained sediment with at least 80% sand retained in a No. 230 sieve and TOC content of less than 0.5%.
Low (L)	Typical locations include areas adjacent to entrance channels, rural harbors, navigable side sloughs, and small recreational docks. General characteristics of Low-ranked sites include: • Low concentrations of non-bioaccumulative COCs may be present at site (at or below SL values) and/or no significant response in biological tests. • Sites have higher percentage of fine-grained sediments (and associated TOC), but few sources of potential contamination exist. • Bioaccumulative compounds are not likely present at levels of concern based on review of historical data and comparison to region-specific BTs. • Depositional materials do not originate from or near contaminated areas and do not contain chemical contaminants at levels of concern.
Low-Moderate (LM)	A "low" rank may be warranted for the site, but sufficient data is unavailable to validate the "low" rank.
Moderate (M)	Typical locations include harbors with limited shoreline industrial development that may include ferry terminals, fueling and ship berthing facilities, construction facilities, military sites, and fish processing facilities, and may include locations located close to moderate-sized sewer or stormwater outfalls, mining activities, or logging. General characteristics of Moderate-ranked sites include: • Concentrations of COCs in project sediments are in a range known to cause adverse response in biological tests. • Locations where sediments are subject to sources of contamination, where existing or historical use of the site or contamination within the watershed has the potential to cause sediment contamination, or bioaccumulation has been identified as a potential problem for higher level receptors. • Areas characterized with aggregating materials that could have originated near contaminated areas.
High (H)	Typical locations include urban areas and shoreline areas with major industrial development. Projects located within or adjacent to ADEC contaminated or CERCLA cleanup sites may require more intensive sampling and/or higher-resolution chemical analyses. General characteristics of Moderate-ranked sites include one or more of the following conditions in the project area: • High concentrations of COCs in sediments (relative to SLs) and/or significant adverse responses in at least one of the last two cycles of biological tests. • Locations where sediments are subject to numerous sources of contamination, including industrial runoff, past releases, and stormwater outfalls, or where existing or historical use of the site or within the watershed has the potential to cause sediment contamination. • Bioaccumulation has been identified as a problem for receptors exposed to accumulated sediments.

A single ranking may be assigned to a project depending upon the size of the proposed dredging area, volume proposed for dredging, and the distribution of potential contaminant sources. After gathering the Tier 1 information, the dredging proponent may propose a rank for the project. However, the Agencies make the final decision regarding the project rank. There is a single rank for the overall project. However, a project's DMMUs can rank differently and require different sampling intensity. This is discussed more in Section 5.4. There are currently five annual O&M projects in Alaska that have a project rank. Their project ranks are based on the latest information and are subject to change in the future (**Table 5-2**).

Table 5-2. *Current Area and Ranking for O&M Projects in Alaska*

Area	Details	Rank[1]
Anchorage Harbor	Coastal inlet subject to ebb and flood of strong tides.	Low-moderate
Nome Harbor	Bypass dredging to complete longshore transport of sand.	Low-moderate
Dillingham SBH	Rural half tide harbor with seasonal use.	Low-moderate
Ninilchik SBH	Rural half tide harbor with seasonal use.	Low-moderate
USCG Berth, Pioneer Dock, Homer, Alaska	Fine sand; area adjacent to Homer SBH entrance channel.	Low
Homer SBH - Entrance Channel DMMU	Coarse accumulated material and coal fragments originating from areas distant from sources of contamination.	Low
Homer SBH – Inner Harbor DMMU	Rural harbor with fine-grained sediments.	Moderate

SBH = Small Boat Harbor, USCG = United States Coast Guard.
[1]Rankings are as of May 2024.

5.1.2. Outfalls

Some small dredging projects consist of the removal of sediment discharged from an outfall, or area located directly adjacent to an outfall. Outfall within a general geographic area is ranked *low*, *low-moderate*, or *moderate*, but it is possible that these sediments contain chemicals at a level of concern far greater than the area in general. Therefore, such dredging projects may be given a rank higher than the general rank of the area by the Agencies. This decision will be made on a case-by-case basis, with consideration given to the type and size of the outfall, the shoaling pattern relative to the outfall, and any other relevant information available to the dredging proponent, such as catch basin data, particulate data, and types of activities associated with the outfall.

5.1.3. Re-Ranking of Areas/Projects/Project Reaches

The Agencies will re-evaluate rankings after each characterization. A project area can be ranked higher (e.g., from low-moderate to moderate) based on the results of a single characterization (e.g., elevated chemistry, a bioassay failure, or by adversely changed conditions in or near the dredge area). Consistent results from two consecutive characterizations are required before a ranking can be lowered (e.g., from high to moderate).

Unique to Alaska, prior to a new project (e.g., port, ferry terminal) being constructed the project maybe ranked low or very low. This may be due to the project location being sited in an undeveloped area and with no potential proximal sources of contamination. However, once the project is constructed and maintenance dredging becomes necessary, the project must be re-ranked to consider the need for sediment testing.

5.2. Recency Guidelines

Recency guidelines indicate how often a project needs to conduct sediment characterization. Recency guidelines apply to both projects that have been tested but not yet dredged, and to projects that have been maintained with repeated dredging operations since previous testing. Recency of data is a key consideration in determining whether available data is still representative of the current environment. Recency guidelines for existing information refer to the duration of time for which the chemical and biological characterization of project-specific sediment remains adequate and valid for decision-making without further testing. The recency expiration dates are calculated from the time sediment is sampled. With older data there is increased potential for a "changed condition" that could alter its validity. Data must be sufficiently recent to be considered representative of the material to be dredged.

The ranking system for dredging projects takes into consideration both the sources of contamination and historical physical, chemical, and biological testing data (which are considered an integrated reflection of the effects of sources on the project area). Therefore, the recency guidelines allow characterization data to be valid for a recency period based on the project rank. The recency guidelines for high, moderate, low-moderate, low, and very low-ranked projects are periods of 3, 5, 6, 7, and 10 years, respectively (**Table 5-3**).

Table 5-3. *Recency Guidelines for ADMEF Projects*

Rank	Recency Period (Years)
High	3
Moderate	5
Low-moderate	6
Low	7
Very Low	10

When other permitting requirements prevent a project from being dredged during the recency period, extension of the recency period will be considered on a case-by-case basis. When considering whether existing data continues to adequately characterize sediment from a specific project, the Agencies will review previous characterization data, any new data from the dredge site or vicinity and site use. Based on this review, the Agencies may extend the recency determination, typically by one year. This extension may be allowed with no additional testing, may require some level of additional testing, or special conditions.

The recency guidelines do not apply when a known "changed" condition (e.g., spills, new discharges, or new COCs) occurs after the most recent samples were obtained. For subsurface sediments, the potential for contamination from groundwater sources must be considered.

Dredging proponents must request a recency extension from the Agencies if recency guidelines are likely to be exceeded at their project site prior to dredging. The recency extension request should thoroughly evaluate the site for changed conditions, including spills that have occurred in the vicinity since the project was last characterized. The Agencies will respond in writing or by email to the request and provide a recency extension (if appropriate) after the request has been evaluated.

For projects with upland disposal, the Agencies will use BPJ regarding recency.

5.3. Refine the Conceptual Dredging Plan

A conceptual dredging plan makes a practical project-specific plan for how dredging can be accomplished by taking into consideration several factors, including: the depth and shape of the dredge prism, physical characteristics of the sediment, side slopes, practicable dredge cut widths and depths, available dredging methods and equipment, physical and logistical constraints, dredging priorities of the dredging proponent, and conventional construction practices at similar dredging projects. There is no “one size fits all” approach.

For projects with surface and subsurface DMMUs, an important component of the conceptual dredging plan is to consider how surface and subsurface material will be dredged separately if one or the other is found unsuitable for in-water discharge. A geophysical survey with sub-bottom profiling may be useful for delineating subsurface DMMUs. Both horizontal and vertical buffers may be needed between suitable and unsuitable DMMUs. A 1-foot vertical buffer is typically required above and below an unsuitable DMMU. Thus, when dredging a suitable DMMU above an unsuitable DMMU, 1-foot of suitable DMMU sediment will need to be left above the unsuitable DMMU. Additionally, if dredging the unsuitable DMMU, at least 1-foot vertical sediment buffer is required to be dredged beyond the furthest extent of contamination. Usually, the horizontal buffer is established halfway between sampling points in the suitable and unsuitable DMMUs, but a different approach may be used if additional data is available. Horizontal and vertical buffers should be considered when developing the conceptual dredging plan to avoid a DMMU being too thin or patchy to feasibly dredge separately.

Similar consideration must be paid to the division of the dredging area into DMMUs horizontally. If one area (such as an access channel to a boat harbor) is of higher priority for dredging than an adjacent area (such as one or more finger piers), then combining the two areas into one DMMU may lead to adverse consequences if one of the DMMUs is found unsuitable for in-water discharge. Thus, it is recommended that DMMU division takes into consideration areas of similar physical characteristics and risk level.

Construction level detail is not needed at this point in the process. However, a realistic conceptual dredging plan will aid in delineating DMMUs and avoiding the situation where the findings in the Suitability Determination negatively impact the ability to dredge a project.

5.4. Determine the Number of DMMUs and Field Samples

The number of field samples to be taken and the number of laboratory analyses conducted to fully characterize the sediments for any given project must be sufficient to allow for an adequate assessment. The total anticipated dredging volume for the project must be well established; see Section 3.5. for additional details. The following guidelines within this section. specify a maximum volume of dredged material that can be represented by a single field sample and by a single laboratory analysis based on the ranking of the project. They are considered “minimum” requirements in that the dredger may opt for, or regulatory agencies may require, additional samples or analyses if warranted.

DMMU rankings within a project can be affected by various factors identified during the Tier 1 analysis (e.g., sediment composition, point contaminated sources, wave energy, etc.) that may lead a DMMU to be ranked lower or higher than the overall project rank. Agencies must agree to the separate ranking of a DMMU. Each DMMU will be subjected to the sampling and material management requirements of its rank rather than the project’s rank.

NOTE: The ADMEF does not address sampling and analysis requirements for projects located within or adjacent to a State contaminated/CERCLA cleanup site which may be subject to project-specific sampling and testing requirements. Please contact the Agencies early in your project planning process for assistance.

5.4.1. Dredged Material Management Units

A DMMU is the smallest volume of dredged material that is truly able to be dredged (i.e., capable of being dredged independently from adjacent sediments) and for which a separate dredged material management decision can be made by the Agencies. **A given volume of**

sediment can only be considered a DMMU if it is capable of being evaluated, dredged, and managed separately from all other sediment in the project.

All the field samples taken within a DMMU are composited to provide a single sediment sample for laboratory analysis that is representative of that DMMU. Therefore, the selection of sampling locations and the development of a compositing scheme must provide an accurate representation of the condition of each DMMU. In general, samples should be distributed across the dredging prism to target the bulk of the dredge volume. However, special circumstances, such as the presence of sources of contamination, may dictate otherwise. The location of point sources in the vicinity of the project must be taken into consideration when locating field samples, but "worst-case" sampling should **not** be the goal of full characterization. Tier 1 information, including the location of point sources, should be included in the SAP and should support the sampling locations selected to ensure representative sampling of the proposed dredged sediments.

5.4.2. Number of DMMUs

Sediment in any given project is considered either “heterogeneous” or “homogeneous.” Heterogeneous sediment is known, or presumed, to have different contamination levels in the surface and subsurface sediments. Heterogeneous sediments are sampled with a core sampling device to sample the entire depth of the dredge prism.

To characterize heterogeneous sediments, different sampling intensities are used for the surface and subsurface portions of the dredge prism (**Table 5-4**). Heterogeneous sediment is usually divided into “surface” (0 to 4 feet of the dredging prism) and “subsurface” (greater than 4 feet below the sediment surface). Sub-bottom profiling may be used to justify variance from the generic vertical delineation (0-4 feet and greater than 4 feet).

Example: Using **Table 5-4**, in a *moderate*-ranked heterogenous sediment project with 32,000 cubic yards (CY) of surface material (0 to 4-foot cut depth) and 24,000 CY of subsurface material (at 4-foot cut depth or deeper), a total of three DMMUs are required (two from the surface volume and one from the subsurface volume).

This approach assumes that surface material is generally more contaminated than underlying material. It has since been shown that the reverse can be true as well. Legacy contamination may exist in the deeper sediment and more recently deposited sediment may be relatively uncontaminated. In such cases, **Table 5-4** will not apply. The specific conditions for a particular dredging project will dictate the volume limits for DMMUs.

Table 5-4. *Maximum Sediment Volume Represented by each DMMU*

Project Rank	Maximum DMMU Volume		
	Heterogeneous Sediment (Contamination Level Decreases with Depth[1])		Homogenous Sediment (Well-Mixed)
	Surface	Subsurface	
Very Low	Not Applicable	Not Applicable	100,000 CY
Low	48,000 CY	72,000 CY	60,000 CY
Low-Moderate	32,000 CY	48,000 CY	40,000 CY
Moderate	16,000 CY	24,000 CY	20,000 CY
High	4,000 CY	12,000 CY	8,000 CY

[1] The listed volumes are applicable for contamination anticipated to decrease with depth. If contamination increases with depth or there is no suspected difference between surface and subsurface contamination, project specifics will dictate the appropriate volume limits for the surface and subsurface DMMUs.

For projects which are dredged frequently (e.g., every 2 to 3 years) due to rapid or routine shoaling, the sediments are expected to be relatively homogeneous and the distinction between surface and subsurface sediments becomes less important. In this case, DMMU volumes may be based on the average of surface and subsurface maximum allowable volumes. The proposed dredging volume may be divided by this average volume to determine the number of DMMUs. Grab samples are usually considered adequate to characterize homogeneous sediments.

5.4.3. Sampling Intensity

Typically, a field sample should be collected for every 8,000 CY of material to be dredged for projects in areas ranked low or low-moderate, and a field sample should be collected for every 4,000 CY for projects in areas ranked moderate or high (**Table 5-5**). However, the field sample ratio may be modified for practical reasons on a project-specific basis if requested by the dredging proponent and approved by the Agencies.

Unlike the maximum volume of a DMMU (**Table 5-4**), the maximum volume of a field sample does not vary with sediment depth. Continuing with the example presented above, a moderate-ranked project with two, 16,000 CY (32,000 CY total) surface sediment DMMUs and one, 24,000 CY subsurface sediment DMMU would require a total of 14 field samples: four for each surface sediment DMMU volume and six for the subsurface sediment DMMU volume.

A composite sample is used to represent the collective material within a DMMU and is an equal mixture of all field samples collected within said DMMU. Thus, the four field samples from each of the two surface DMMUs in the aforementioned example could be combined to form two composite samples: one composite sample for each surface DMMU. Then the six field samples from the subsurface DMMU could be combined to form a single composite sample.

Table 5-5. *Maximum Sediment Volume Represented by a Single Field Sample*

Project Rank	Maximum Field Sample Volume (CY)
Very Low	Project specific
Low	8,000
Low-moderate	8,000
Moderate	4,000
High[1]	4,000

[1] Projects located within or adjacent to an ADEC contaminated/CERCLA cleanup site may be subject to project specific sampling and testing requirements.

5.5. Determining the Contaminants of Concern List

The standard list of COCs for both marine and freshwater projects can be found in **Table 8-3**, but additions can be made on a case-by-case basis based on Tier 1 analysis and prior sampling efforts (See Section 8). Tributyltin (TBT) analysis is determined on a case-by-case basis for freshwater and marine projects. Dioxins/furans (D/F) analyses are determined on a case-by-case basis for both freshwater and marine projects. Information on when and where analyses of D/F and TBT are needed can be found in Section 8.3.1. and Section 8.3.2., respectively. Other COCs in limited areas are discussed in Section 8.3. as well.

Emerging COCs include per- and polyfluoroalkyl substances (PFAS) chemicals (https://www.epa.gov/pfas/pfas-explained) found in water, air, fish and soil at locations across the Nation and the globe. Recent early 2024 EPA advances in addressing PFAS are found at https://www.epa.gov/pfas/key-epa-actions-address-pfas. PFAS analysis may be required for certain dredging project proposals and the applicable evaluation criteria will be determined through agency coordination during pre-application and initial coordination.

If upland disposal is proposed, additional COCs, specifically metals, may need to be analyzed not just for the sediment but at the proposed upland disposal location (ADEC 2013). Other tests that may be required are leachate and paint filter testing. It is recommended that dredging proponents check with the applicable landfill(s) to determine if there will be additional testing requirements.

5.6. Sampling Methods

The goal of sediment sampling is to characterize each individual DMMU by collecting a sample (or a composited sample if multiple samples) that will be representative of the DMMU. The minimum sampling requirements discussed above are based on volumetric measurements. The method of sampling required, however, depends on the type of project. The sampling methodology to be used must be presented in the SAP along with the rationale for selection.

5.6.1. Core Sampling

For projects with heterogeneous sediment and for new-work dredging, the dredging proponent will be required to take core samples from the sediment/water interface down to the maximum depth of dredging, including overdepth and leave surface.

There are numerous options available for obtaining core samples. These include impact corers, hydraulic push corers, vibracorers, augers with split spoons or Shelby tubes, sonic corers, etc. The methodology chosen will depend on availability; cost; efficacy; presence of wood waste, debris or rip rap; type of sediment; and anticipated sediment recoveries/depth of refusal.

Core samplers are typically used in the following situations:

- Dredge prism and/or leave surface composition is unknown (new-work dredging);
- Project sediments are heterogenous (i.e., sediment layers have different characteristics or contaminant concentrations are potentially non-uniform);
- Stratified DMMUs are planned; and/or,
- Leave surface samples are planned (Section 5.7.).

When core sampling is planned in coarse-grained sediments, a grab sampler should be included as a contingency in case core samples cannot be recovered or core recovery is low.

5.6.2. Grab Sampling

Sediments in frequently dredged areas are assumed to be relatively homogeneous. For homogenous projects not in high-ranked areas, grab samples will be considered adequate to represent the dredged material, even if shoaling results in sediment accumulation greater than 4 feet. Grab samples are also adequate in situations where the thickness of the sediment to be dredged is less than 2 feet because the grab sampler is presumed to penetrate to a depth capable of collecting a representative sample of a thin layer of dredged material. The minimum number of grab samples required can be calculated using the applicable volumes listed in **Table 5-4** and **Table 5-5**.

5.7. Post-Dredge Sediment Surface

Dredging alters environmental conditions in the dredging area by exposing new sediments, i.e., leave surface, to direct contact with biota and the water column. Leave surface samples should be collected during Tier 2 mobilization and archived, if not immediately analyzed, in the event overlying material is found to be unsuitable, projects in the vicinity show evidence of subordinate stratum contamination, or there is any reason to believe the post dredge surface may not meet applicable standards. The “leave surface sample” represents the sediment that will be exposed by dredging. Leave surface samples are typically collected from the first 2 feet below the dredging overdepth and must be collected during sampling for all projects requiring core sampling. Leave surface sample collection and analysis guidance is as follows:

- Leave surface samples will be collected and archived for every core sampling location, regardless of rank. Archived sediment must be maintained frozen at ≤ -18 Degree Centigrade (°C).
- If an immediately overlying DMMU is found to be contaminated (e.g., unsuitable for unconfined in-water discharge), the associated underlying leave surface sample must be analyzed to verify the sediment quality of the post-dredge leave surface.
- If there is reason-to-believe that concentrations of COCs increase with depth, the Agencies may require leave surface samples to be analyzed concurrently with analysis of the DMMUs.
- Leave surface sample analyses will initially consist of sediment conventional and chemical analyses. If the results of these analyses indicate that the sediment to be exposed by dredging will be degraded relative to the existing sediment surface, the dredging proponent may be required to remobilize and resample locations with degraded leave surface samples to perform required biological testing (bioassays and/or bioaccumulation testing) or the degraded sediment may need to be removed or capped with clean sand. The thickness of the clean sand layer will be determined in coordination with the Agencies.
- For most projects, a decision about leave surface sample analysis will be made after review of the chemistry/bioassay data associated with the dredged material. The dredging proponent always has the option of conducting leave surface analysis concurrently with the dredge prism analysis.

For further discussion of leave surface testing and leave surface evaluations, see Section 12.

6. PREPARING THE SAMPLING AND ANALYSIS PLAN

Once the required numbers of DMMUs and field samples have been calculated and a dredging plan conceived, the SAP may be developed. The DMMUs and field samples must be distributed within the actual dredging prism in a manner consistent with the definition of a DMMU and any project-specific constraints. It is not necessary or always desirable to set the volumes characterized by each individual sample or DMMU to the maximum from **Table 5-4**. BPJ is necessary in the allocation of DMMUs and the development of a sampling and compositing plan.

In dividing the proposed dredging volume into DMMUs, it is important to ensure that the DMMUs be fully reflective of the dredging plan and that the DMMUs are truly able to be dredged. If an individual DMMU (represented by one or more field samples) is found unsuitable for unconfined in-water discharge, then that DMMU must be capable of being dredged independently from adjacent sediment (recall that a 1-foot vertical buffer above the unsuitable DMMU and below the furthest extent of contamination will also be declared unsuitable). Additional DMMUs – beyond the minimum number – may be required to achieve an appropriate dredging plan (e.g., where different sediment types, spatially distinct areas, or project priorities warrant separate DMMUs).

Steps followed in developing characterization requirements must be documented in the SAP developed for review by the Agencies.

A well-designed SAP is essential when evaluating the potential impact of dredged material discharge on the aquatic environment. The SAP is submitted to the Agencies for coordinated review and approval before any sampling is initiated, as shown in **Figure 3-2**. This coordination, including full and open disclosure of information, reduces the chance of having to repeat costly procedures and assists in keeping projects on schedule.

A separate SAP should be prepared for each tier of testing, and each SAP should be focused on the appropriate analytical requirements, e.g., a Tier 2 SAP will not include biological testing information. Where Tier 3 biological testing is required, the SAP will include descriptions on the collection and analysis of reference samples as noted in Section 6.5. and detailed in Section 9 and Section 10.

The SAP must contain the information outlined in the following sections in enough detail to allow the Agencies to determine its adequacy.

6.1. Project Description/Conceptual Dredging Plan

The information outlined below should be provided at the beginning of the SAP. Where appropriate, project details should be presented in tables.

1. Project description that provides scope of work, ranking, total dredge volume, number of DMMUs, and proposed discharge location(s).
2. Site history, including past characterization data, past and current site use, identification of potential sources of contamination, and past permitting, including NPDES permits as well as dredging permits (see Section 4). Historical data should be compared to current criteria.
3. Figures showing site vicinity, plan view of site dredge prism with recent bathymetry (preferably within 1 year), and cross-sections of the dredge prism. In many places in Alaska, bathymetry may not be able to be completed until just before sampling due to weather and ice conditions. In this case, procedures for verifying mudline elevations and target sampling depths and how adjustments will be made in the field and coordinated with the Agencies will need to be described in the SAP.

4. Conceptual dredging plan including total project volume, volume within each surface and subsurface DMMU, and homogeneous/heterogeneous designation. Volumes must include side slopes, overdepth, and if applicable, uncertainty factor and contingency volume (see Section 3.5.).
5. Project schedule for both sediment characterization and dredging. Describe any project elements which may alter expected timelines. For example, due to the remoteness of some Alaska dredging sites, it may be difficult to meet holding times for some analytical methods (e.g., sulfides).
6. The project location must be checked for the presence of invasive species (see Section 4.2.).

6.2. Sampling Design

See Section 5 for details.

1. Project rank and justification.
2. Computation of ADMEF sampling and analysis requirements usually based on surface (0 – 4 feet) and subsurface (more than 4 feet) volumes.
3. Project details, as necessary, to justify the design of the DMMUs.
4. Map(s) of project area with DMMU outlines (including side slopes if available), bathymetry, target sampling locations and, if necessary, cross-sections.
5. Table with DMMU identification, DMMU volume, designation as surface or subsurface DMMU, and number of field samples for each DMMU.
6. Table of sampling locations including coordinates, mudline elevation in relevant datum (e.g., MLLW for marine waters), design depth, overdepth, leave surface depth, and preliminary determination of required core lengths to be assigned to DMMUs and leave surface samples.
7. Compositing plan, including sampling depths relative to both mudline and MLLW (or other vertical datum as appropriate).
8. Leave surface sampling plan (if necessary).
9. Personnel involved with the project and their respective responsibilities and contact information, including project planning and coordination, field sampling, chemical and biological testing labs, quality assurance (QA) management, data validation, and final report preparation.
10. Signature page for subcontractors – signatures only needed with final SAP.

6.3. Sampling Methodology

See Section 7 for details.

1. Sampling equipment and capability.
2. Horizontal datum – North American Datum (NAD) 83, High Precision Geodetic Network (HPGN) 83, High Accuracy Reference Network (HARN) 83 or World Geodetic System (WGS) 84.
3. Horizontal positioning system and accuracy (must be less than ± 3 meters).
4. Method for determining real-time water depths at sampling stations.
5. Sample acceptance requirements (e.g., penetration and recovery requirements for

cores).

6. Description of the use of water depths, tide elevations, penetration, and recovery data to determine the actual core lengths to be assigned to DMMUs and leave surface samples.
7. Description of the sampling equipment to be onsite. Due to the remoteness of many dredging locations in Alaska, planning to have multiple types of sampling equipment and backup of critical equipment onsite is advantageous. This will prevent a loss of time due to having to demobilize and remobilize to ensure the right sampling equipment for the location is onsite.
8. Decontamination procedures.
9. Table of analytical groups (e.g., semi-volatiles, metals, bioassays) with planned sample volumes, container sizes and type, holding times, and conditions; this table should also include archived samples.
10. Sulfide's sampling and preservation procedures (see Section 7.4.8.).
11. Description of entries that will be made in field/sampling logs.
12. Description of core logging.
13. Chain-of-custody procedures (see Section 7.4.10).
14. Proposed sampling schedule.

6.4. Chemical Analysis

See Section 8 for details.

1. Plans for physical and chemical laboratory testing, including grain-size analysis, sediment conventional parameters and COCs.
2. Table(s) of current COCs, with relevant regulatory limits (ADMEF marine and/or freshwater) clearly indicated with correct units of measure, including extraction/digestion methods, and analytical methods for all COCs.
3. Table(s) of QA parameters, frequency of analysis, and performance measurement criteria. This includes method reporting limits (e.g., practical quantitation limit [PQL] or limit of quantitation [LOQ]), method detection limits (MDLs; a type of detection level [DL]), and if applicable limits of detection (LODs) for all COCs.
4. Identification of standard reference materials (SRMs) to be used for semi-volatiles, pesticides, and metals, including the SRM certificates and the acceptance ranges the lab plans to use for quality control (QC), if applicable.
5. D/F quality assurance and interpretation guidelines, if necessary.
6. Validation stage for each analytical group.
7. Chemistry lab reporting requirements and case narrative describing analytical problems.

6.5. Biological Analysis

The information outlined below should be provided in a Tier 3 SAP. See Section 9 for details.

1. Selection of tiered or concurrent bioassays.
2. Bioassays to be used, species-selection rationale, and a brief description of the

protocols including a table describing test conditions.

3. Decision-making process for determining amphipod species, given project-specific grain size, and clay content (i.e., if clay content is greater than 20%, use *Ampelisca abdita*).
4. Decision-making process for determining whether to purge for ammonia or sulfides and/or run a reference toxicant (Ref Tox) with a lethal concentration killing 50% of a population (LC_{50}) test for ammonia.
5. Decision-making process for determining whether to use the larval resuspension protocol.
6. Statement that larval test will be aerated.
7. Water quality monitoring parameters, schedule, and acceptance limits.
8. Proposed collection location of reference sediments and how reference sediments will be matched to test sediments; the wet-sieving protocol should be included.
9. Table with bioassay interpretation and reference/control performance standards.
10. List of data to be provided to the Agencies if bioassays are needed: grain-size and sediment conventional data (notably ammonia and sulfides) for DMMUs to be tested.

If bioaccumulation testing (Section 10) is required, the Agencies should be coordinated with for appropriate SAP development.

6.6. Reporting Requirements

The following are required elements of a Sediment Characterization Report, as appropriate for the tier of testing, and should be listed in the SAP:

1. Explanations of any deviations from approved SAP.
2. Sampling equipment and protocols used.
3. Procedure used to locate sampling positions.
4. Table with coordinates of actual sampling locations, measured water depth at each location, and real-time tidal stage and/or mudline elevations (tide-corrected to MLLW in marine waters) at the time of sampling each station.
5. Figure showing target and actual sampling locations with DMMU outlines.
6. Penetration and recovery data.
7. Compositing scheme with actual core lengths and depths (referenced to both MLLW and the mudline).
8. Analytical QA/QC section, including case narrative describing analytical problems.
9. Table of results for physical and conventional analyses, including grain size analysis.
10. Table of analyzed concentrations for all ADMEF COCs, lab and validation qualifiers, method reporting limits (e.g., PQLs/LOQs), MDLs/DLs, and as applicable LODs with ADMEF guideline exceedances highlighted.
11. Chemistry QA review and validation results.
12. Summary table(s) of bioassay results, QA data and interpretation.
13. Appropriate appendices, such as:

- Sampling/field log
- Core logs: including photographs of each extruded core with sample intervals delineated by elevation. A measuring tape must be visible in all photographs.
- Bioassay report
- Validation report
- Chain-of-custody forms

6.7. Health and Safety Plan

A brief, site-specific health and safety plan (HASP) is recommended in addition to the SAP. The HASP should include the following at a minimum:

1. Safety procedures including activity hazards analysis for each job activity.
2. Emergency procedures including directions to the nearest medical facility.

7. SAMPLING

7.1. Timing of Sampling

Sampling must be conducted according to a project-specific SAP that has been approved by the Agencies. It should be accomplished well in advance of dredging to allow time for testing, data review, and permitting.

In some cases, a pre-sampling bathymetric survey may not be performed until just prior to dredging due to remoteness of the site or ice conditions. For projects that are routinely dredged, historical bathymetry may be used to develop the SAP with knowledge that they may be adjusted based off bathymetric surveys immediately prior to dredging operations. To allow for adjustments, during SAP development, dredging proponents should consider adding an uncertainty factor to the dredge volumes to ensure adequate characterization of the potential dredge material (e.g., number of DMMUs, number of cores/samples). The pre-dredging bathymetry should be conducted to verify the mudline and determine any necessary changes to the SAP prior to dredging. Dredging proponents will coordinate with the Agencies to maintain collective awareness about changes in the project and gain concurrence regarding the adequacy of testing.

7.2. Sampling Approach

If the preceding tier indicates sampling and analysis is required, the dredging proponent will be required to sample the sediment for physical, chemical and, if necessary, biological analyses. **The proposed sampling approach should be clearly documented in the project-specific SAP.** There are several sampling approaches that the dredging proponent may take and three of the most common are described below:

1. Concurrent Testing: Collect sufficient sediment for all chemical and biological tests potentially required and run these tests concurrently.
2. Tiered Testing with Archiving: Collect sufficient sediment as above but archive adequate sediment for biological testing pending the results of the chemical analysis.
3. Tiered Testing with Resampling: Collect only enough sediment to conduct the chemical analyses and, if biological testing is required, re-sample the site (chemistry re-analysis required with new sampling).

Concurrent testing is the least time consuming and is likely the most economical when the need for biological testing is expected because the need to collect (and re-analyze) additional sediment for bioassays is eliminated. For tiered testing, the sediment to be used for biological testing must be stored in the dark at 0 to 6 °C with zero headspace (or with headspace purged with nitrogen) while chemical tests are completed. Maximum holding time for biological testing is 56 days. The 56-day holding time starts the day the first core or grab samples representing a DMMU are collected.

In Alaska, it is expected that most projects would conduct tiered testing with re-sampling given the relatively lower likelihood that biological testing would be needed. If bioassay testing is not planned, and one or more COCs exceed the SLs, the dredging proponent must either 1) investigate, explain, and gain agency concurrence on a decision that further testing is not required, 2) transport the material to an upland disposal facility, 3) collect/use additional sediment for bioassays and reanalysis of sediment conventional parameters and chemistry if applicable, or 4) if it is a metal exceedance and believed to be related to natural background concentrations, provide information supporting such affirmation, e.g., comparison to appropriate background concentrations, literature documenting watershed geology, known site and watershed uses, and historical context of discharge sites.

Tiered testing with resampling would involve a second mobilization to the project site to collect an adequate volume of sediment for biological testing if the Tier 2 chemical testing indicates COCs exceed the SLs. If resampling efforts are required for the biological testing, sampling must occur at the same stations of the previous sampling effort. The original exceedance of SLs may require that Tier 3 biological testing be completed even if the chemical analysis associated with the resampling provides COC concentrations below the SLs; i.e., the decision to proceed to Tier 3 is not solely reversed based on resampled chemical data.

7.2.1. Background Sampling

Dredging proponents are encouraged to consider background sediment sampling as part of their sampling strategy. Background sediments are used to establish the concentrations of substances that can occur naturally, but may also be associated with pollution. Arsenic, chromium and many other metals are naturally occurring throughout Alaska. The naturally existing concentrations of these metals are typically referred to as "background." However, these metals may also be present from anthropogenic activities. Anthropogenic is defined as "of human origin or resulting from human activity." The purpose of background sampling is to differentiate between naturally occurring and anthropogenic substances. A dredged material COC SL exceedance with a COC concentration that is consistent with the background concentration of the COC may be considered naturally occurring, and the discharge of that dredged material may be authorized if the other COCs are below the SL.

Careful consideration and agency agreement regarding the specific parameters of the background sampling is necessary for the background sampling to satisfy its intended purpose. The background samples should originate from the same parent material as the dredged material and be of substantially similar sediment conventional characteristics as the dredged material, i.e., grain size and TOC. The background samples should also be collected from an area removed from the potential anthropogenic sources of contamination that could affect COC concentrations. The location of background samples should be included in the SAP, and subject to Agency review and approval.

7.3. Positioning Methods

7.3.1. Horizontal Control

Samples should be obtained as near as possible to the target locations provided in the project sampling plan. A precision navigation system must be used to navigate to and record all sediment sampling locations to a minimum geodetic accuracy of ± 3 meters. Such accuracy can be obtained with a range of positioning hardware, e.g., differential or Real-time Kinematic (RTK) Global Positioning System (GPS), electronic distance measuring devices, etc. The positioning system to be used and associated QA/QC procedures must be documented in the SAP.

If sampling locations are referenced to a local coordinate grid, the grid should be tied to NAD 83 or WGS 84 to allow conversion to latitudes and longitudes. The NAD 27 is outdated and should not be used. **Table 7-1** outlines the required level of accuracy. Decimal degrees are preferred.

Table 7-1. *Required Accuracy for Sample Positioning*

Coordinates in:	Level of Accuracy
Degrees Minutes Seconds	2 decimal places
Degrees Minutes	4 decimal places
Decimal Degrees	6 decimal places
State Plane	Nearest foot
Universal Transverse Mercator (UTM)	Meters, with 1 decimal place

7.3.2. Vertical Control

Accurate vertical measurement/calculation of sampling depths is required to ensure that the designated DMMU(s) and leave surface(s) are sampled as planned. Tidal fluctuations, river flows, and changing reservoir (e.g., lake) levels can complicate depth interval calculations. A variety of tools are available to establish vertical control and make accurate depth determinations possible. These include, but are not limited to, tide boards, nearby NOAA harmonic stations, electronic tide gauges calibrated to MLLW, RTK GPS instrumentation, support vessel depth finder, lead line, or other approved method of determining vertical position.

The coordinate system for reporting vertical sampling data will vary based on location and project specifics. All survey control must be tied into the National Spatial Reference System (NSRS). Project Vertical Control shall be referenced to MLLW based on the 1983-2001 tidal epoch or newer, holding NOAA's National Ocean Service (NOS) Benchmark data for the local location.

The SAP must clearly describe which tools and procedures will be used to ensure accurate vertical measurements.

7.4. Sample Collection and Handling Procedures

Proper sample collection and handling procedures are vital for maintaining the integrity of the sample. If the integrity of the sample is compromised, the analysis results may be unacceptable. Procedures for decontamination, sampler deployment, sample logging, sample extrusion, compositing, sample transport, chain of custody, archiving, and storage should be discussed in the SAP.

7.4.1. Sediment Volume Requirements

In Alaska, 7 liters of composited and homogenized sediment are recommended to provide adequate volume for standard testing of physical, chemical, and bioassay analysis. Bioassay analysis requires a minimum of 5 liters while physical and chemical analysis requires approximately 1 liter of sediment. An additional 1 liter should be archived for possible chemical retesting. Additional sample volume beyond the 7 liters may be necessary for analysis of additional special COCs.

Bioaccumulation testing requires a large sediment volume beyond the amount needed for standard testing, Thus, most dredging proponents do not collect this additional material during the initial sampling event but wait to see if any BTs are exceeded. If bioaccumulation testing is triggered, a second round of sampling would become necessary, along with physical and chemical re-testing of the DMMU(s) in question.

For all projects where samples are taken with coring devices, sediment that will be exposed by dredging must also be sampled. Please refer to Section 5.7.

7.4.2. Decontamination Procedures

Clean, certified, sampling containers must be provided by the laboratory for all chemical analyses. Bioassay containers should be selected in consultation with the bioassay laboratory and may include high-density polyethylene (HDPE) bags, HDPE buckets, or wide-mouth glass containers. All sampling equipment and utensils (spoons, mixing bowls, extrusion devices, sampling tubes and cutter heads, etc.) should be made of non-contaminating materials and be thoroughly cleaned prior to and throughout use. The intention of these procedures is to avoid contaminating or cross-contaminating sediments to be tested. Poor decontamination practices could result in dredged material, which would otherwise be found acceptable for in-water discharge, being found unacceptable. An adequate decontamination procedure is required and must be provided in the SAP.

Typical decontamination procedures for sampling equipment include the following steps:

1. Remove excess sediment with a brush and *in situ* water,
2. Clean with a phosphate-free detergent solution (such as Liquinox®), and
3. Rinse equipment thoroughly with clean *in situ* water.

Additional decontamination steps such as a solvent rinse or dilute acid rinse may be necessary for contaminated sites or sites with a higher possibility of encountering contamination. Consult the ADEC Field Sampling Guidance's, "Section 12.8. Equipment Decontamination" for more specific guidance (ADEC 2022).

After decontamination, sampling equipment should be protected from recontamination. Any sampling equipment suspected of contamination should be decontaminated again or removed from use. During core sampling, extra sampling tubes should be available on-site to prevent interruption of operations should a sampling tube become contaminated. Sampling utensils should be decontaminated again after all sampling has been conducted for a given DMMU to prevent cross-contamination. Disposable nitrile gloves are typically used and disposed of between DMMUs.

Sampling vessels and equipment should be decontaminated for the potential presence of invasive species and to prevent transfer of invasive species from site to site. ADF&G recommends protecting Alaska's waters and native aquatic species, by following these guidelines (http://www.ADF&G.alaska.gov/index.cfm?ADF&G=invasive.prevention):

1. **CLEAN** — Rinse and remove any mud, sediment, and/or plant debris from all gear, boats, and boat trailers, floatplane rudders and floats, and anything that comes into contact with the water.
2. **DRAIN** — Empty all water from coolers, bilge pumps, buckets, and wring out gear before leaving the boat launch or fishing areas.
3. **DRY** — Completely dry gear between waterbodies or trips. Equipment that remains damp can harbor small particles of invasive species that can remain viable for weeks. If drying gear completely is not possible – decontaminate.
4. **DECONTAMINATE** — Freeze gear until solid or wash gear in 140 degrees Fahrenheit hot water scrubbing with a stiff bristle brush. If drying, freezing, or heating gear is not feasible, use a 2% bleach solution to clean gear away from freshwater recreation sites. Spray or rinse gear for one minute. A 2% bleach solution can be made easily by mixing 2.5 ounces of chlorine bleach with tap water to make 1 gallon of solution. Note, bleach solutions may degrade gear made of absorbent materials. Rinse gear on land, away from freshwater fishing areas, and dispose of disinfectants as indicated on the label.

7.4.3. Sample Collection

Sampling procedures and protocols will vary depending on the sampling methodology chosen. Whatever sampling method is used, measures should be taken to prevent sample exposure to sources of contamination such as the sampling platform, grease from winches, engine exhaust, etc. Core sampling methodology should include the means for determining when the core sampler has penetrated to the required depth. If the core is driven deeper than required, field records and core logging must be adequate to allow the proper core section(s) to be taken post-sampling for inclusion in the sample composite(s), as well as for the leave surface sample. The sampling location must be referenced to the actual deployment location of the sampler, not to another part of the sampling platform such as the bridge of a sampling vessel.

7.4.4. Core Penetration and Percent Recovery

To provide a good representation of the DMMU, each core collected needs to be representative of the sediment column being characterized. The criteria that will be used to determine if a core is acceptable for use must be outlined in the SAP. At a minimum, these should include acceptance criteria for core penetration and percent recovery.

The core should penetrate to the lower limit of the 2-foot leave surface sample. If refusal occurs prior to reaching this depth, due to woody debris, gravel, deep sand deposits or dense native material, additional attempts should be made to reach the target depth.

Percent recovery is defined as the length of the sediment core retrieved divided by the depth of core penetration:

$$\text{Percent Recovery} = \frac{\text{Sample Core Length}}{\text{Depth of Core Penetration}} \times 100$$

Under ideal conditions percent recovery would be 100%, but this is rarely the case due to variability in sediment type and coring conditions. To assure that the dredge prism is adequately characterized, the recommended core acceptance criterion for percent recovery is at least 75%. If project specifics dictate that a 75% recovery may not be possible, justification for use of a different percent recovery threshold must be agreed upon during coordination with the Agencies.

Alaska fieldwork is often remote and without cellphone service (requiring satellite phone service). Often, this makes communication while in the field challenging to discuss with the Agencies on how to proceed when core recovery is lower than 75%. For projects where low recoveries are possible and communication is challenging while in the field, provisions and contingencies will be discussed in advance and written into the SAP in order for field work to continue without the risk of cores being rejected due to low recovery.

If the penetration and/or recovery criteria are not met during the first sampling attempt, at least two more attempts must be made within 10 feet of the target coordinates. If, after three attempts, the penetration and/or recovery criteria have not been achieved, the Agencies must be contacted to determine the path forward unless a prior contingency action was included in the SAP and approved by the Agencies. If the contingency action is successful, a dredging proponent would not need to contact the Agencies. Prior to relocating sampling stations or accepting lower-recovery core samples, Agencies should be contacted for guidance.

If less than the agreed percent recovery is obtained, then careful consideration must be made regarding whether to correct for recovery of core depths. Dense sandy material is unlikely to compact, so it is more likely that either bypass or loss of material from the bottom of the core occurred. If recovery fails to meet guidance (more than the agreed percent recovery), the Agencies must be contacted regarding whether to assume compaction (correct for recovery) or loss/bypass (do not correct for recovery). Do not assume core compaction and apply a compaction recovery factor without first consulting with the Agencies.

7.4.5. Sampling Logs

As sediment is collected, whether by core or grab, sampling/field logs must be completed. The following should be included in this log:

1. Date and time of collection of each sediment sample.
2. Names of field supervisors and person(s) collecting and logging in the sample.

3. Weather conditions.
4. The sample station number and individual designation numbers assigned for individual core sections.
5. Penetration depth of each coring attempt and notation of any resistance of the sediment column to coring.
6. Percent recovery of each coring attempt and percent recovery calculations.
7. The outcome of each coring attempt – either ‘accepted’ or ‘discarded.’
8. The measured water depth at each sampling station and time sample was collected at each station. The mudline elevation, referenced to MLLW, must then be calculated by subtracting the tidal stage from the measured water depth. The method/procedure (e.g., depth finder, sonar, survey, lead line, etc.) used to determine the real-time tidal stage should be documented in the log. Real-time mudline calculations must be in the sampling log for all projects, referencing the appropriate datum.
9. For grab samples: physical sediment description, including type, density, color, consistency, odor, vegetation, debris, biological activity, presence of an oil sheen, or any other distinguishing characteristics or features.
10. Any deviation from the approved SAP.

7.4.6. Extrusion and Core Logging

Sample extrusion and core logging can occur either at the sampling site (e.g., on board the sampling vessel), onshore, or at a remote facility. If cores are to be transported to a remote facility for processing, they should be stored upright on ice onboard the sampling vessel and during transport. The cores should be sealed in such a way as to prevent leakage, disturbance, and contamination. If the cores will be sectioned at a later time, thought must be given to core integrity during transport and storage to prevent loss of stratification. Any extrusion method(s) should be provided in the SAP, including procedures to prevent contamination.

Core logging can provide valuable information, not only for sediment characterization, but also for dredging project design and operations. It is recommended that core logging be conducted using the Unified Soil Classification System. The core logs must include a qualitative physical description, including sediment type, density, color, consistency, odor, stratification, vegetation, debris, biological activity, presence of an oil sheen, or any other distinguishing characteristics or features. If native sediment is encountered, it is useful to note the point of contact (elevation) on the core log. Finally, the core logs should record penetration and recovery, and indicate the core sections representing the DMMUs and leave surface samples. If core lengths are corrected for percent recovery, the core depths should be logged based on collected depths prior to any corrections being made. Core sections collected from elevations deeper than the lower limit of the leave surface sample are discarded and recorded as such in the core logs.

7.4.7. Compositing and Sub-sampling

For composited samples, representative volumes of sediment (referred to as field samples or aliquots) are removed from each core section or grab sample comprising a composite. For core samples, sediment is collected from along the entire length of each core section. The composited sediment should be thoroughly mixed to a uniform color and consistency and should occasionally be stirred while individual samples are taken of the composite. A photograph of the material in the homogenization vessel, including the sample ID number, should be collected. This will ensure that the mixture remains well-mixed and that settling of coarse-grained sediments does not occur.

After compositing and sub-sampling are performed, the sample containers must be refrigerated or stored on ice until delivered to the analytical laboratory. Each sample container must be clearly labeled with the project name, sample/composite identification, type of analysis to be performed, date and time, and initials of person(s) preparing the sample and referenced by entry into the logbook.

7.4.8. Sulfides Sampling

When a project requires testing for sulfides, total bulk sulfides should be analyzed on the composited sediment sample representing a DMMU. Conducting sulfides analysis on a composite rather than individual station samples provides a more realistic assessment of the concentration of total sulfides in sediment archived for bioassays. Exceptions to this procedure for total sulfides might be made for sediment testing performed for cleanup or for projects where wood waste in leave surface material may be an issue. In those cases, total sulfides should be performed on single (not composited) samples.

An approved method for testing sulfides is preserving sulfides with 5 milliliters of 2 Normal zinc acetate per 30 grams of sediment. The sulfides sample sediments are placed in the jar with the preservative, covered, and shaken vigorously to completely expose the sediment to the zinc acetate. The sulfides sampling jars should be clearly labeled with the project name, sample/composite identification, type of analysis to be performed, date and time, and initials of person(s) preparing the sample and referenced by entry into the logbook. The sulfides sampling jars should indicate that zinc acetate has been added as a preservative.

Other methods would need prior approval from the Agencies.

7.4.9. Preservation and Holding Times

After compositing and sub-sampling are performed, the sample containers must be refrigerated or stored on ice until delivered to the analytical laboratory. The holding time is the length of time allowed between sample collection and analysis. The holding time differs for different analytes and test types. Holding times for the standard list of ADMEF COCs is in **Table 7-2**.

For some large projects, more than one core is collected and composited together to form an analytical sample. Sometimes cores are stored over ice or in a refrigerated room until all cores to be composited for a DMMU are collected. In this situation, the holding time for the composited sample begins on the day that the first core is collected. Cores should be held for the minimum time possible before processing. All sample material must be preserved according to the temperature requirements in **Table 7-2**.

Table 7-2. *Sample Holding Times and Storage Guidance*

Sample Type	Holding Time	Temperature/ Preservaiton[1]	Sample Size[2]	Container[3]
Particle Size	6 Months	0-6 °C	100-200 g (75-150 ml)	16 oz. Glass or HDPE
Total Solids	14 Days	0-6 °C	125 g (100 ml)	8 oz. Glass or HDPE
	6 Months	-18 °C or colder		
Total Volatile Solids (TVS)	14 Days	0-6 °C	125 g (100 ml)	
	6 Months	-18 °C or colder		
Total Organic Carbon	14 Days	0-6 °C	125 g (100 ml)	
	6 Months	-18 °C or colder		
Metals (except Mercury)	6 Months	0-6 °C	50 g (40 ml)	4 oz. Glass
	2 Years	-18 °C or colder		
Mercury[4]	28 Days	≤ 6 °C	50 g (40 ml)	
	1 Year	-18°C or colder		
Semi-volatiles, Pesticides and Polychlorinated biphenyls (PCBs)	14 Days until extraction	0-6 °C	150 g (120 ml)	(2) 4 oz. Glass or 8 oz. Glass
	1 Year until extraction	-18 °C or colder		
	40 Days after extraction	0-6 °C		
Total Petroleum Hydrocarbons	14 Days	0-6 °C	100 g	4 oz. Glass
Ammonia	7 Days[5]	0-6 °C	25 g (20 ml)	4 oz. Glass
Total Sulfides	7 Days[5]	0-6 °C with 5 ml of 2N Zn Acetate per 30 g of sediment	50 g (40 ml)	4 oz. Glass
Tributyltin (bulk sediment)	6 Months	-18°C or colder	50 g (40 ml)	4 oz. Glass
Dioxins/Furans	14 Days until extraction	0-6 °C	50 g (40 ml)	4 oz. Amber Glass Jar
	1 Year until extraction	-18°C or colder		
Bioassay	8 Weeks	0-6 °C with zero headspace or headspace purged with Nitrogen	5 liters	(5) 1-liter Glass or HDPE Jars or Polyethylene Bags
Bioaccumulation	8 Weeks	0-6 °C	Varies[6]	Glass or HDPE
Archive	Variable	-18 °C or colder	1 liter	Min. 16 oz. Glass

g = Gram, ml = Milliliter, oz. = Ounce.

[1] During transport to the lab, samples will be stored on ice. The archived samples will be frozen as soon as possible by the dredging proponent or immediately upon receipt by the lab. Jars to be frozen must include headspace to prevent breakage.

[2] Recommended minimum field sample sizes for laboratory analysis. Actual volumes to be collected have been increased to provide a margin of error and allow for retests.

[3] These containers are guidelines based on typical laboratory requirements. Sample analyses jars may also be combined for appropriate testing.

[4] An extended mercury holding time will not be allowed in sediment sampled from sites with known or potential mercury releases. Extended holding times for mercury must be documented in the SAP.

[5] Holding times for ammonia and sulfides may be difficult to meet for some remote locations in Alaska. The need for extended holding times for ammonia and sulfides must be documented in the SAP.

[6] See **Table 10-7**.

Samples reserved for bioassays are stored in the dark at 0 to 6˚C in containers or polyethylene bags with zero headspace, or with headspace purged with nitrogen, for up to 56 days pending initiation of any required biological testing.

7.4.10. Sample Handling, Transport and Chain of Custody Procedures

Sample transport and chain-of-custody procedures should follow these guidelines:

1. If sediment cores are taken in the field and transported to a remote site for extrusion and compositing, chain-of-custody procedures should commence in the field for the core sections and should track the compositing and subsequent transfer of composited samples to the analytical laboratory.
2. If compositing occurs in the field, chain-of-custody procedures should commence in the field and track transfer of the composited samples to the analytical laboratory.
3. Samples should be packaged and shipped in accordance with U.S. Department of Transportation regulations as specified in 49 CFR 173.6 and 49 CFR 173.24.
4. Individual sample containers should be packed to prevent breakage and transported in a sealed ice chest or other suitable container.
5. Use of gel ice is recommended. Wet ice, if used, should be double-bagged and well-sealed to prevent leakage.
6. A temperature blank should be included in each cooler.
7. Each cooler or container containing sediment samples for analysis should be delivered to the laboratory as soon as practicable once sealed.
8. Chain-of-custody forms should be enclosed in a plastic bag and taped to the inside lid of the cooler.
9. Signed and dated chain-of-custody seals should be placed on all coolers prior to shipping.
10. The shipping containers should be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the container, and consultant's office name and address) to enable positive identification.
11. Upon transfer of sample possession to the analytical laboratory, the chain-of-custody form should be signed by the persons transferring custody of the sample containers. The shipping container seal should be broken, and the condition of the samples should be recorded by the receiver, including the temperature of the temperature blank.
12. Chain-of-custody forms should be used internally in the lab to track sample handling and final disposition.

7.5. Field Sampling Checklist

The following checklist is intended to guide the sampling event. This checklist is not complete and some of the items listed below may not be necessary for every sampling event. Sampling staff are encouraged to adapt this list to meet their field sampling needs:

Paperwork

- ☐ SAP (approved by the Agencies)
- ☐ Field checklist

- ☐ Field map(s) with recent bathymetry and target field sample locations
- ☐ Sample summary table/compositing scheme
- ☐ Waterproof field logbook
- ☐ Waterproof grab and/or core sample log forms (with known fields completed)
- ☐ Chain of custody forms
- ☐ Laboratory address(es)
- ☐ Shipping forms for cooler shipment
- ☐ Cooler labels for dry ice (if used as a sample preservative)

Sampling Equipment

- ☐ Sediment sampler
- ☐ Generator/power supply for powered samplers
- ☐ Contingency grab sampling (for core sampling in sand)
- ☐ Extra parts/sampler repair kit
- ☐ Core liner (or sacrificial aluminum cores)
- ☐ Core catchers
- ☐ Core caps
- ☐ Duct tape
- ☐ Tools for core setup and processing (core samplers only)

Horizontal and Vertical Positioning Equipment

- ☐ GPS and onboard chart plotter
- ☐ Depth finder (and measurement of sensor below waterline)
- ☐ Lead line
- ☐ Smartphone or onboard computer with access to tides or river levels
- ☐ Staff gauge or electronic gauge vertical datum information

Decontamination Equipment

- ☐ Distilled, deionized water
- ☐ Phosphate-free, laboratory-grade decontamination soap
- ☐ Brushes and pole-brush (for cores and core-liners)
- ☐ Primary wash bucket
- ☐ Wash/rinse pans(s)

Sample Processing and Handling

- ☐ Boxes of latex-free, nitrile gloves (multiple sizes)
- ☐ Hand sanitizer
- ☐ Paper towels

- ☐ Stainless steel bowls/utensils/trays for sample processing and compositing
- ☐ Aluminum foil
- ☐ Pre-labeled sample jars (checked against SAP) and extras (in case of breakage)
- ☐ Jar labels, extras
- ☐ Zinc acetate for sulfide samples
- ☐ 1-gallon Ziploc bags (grain size samples only)
- ☐ Duct tape
- ☐ Camera
- ☐ Wet-sieving equipment

Sample Packing and Shipping

- ☐ Coolers
- ☐ Sample coolant/preservative (wet, blue, or dry ice)
- ☐ Completed chain of custody forms
- ☐ Custody seals for coolers
- ☐ Copy of SAP tables summarizing
    - List of analytes
    - Sample quantitation limits and SLs
    - Compositing scheme and instructions (for samples composited in the lab)
- ☐ Photocopy or photograph of completed chain of custody forms
- ☐ 1-gallon Ziploc storage bag for chain of custody forms and copy of SAP tables
- ☐ Temperature blank
- ☐ Retained copy of shipping form or courier receipt

Tools

- ☐ Screwdriver
- ☐ Pliers
- ☐ Pipe wrench
- ☐ Crescent wrench
- ☐ Hack saw
- ☐ Box cutters and/or knife
- ☐ Circular saw (with jig) or power shears (for splitting core linters)
- ☐ Wire cutters
- ☐ Hammer
- ☐ Rubber mallet
- ☐ Tape measure

Personal Equipment

- ☐ Personal Flotation Device (life vest or coat)
- ☐ Hard hat
- ☐ Steel toed boots or shoes
- ☐ Leather or rubber work gloves
- ☐ Rain gear (jacket and pants)
- ☐ Cold weather gear
- ☐ Drinking water
- ☐ Field food
- ☐ Hat and/or sun protection
- ☐ First Aid kit

7.6. Pre-Sampling Conference Call

A pre-sampling conference call with the dredging proponent's sampling team and ADMEF Agencies may be required. The purpose of the pre-sampling conference call is to go through the SAP to ensure both the Agencies and the sampling team understand the details of the sampling event and identify potential pitfalls or missing information that may compromise the quality of the samples being collected for laboratory analysis. The Agencies will review the following information with the sampling team:

- Project sampling details, including experience of the sampling team using the sampling equipment in the type of material and depths to be sampled;
- Horizontal positioning and establishment of vertical control and adjustment of sampling depths for unanticipated changes in mudline elevation;
- Criteria for accepting/rejecting samples;
- For core sampling:
    - Measurement of core penetration and recovery;
    - Penetration and recovery acceptance/rejection criteria; and,
    - Differentiation of DMMU(s) and leave surface material based on recovery.
- Composition of DMMU samples and who will be doing the compositing (field team or lab);
- Agreement on the laboratory analyses to be conducted and sample quantitation limits to be achieved (Note, the quantitation limits may vary based on sediment characteristics);
- Determination of sampling date(s) and identification of the Agencies contact(s) for coordination during the sampling event; and,
- The potential circumstances requiring communication with the Agencies (e.g., relocation of sampling stations due to refusal; recovery rates not meeting acceptance criteria); weather delays.

8. TIER 2: CHEMICAL TESTING

Chemical testing of the dredged material may be required after an assessment of existing information for a project during the Tier 1 phase. Chemical analysis includes both the measurement of "conventional" parameters and the measurement of concentrations of chemicals identified as COCs for the project.

8.1. Sediment Conventional Parameters

Sediment conventional parameters provide information about the physical nature of the dredged material and aid the interpretation of the chemical and biological test results. These analyses should be performed on all test sediments, as well as on reference and/or background sediments, when required.

Table 8-1 lists the sediment conventional parameters required for analysis with the recommended analytical methods. Any established and well-documented method that can meet the QC requirements outlined in this section may be used. The methods to be used for the project must be clearly articulated in the SAP and approved by the Agencies prior to testing taking place. Although not an exhaustive list, this table also includes sediment conventional parameters that may be required on a case-by-case basis depending on the history surrounding the site.

Table 8-1. *Mandatory and Case-by-Case Sediment Conventional Parameters and Recommended Analytical Methods*

Sediment Conventional	Analysis Method	Required?
Grain Size	PSEP (1986)/ASTM D-422[1] (modified)	Always
Total Organic Carbon (TOC)	SM 5310B/EPA 9060	Always
Total Solids	PSEP (1986)/SM2540G	Always
Total Volatile Solids (TVS)	PSEP (1986)/SM2540G	Case-by-Case[2]
Total Sulfides	PSEP (1986)/Plumb (1981)/SM4500-S2	Case-by-Case[3]
Ammonia	Plumb (1981)/SM4500-NH3	Case-by-Case[3]
Biological Oxygen Demand (BOD)	PSEP (1986)	Case-by-Case
Chemical Oxygen Demand (COD)	PSEP (1986)	Case-by-Case

SM = Standard Method, ASTM = American Society for Testing Materials.

[1] ASTM D-422 modified may be used for ADMEF sediment characterization although the method has been replaced by ASTM D-6913 (sieve) and D-7928 (hydrometer).

[2] Total Volatile Solids is relevant in situations wherein there is potential for high amounts of organic material.

[3] Total Sulfides and ammonia analyses are mandatory if biological testing is required.

Sediment grain size may be determined using either the PSEP (PSEP 1986) or American Society for Testing Materials (ASTM) Method D-422 (modified sieve sizes). These methods subdivide the fines (i.e., silt and clay fractions) using pipette and hydrometer, respectively. The PSEP protocols (1986) were developed for Puget Sound and provide a set of compiled testing methods appropriate for sediment that are generally recommended for site investigations, but ASTM may be preferable for engineering calculations. One of the following sieve series must be used:

1. Sieve size 5, 10, 18, 35, 60, 120, and 230 (PSEP 1986); or,
2. Sieve size 4, 10, 20, 40, 60, 140, 200, and 230 (ASTM D-422 modified).

In both protocols, fine-grained material is defined as the material passing the No. 230 sieve. The following general classifications are used in the ADMEF:

- Gravel: >2,000 microns (2 millimeters)
- Sand: 62.5 to 2,000 microns
- Silt: 3.9 to 62.5 microns
- Clay: 0 to 3.9 microns

TOC is a key index parameter that affects the adsorptive capacity and bioavailability of organic contaminants and some metals in sediments and methods specified in **Table 8-1** are recommended. Sediment TOC analysis laboratory methodology or standard operating procedures should be provided, for agency review and concurrence, during SAP preparation to confirm the proposed preparatory and analytical methods are appropriate for sediments and consistent with current practices. Other conventional analyses using other promulgated methods (i.e., ASTM, etc.) are subject to the Agencies approval if the preparation accounts for the high percent moisture of sediments, which may require larger sample volumes to provide adequate representativeness. PSEP (1986) and Plumb (1981) methods should be referenced prior to modifying other promulgated methods not listed in **Table 8-1**.

8.2. Standard List of Chemicals of Concern

The ADMEF contains a default list of constituents analyzed in most dredging projects. The standard COCs have one or more of the following characteristics:

- A demonstrated or suspected effect on ecological receptors or human health.
- One or more present or historical sources, resulting in high concentration when compared to natural conditions, and of sufficient magnitude to be of concern.
- A potential for persisting in a toxic form for long periods in the environment.
- A potential for entering the food web (bioavailability).

Different guidelines are established for marine and freshwater systems. Freshwater standards are to be used for locations with salinity less than 0.5 parts per thousand (ppt) and marine standards apply to locations with salinity greater than 25 ppt. In-water discharge sites or dredging prisms with salinity between 0.5 to 25 ppt will be evaluated on a case-by-case basis. Selection of the appropriate suite of chemical analyses is based on the location at which sediment toxicity is being evaluated.

The surface exposed by dredging (leave surface) will be evaluated using the COCs appropriate for the dredge site. The effects of in-water discharge of dredged material will be evaluated using the COCs appropriate for the discharge site. The Agencies will determine which set of chemical analyses (freshwater or marine) will be used to evaluate the dredging project. In some projects, both the freshwater and marine COCs may need to be analyzed (e.g., a dredging project in a freshwater environment proposing to discharge dredged material in a marine environment).

COCs that have been shown to be widespread in the environment are included on the standard list of ADMEF COCs. Chemical testing, when required, will involve analysis of these COCs. **Table 8-2** lists these chemicals and presents the currently used marine and freshwater ADMEF SLs for each chemical.

Table 8-2. *ADMEF COCs and Associated Benthic Toxicity Screening Levels and Bioaccumulation Triggers*

Chemical	CAS[1] Number	Use for Marine Projects			Use for Freshwater Projects	
		SL	BT	ML	SL1[2]	SL2[3]
MANDATORY STANDARD CONTAMINANTS OF CONCERN						
Metals[4] (mg/kg dry weight)						
Antimony	7440-36-0	150	---	200	---	---
Arsenic	7440-38-2	57	507.1	700	14	120
Cadmium	7440-43-9	5.1	---	14	2.1	5.4
Chromium	7440-47-3	260	---	---	72	88
Copper	7440-50-8	390	---	1,300	400	1,200
Lead	7439-92-1	450	975	1,200	360	>1,300
Mercury	7439-97-6	0.41	1.5	2.3	0.66	0.8
*Nickel**	*7440-02-0*	---	---	---	*38*	*110*
Selenium	7782-49-2	---	3	---	11	>20
Silver	7440-22-4	6.1	---	8.4	0.57	1.7
Zinc	7440-66-6	410	---	3,800	3,200	>4,200
PAHs (µg/kg dry weight)						
Naphthalene	91-20-3	2,100	---	2,400	---	---
Acenaphthylene	208-96-8	560	---	1,300	---	---
Acenaphthene	83-32-9	500	---	2,000	---	---
Fluorene	86-73-7	540	---	3,600	---	---
Phenanthrene	85-01-8	1,500	---	21,000	---	---
Anthracene	120-12-7	960	---	13,000	---	---
1-Methylnaphthalene[5]	*90-12-0*	---	---	---	---	---
2-Methylnaphthalene[5]	91-57-6	670	---	1,900	---	---
Total LPAH	**---**	**5,200**	**---**	**29,000**	**---**	**---**
Fluoranthene	206-44-0	1,700	4,600	30,000	---	---
Benz(a)anthracene	56-55-3	1,300	---	5,100	---	---
Pyrene	129-00-0	2,600	11,980	16,000	---	---
Chrysene	218-01-9	1,400	---	21,000	---	---
Benzofluoranthenes (b,-j,-k)	205-99-2 205-82-3 207-08-9	3,200	---	9,900	---	---
Benzo(a)pyrene	50-32-8	1,600	---	3,600	---	---
Indeno(1,2,3-cd) pyrene	193-39-5	600	---	4,400	---	---
Dibenz(a,h)anthracene	53-70-3	230	---	1,900	---	---
Benzo(g,h,i)perylene	191-24-2	670	---	3,200	---	---
Total HPAH	**---**	**12,000**	**---**	**69,000**	**---**	**---**
Total PAHs[6*]	**---**	**---**	**---**	**---**	***17,000***	***30,000***
Chlorinated Hydrocarbons (µg/kg dry weight)						
1,4-Dichlorobenzene	106-46-7	110	---	120	---	---
1,2-Dichlorobenzene	95-50-1	35	---	110	---	---
1,2,4-Trichlorobenzene	120-82-1	31	---	64	---	---
Hexachlorobenzene (HCB)	118-74-1	22	168	230	---	---
*beta-Hexachlorocyclohexane**	*319-85-7*	---	---	---	*7.2*	*11*
Phthalates (µg/kg dry weight)						
Dimethyl phthalate	131-11-3	71	---	1,400	---	---

Chemical	CAS[1] Number	Use for Marine Projects			Use for Freshwater Projects	
		SL	BT	ML	SL1[2]	SL2[3]
Diethyl phthalate	84-66-2	200	---	1,200	---	---
Di-n-butyl phthalate	84-74-2	1,400	---	5,100	380	1,000
Butyl benzyl phthalate	85-68-7	63	---	970	---	---
Bis(2-ethylhexyl) phthalate	117-81-7	1,300	---	8,300	500	22,000
Di-n-octyl phthalate	117-84-0	6,200	---	6,200	39	>1,100
Phenols (µg/kg dry weight)						
Phenol	108-95-2	420	---	1,200	120	210
2-Methylphenol	95-48-7	63	---	77	---	---
4-Methylphenol	106-44-5	670	---	3,600	260	2,000
2,4-Dimethylphenol	105-67-9	29	---	210	---	---
Pentachlorophenol	87-86-5	400	504	690	1,200	>1,200
Miscellaneous Extractables (µg/kg dry weight)						
Benzyl alcohol[7]	100-51-6	57	---	870	---	---
Benzoic acid	65-85-0	650	---	760	2,900	3,800
Dibenzofuran	132-64-9	540	---	1,700	200	680
Hexachlorobutadiene	87-68-3	11	---	270	---	---
N-Nitrosodiphenylamine	86-30-6	28	---	130	---	---
*Carbazole**	*86-74-8*	---	---	---	*900*	*1,100*
Pesticides and PCBs (µg/kg dry weight)						
4,4'-DDD	72-54-8	16	---	---	---	---
4,4'-DDE	72-55-9	9	---	---	---	---
4,4'-DDT	50-29-3	12	---	---	---	---
Sum of 4,4'-DDD, 4,4'-DDE, 4,4'-DDT	**---**	**---**	**50**	**69**	**---**	**---**
*2,4'-DDD and 4,4'-DDD**	---	---	---	---	*310*	*860*
*2,4'-DDE and 4,4'-DDE**	---				*21*	*33*
*2,4'-DDT and 4,4'-DDT**	---				*100*	*8,100*
Aldrin	309-00-2	9.5	---	---	---	---
Total Chlordane (sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, oxychlordane)	5103-71-9 5103-74-2 5103-73-1 39765-80-5 27304-13-8	2.8	37	---	---	---
Dieldrin	60-57-1	1.9	---	1,700	4.9	9.3
Heptachlor	76-44-8	1.5	---	270	---	---
*Endrin Ketone**	*53494-70-5*	---	---	---	*8.5*	*>8.5*
Total PCBs (Aroclors)	---	130	38[8]	3,100	110	2,500
CASE-BY-CASE CONTAMINANTS OF CONCERN[9]						
Dioxins/Furans (ng/kg dry weight)						
Total TEQ	---	See Section 8.3.1.				
Organometallic Compounds[10] (Unit of Measure Varies)						
Tributyltin (TBT) ion (bulk; µg/kg)[11]	36643-28-4	---	73	---	47	320
Tributyltin (TBT) ion (porewater, µg/L)	36643-28-4	---	0.15	---	---	---

Chemical	CAS[1] Number	Use for Marine Projects			Use for Freshwater Projects	
		SL	BT	ML	SL1[2]	SL2[3]
*Monobutyltin ion (bulk; µg/kg)**	*78763-54-9*	---	---	---	*540*	*>4,800*
*Dibutyltin ion (bulk; µg/kg)**	*10-53-502*	---	---	---	*910*	*130,000*
*Tetrabutlytin ion (bulk; µg/kg)**	*1461-25-2*	---	---	---	*97*	*>97*
Bulk Petroleum Hydrocarbons (mg/kg)						
*TPH – Diesel**	---	---	---	---	*340*	*510*
*TPH – Residual**	---	---	---	---	*3,600*	*4,400*

TEQ = Toxicity Equivalence, ML = Maximum Level, SL1 = Screening Level 1, SL2 = Screening Level 2, LPAH = Low Molecular Weight Polycyclic Hydrocarbon, DDD = Dichloro-diphenyl-dichloroethane, DDE = Dichloro-diphenyl-dichloroethylene, DDT = Dichloro-diphenyl-trichloroethylene, HPAH = High Molecular Weight Polycyclic Hydrocarbon, PAH = Polycyclic Aromatic Hydrocarbons, TPH = Total Petroleum Hydrocarbon, PCBs = Polychlorinated Biphenyls

1 CAS Number is the Chemical Abstract Service Registry Number.

2 SL1 corresponds to a concentration below which adverse effects to benthic communities would not be expected.

3 SL2 corresponds to a concentration above which more than minor adverse effects may be observed in benthic organisms. Chemical concentrations at or below the SL2 but greater than the SL1 correspond to sediment quality that may result in minor adverse effects to the benthic community.

4 Natural minerology may contribute to dredged material with inorganic metal concentrations above the SL. In such cases, as long as the metal concentrations are not linked to anthropogenic sources and the dredged material concentrations are within an acceptable range for the discharge site, the metals may be representative of the natural background and do not automatically trigger biological testing. Additional sediment characterization may be required if the discharge site is not suitable for the measured sediment metal concentration of the dredged material.

5 1-Methylnaphthalene and 2-Methylnaphthalene are included in the summation of total PAH for freshwater projects. 2-Methylnaphthalene is analyzed for marine projects but is not included in the summation for total LPAHs. 1-Methylnaphthalene is not analyzed for marine projects.

6 Total PAHs for freshwater projects include the sum of all PAHs listed.

7 The Agencies will use BPJ to determine the need for biological testing for projects in which benzyl alcohol is the only COC with a SL exceedance present in project sediments (DMMP 2016).

8 This value is normalized to TOC and is expressed in mg/kg carbon.

9 Analyses required only when there is sufficient reason-to-believe it is present in a given location.

10 D/F and TBT are not standard COCs for marine or freshwater projects. They may be required on a case-by- case basis (see Sections 8.3.1. and Section 8.3.2., respectively).

11 Bulk sediment measurement of TBT is recommended for dredged material and leave surface sample evaluations, although porewater TBT remains an option. See Section 8.3.2. for further details.

Analytes printed in italics and labeled with an asterisk (*) apply ONLY to freshwater.

8.2.1. Chemical Evaluation Guidelines

Apparent effects threshold (AETs) values, as developed in the PSDDA, were the main basis for establishing ADMEF evaluation guidelines for marine sediment. For freshwater sediment, the Agencies have adopted the State of Washington's Floating Percentile Method (FPM) due to the lack of Alaska-specific freshwater evaluation guidelines. For details regarding AETs, see PSDDA 1988. For details regarding FPM, see SAIC and Avocet 2003 and Ecology 2011.

8.2.1.1. Marine Screening Levels and Maximum Levels

The SL is defined as the COC concentration at or below which there is no reason to believe that dredged material discharge would result in unacceptable adverse effects to benthic species. For most COCs, the SL is set equal to the Lowest Apparent Effects Threshold (LAET). DMMUs with chemical concentrations present at levels above the SL require biological testing before a decision can be made on the suitability for unconfined, in-water discharge.

The maximum level (ML) is equal to the highest Apparent Effects Threshold (HAET) – a chemical concentration at which all biological indicators with AETs show significant effects. The ML values are not used by the Agencies as pass/fail indicators, but rather serve to provide valuable information to dredging proponents regarding the likely outcome of bioassays. While some DMMUs with ML exceedances have passed biological testing, the majority have failed. By comparing sediment COC data to the MLs, a dredging proponent can better judge how to proceed with the project, i.e., whether to invest more time and money into further testing for unconfined, in-water discharge, or to explore other discharge options and testing for those options (e.g., leachate tests for upland disposal).

Regarding the SLs and MLs, the following scenarios are possible:

1. All chemicals are at or below their SLs: no biological testing is needed; the DMMU is considered suitable for unconfined, in-water discharge.
2. One or more chemicals are present at levels between SL and ML: standard bioassay testing is needed (see Section 9). Potential exceptions may be agreed upon by the Agencies when COC concentrations in the background sediment are equal to or higher than the dredged material.
3. One or more chemicals are present at levels above the ML: standard bioassay testing may still be pursued prior to decision on whether or not to conduct bioaccumulation testing, but there is a high probability that the dredged material will fail Tier 3 bioassay testing.

8.2.1.2. Marine Bioaccumulation Triggers

BT values are used as guidelines to determine when bioaccumulation testing is required. If any COC exceeds the BT guideline value, additional information via bioaccumulation testing will be required to determine whether dredged material is suitable for unconfined, in-water discharge. Discussion on bioaccumulation testing is presented in Section 10.

8.2.1.3. Freshwater Screening Levels

The “screening level 1” (SL1) is defined as the COC concentration at or below which there is no reason to believe that dredged material discharge would result in unacceptable adverse effects to benthic species. The SL1 is currently set equal to the Washington State SMS Sediment Cleanup Objective (SCO) which represents a no adverse effects level. The SCO/SL1 is the goal for freshwater sediments for the protection of benthic communities. DMMUs with chemical concentrations present at levels above the SL1 require biological testing before a decision can be made on the suitability for unconfined, open-water discharge in freshwater.

The “screening level 2” (SL2) is equivalent to the Washington State SMS Cleanup Screening Level (CSL), which corresponds to a concentration above which more than minor adverse effects may be observed in benthic organisms and is used to define potential cleanup sites. In **Table 8-2**, the “>” symbol indicates that the toxicity threshold is unknown but above the listed concentration. COC concentrations at or below the SL2 but greater than the SL1 correspond to sediment quality that may result in minor adverse effects to the benthic community. Like the ML for marine sediments, the SL2 values are not used by the Agencies as pass/fail indicators, but rather serve to provide valuable information to dredging proponents regarding the likely outcome of bioassays.

Regarding the SL1 and SL2, the following scenarios are possible:

1. All chemicals are at or below their SL1s: no biological testing is needed; the DMMU is considered suitable for unconfined, in-water discharge at an approved freshwater site.
2. One or more chemicals are present at levels between SL1 and SL2: standard biological testing is required (see Section 9). Potential exceptions may be agreed upon by the Agencies when COC concentrations in the background sediments are equal to or higher than the dredged material.
3. One or more chemicals are present at levels above the SL2: standard biological testing may still be pursued prior to decision on whether or not to conduct bioaccumulation testing, but there is a high probability that the dredged material will fail Tier 3 bioassay testing.

8.2.1.4. Freshwater Bioaccumulation Triggers

There are currently no BTs for characterization of freshwater sediment. The need for bioaccumulation testing for freshwater projects will be determined on a case-by-case basis. Factors that may be considered include, but are not limited to, CWA Section 303(d) listings (impaired waters and total maximum daily loads), regional background concentrations of bioaccumulative contaminants of concern (BCOCs), conceptual site models, presence of ESA-listed species, etc.

8.2.2. Analytical Methods

There are no required analytical methods for standard COCs in the ADMEF. Any established and well-documented method that can meet the QC requirements outlined in this section may be used. The PSEP protocols are recommended to be consulted for sample cleanup procedures and method modifications. The methods to be used for a project must be clearly articulated in the SAP and approved by the Agencies prior to testing. **Table 8-3** lists commonly used sediment methods for the standard COCs. The chosen methods should have minimum quantitation levels that are below the applicable sediment SLs in **Table 8-2**.

In Alaska, sediment may contain rare earth elements, including elements with double-charged ions that have the potential to interfere with the quantitation of certain elements (e.g., selenium, arsenic). Fortunately, new technologies are available now to overcome interferences that may be present in the matrix of the sample. Many laboratories use a “reaction” or “collision” cell that are designed to eliminate common interferences, as part of their Inductively Coupled Plasma Mass Spectrometry (ICP-MS) instrumentation. Each cell has strengths and weaknesses, so it may be necessary to run the analysis using multiple cells to identify interference.

It is recommended to inform the labs of any suspected matrix issues with the samples to allow appropriate measures to investigate and mitigate any potential adverse effects in order to optimize analyses.

Table 8-3. *Recommended Analytical Methods for Standard COCs*

Standard COCs	Prep Method	Analysis Method[1,2]
METALS		
Antimony, Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Silver, Zinc	EPA 3050B	EPA 6010/6020
Selenium	EPA 3050B	EPA 6020/7740/7742
Mercury	EPA 7471/3050BMod	EPA 7471/6020Mod
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)	EPA 3541/3550	EPA 8270
CHLORINATED HYDROCARBONS		
1,2-Dichlorobenzene, 1,4-Dichlorobenzene, 1,2,4-Trichlorobenzene	EPA 3550	EPA 8260/8270
Hexachlorobenzene (HCB)	EPA 3540/3550	EPA 8270/8081
PHTHALATES	EPA 3550	EPA 8270
PHENOLS	EPA 3550	EPA 8270
MISCELLANEOUS EXTRACTABLES		
Benzyl alcohol, Benzoic acid, Dibenzofuran, N-Nitrosodiphenylamine	EPA 3550	EPA 8270
Hexachlorobutadiene	EPA 3540/3550	EPA 8270/8081
PESTICIDES and PCBs		
Pesticides	EPA 3540/3541/3550	EPA 8081
Polychlorinated Biphenyls (PCB) Aroclors	EPA 3540/3550	EPA 8082
TOTAL PETROLEUM HYDROCARBONS	NWTPH-Dx[3]	NWTPH-Dx[3]

[1] A recent version of the analytical method should be used. Other methods or versions of methods may be proposed and used with the Agencies' approval.

[2] Selected Ion Monitoring (SIM) may be used for Method 8270 if reporting limits cannot be brought below SL.

[3] Total Petroleum Hydrocarbons by Gas Chromatography/Flame Ionization Detection – Analytical Methods for Petroleum Hydrocarbons.

8.2.2.1. Summing Polycyclic Aromatic Hydrocarbons, Benzofluoranthenes, Dichloro-Diphenyl-Trichloroethylene, Chlordane, and Polychlorinated Biphenyls

For comparison to SL, BT, and ML values, a group summation is performed for the Polycyclic Aromatic Hydrocarbons (PAHs), Benzofluoranthenes, Dichloro-Diphenyl-Trichloroethylene (DDT), Chlordane and Polychlorinated Biphenyls (PCBs) families of chemicals using all detected concentrations. Non-detect results are not included in the sum.

Estimated values between the MDL and the laboratory reporting limit (i.e., J-flagged values) are included in the summation at face value and the sum is also J-flagged. Values that are J-flagged due to minor quality control deviations are also to be handled in this way. If all constituents of a group are undetected, the group sum is reported as undetected, and the single highest laboratory reporting limit of all the constituents is reported as the group sum.

- (Marine only) Low molecular weight polycyclic hydrocarbon (LPAH) is the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.

- (Marine only) High molecular weight polycyclic hydrocarbon (HPAH) is the sum of benzofluoranthenes, fluoranthene, pyrene, benz(a)anthracene chrysene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene.
- (Marine only) Total DDT is the sum of 4,4'-Dichloro-diphenyl-dichloroethane (DDD), 4,4'-Dichloro-diphenyl-dichloroethylene (DDE), and 4,4'-DDT.
- (Freshwater only) Total PAHs are the sum of naphthalene, acenaphthylene, acenaphthene, fluorene phenanthrene, 1-methylnaphthalene, 2-methylnaphthalene, anthracene, benzofluoranthenes, fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene.
- (Freshwater only) DDT, DDD, and DDE values are the sum of both the 2,4'- and 4,4'-isomers.
- Benzofluoranthenes are the sum of the b, j, and k isomers.
- Total chlordane is the sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane.
- Total PCBs include the sum of the following Aroclors: 1016, 1221, 1232, 1242, 1248, 1254, and 1260. If present, Aroclor-1262 and 1268 should be reported but not included in the total PCB summation.

The group sums, as well as the concentrations of individual constituents, must be included in the Sediment Characterization Report.

8.3. Special Contaminants of Concern

In addition to the list of standard COCs, there are COCs that may be required for analysis by certain dredging projects based on site-specific conditions found during Tier 1. The need for adding any non-standard chemicals to a project's COC list will be determined in coordination with the Agencies. Common non-standard COCs include D/F and TBT, along with by-products from degradation of wood waste or seafood processing waste, or constituents used for aquaculture are further discussed below. Other COCs may need to be analyzed for specific projects depending on site-specific information.

8.3.1. Dioxins and Furans

Polychlorinated dibenzo-dioxins (PCDDs) and polychlorinated dibenzo-furans (PCDFs) are commonly referred to together as "dioxins," or simply "dioxin," and abbreviated as D/F throughout the ADMEF. Dioxins are a group of 210 chlorinated organic compounds (congeners) with similar chemical structures. The toxicity of the various congeners varies considerably. The 17 congeners that have chlorine atoms located in the 2,3,7,8 positions (e.g., 2,3,7,8-Tetrachlorodibenzodioxin [TCDD] or 1,2,3,7,8-Pentachlorodibenzofuran [PeCDF]) are the dioxins of known concern for health effects in fish, wildlife, and humans. Of these, 2,3,7,8-TCDD is considered the most toxic and is used as a benchmark for estimating the toxicity of the other 16 congeners; as such, it is assigned a toxicity equivalency factor (TEF) of 1.0. **Table 8-4** provides the human/mammalian TEFs for all 17 congeners of regulatory concern. The toxicity equivalence (TEQ) is calculated by multiplying the TEF of each congener by the concentration of the congener and summing the results. The resulting TEQ is used in evaluating the suitability of dredged material for in-water discharge.

Table 8-4. *Toxicity Equivalency Factors for PCDDs and PCDFs*

Constituent	Congeners / Isomers	Toxicity Equivalency Factor[1]
Dioxins	2,3,7,8-TCDD	1
	1,2,3,7,8-PeCDD	1
	1,2,3,4,7,8-HxCDD	0.1
	1,2,3,6,7,8-HxCCD	0.1
	1,2,3,7,8,9-HxCDD	0.1
	1,2,3,4,6,7,8-HpCDD	0.01
	OCDD	0.0003
Furans	2,3,7,8-TCDF	0.1
	1,2,3,7,8-PeCDF	0.03
	2,3,4,7,8-PeCDF	0.3
	1,2,3,4,7,8-HxCDF	0.1
	1,2,3,6,7,8-HxCDF	0.1
	2,3,4,6,7,8-HxCDF	0.1
	1,2,3.7,8,9-HxCDF	0.1
	1,2,3,4,6,7,8-HpCDF	0.01
	1,2,3,4,7,8,9-HpCDF	0.01
	OCDF	0.0003

[1] World Health Organization (WHO) Human and Mammalian TEFs, from Van den Berg *et al.* 2006.

Dioxins are produced by natural events and are also unintentional byproducts of certain industrial processes. Common Alaskan natural events that can produce dioxins include forest fires or volcanic activity. Industrial processes include incomplete combustion of materials in the presence of chloride, such as burning of fuels, municipal and domestic waste incineration, chlorine bleaching of pulp and paper, and creosote and chlorinated pesticide manufacturing. Structural fires may also be a source of dioxins.

Like the standard ADMEF COCs, dioxins are widespread in the environment. However, due to the cost of analysis, dioxin analysis is only required when there is a reason to believe dioxins may be present at a project site at concentrations above natural background.

8.3.1.1. Dioxin and Furan Analysis and Reporting

This section summarizes the required D/F analysis and reporting procedures.

Analytical Method. The Agencies recommend EPA Method 1613B: Tetra- through Octa-Chlorinated D/Fs by Isotope Dilution High Resolution Gas Chromatography/High Resolution Mass Spectrometry as the most suitable analytical method for sediment. The identification of PCDD/F congeners at low concentrations can be difficult as there is significant possibility of interfering compounds (such as chloro-diphenyl ethers) causing the reporting of artificially elevated values. The laboratory should be consulted for adequate extract cleanups to mitigate interfering compounds as much as possible.

Data Validation. At a minimum, Stage 2B data validation is required for dioxin analysis using the latest National Functional Guidelines for high resolution data review (EPA 2020). However, because of the complexity of the method, the extremely low reporting limits, and the high potential for interfering compounds such as chloro-diphenyl ethers, Stage 4 data validation by an experienced independent validator may be appropriate for some projects. Regardless of validation stage, estimated maximum possible concentration (EMPC) qualifier assessment and gas chromatography (GC) resolution review of 2,3,7,8-TCDD and 2,3,7,8-TCDF must be addressed during data validation.

Data Reporting. The laboratory shall report each of the 2,3,7,8-chlorine substituted PCDD/F congeners on a dry-weight basis. Estimated detection limits (EDLs) and reporting limits shall be reported for each of these congeners. The 17 congeners of interest shall be tabulated as TEQ, both with non-detected values (U) = ½ EDL and with U = 0. The difference between these values gives data reviewers an idea of how much the EDL substitution affects the TEQ summation.

EMPC. The EMPC qualifier is applied when both quantitation ions are detected with a signal to noise ratio of at least 2.5 to 1, but where the ion abundance ratio does not meet the method criteria for positive identification. EMPCs should be qualified as non-detect "U" reported at the level the analyte was detected (the EMPC concentration). If there is reason to believe the EMPC concentration is accurate it may be flagged as estimated "J".

Toxicity Equivalence Calculations. TEQs should be calculated two different ways: (1) non-detected values U = ½ EDL or U = ½ EMPC (when EMPC is qualified as non-detect in data validation) and (2) with non-detected values U = 0. **Table 8-4** presents the specified mammalian TEFs for each of the 17 congeners. Additionally, tabulated total homologue concentrations shall be completed for each sample, blank, and QC sample analyzed.

8.3.1.2. Guidelines for Dioxin and Furan Evaluation

D/F evaluation guidelines have not been developed in Alaska. D/F results will be evaluated on a case-by-case basis. Interim guidance for dispersive discharge will be 4 parts per trillion (pptr) TEQ. When more D/F data is available, guidelines will be re-evaluated. If a non-dispersive discharge site is selected and approved, site specific background concentrations should be determined and used to establish discharge site management objectives.

A bioaccumulation study can be conducted to evaluate sediment above the 4 pptr or site-specific guideline.

8.3.2. Tributyltin

TBT (and other organotins) analysis may be required in freshwater or marine areas affected by vessel maintenance and construction activities, shipping, and frequent vessel traffic (e.g., shipyards, boatyards, harbors, and marine terminals), because TBT was used as an antifoulant in vessel paints. Dredging proponents should also consider including TBT (and other organotins) analysis wherein there exists, currently or in the past, potential sources of such contamination. For example, TBT testing would be required for dredged material that would be removed from high-risk areas for potential TBT (e.g., beneath a grid or boat lift, major combined sewer overflows, and wastewater treatment plant outfalls in more urbanized areas).

Measurement of TBT in sediments by bulk analysis (in lieu of porewater analysis) is recommended and accepted for most dredging projects (DMMP 2015a). Bulk sediment TBT data will be evaluated against the bioaccumulation trigger of 73 µg/kg. If the bulk TBT concentration of a DMMU exceeds 73 µg/kg, bioaccumulation testing must be conducted unless porewater (also known as "interstitial water") data are available.

Porewater TBT data is considered a better approximation of the bioavailable fraction and porewater analysis remains an option for marine projects in addition to, or instead of, bulk analysis, at the discretion of the dredging proponent. In cases where the dredging proponent chooses to collect porewater TBT data, the suitability of the dredged material for in-water discharge will be determined by comparison to the existing bioaccumulation trigger of 0.15 µg/L. If paired bulk and porewater TBT data are collected for a sample, the porewater results will be used to determine suitability of the dredged material for in-water discharge.

Centrifugation is preferred for collecting sediment porewater – for detailed guidance on porewater collection and sample handling refer to, “Tributyltin Analysis: Clarification of Interstitial Water Extraction and Analysis Methods – Interim” (DMMP 1998). Alternative porewater extraction methods may be used in cases where centrifugation is not an effective technique, (e.g., for very sandy sediments) and will be decided on a case-by-case basis by the Agencies. Porewater collection and sample handling should be clearly described in the SAP. Porewater sampling and processing proposed at remote sites should be particularly well documented and understood.

Acceptable methods for measuring TBT involve tropolone/methylene chloride extraction, followed by Grignard derivatization and analysis by gas chromatography/mass spectrometry (GC/MS) (e.g., Krone *et al.* 1989), GC/MS Selective Ion Monitoring (SIM) (e.g., PSEP 1997), or gas chromatography/flame photometric detector (GC/FPD; e.g., Unger *et al.* 1986).

For marine projects, if the TBT concentration in the porewater of a DMMU is above 0.15 µg/L or if the bulk TBT concentration (in the absence of porewater data) exceeds 73 µg/kg, bioaccumulation testing must be conducted using the ADMEF bioaccumulation guidelines in effect at the time of testing. If unacceptable tissue concentrations are measured at the end of the bioaccumulation test, the sediment will be found unsuitable for in-water discharge. It should be noted that standard toxicity bioassays (amphipod mortality, larval development, and *Neanthes* growth tests) are not triggered by exceedances of TBT thresholds, as these bioassays have been shown to be ineffective in the evaluation of TBT toxicity (PSDDA/SMS 1996).

8.3.3. Wood Waste

Wood waste can range in size from intact logs down to fine bark and sawdust. The ADMEF program requires logs and large woody debris to be removed prior to discharge. Projects containing large pieces of wood debris must remove them prior to in-water discharge of dredged material using a clamshell bucket or other approved method, or by passing the dredged material through a 12-inch by 12-inch screen. If a project’s sediments contain a significant quantity of smaller wood debris, the sediments must be analyzed in the laboratory to quantify the wood fraction.

The wood fraction can be quantified in the laboratory on either a volume or a weight-specific basis. While quantifying wood debris in sediments on a volumetric basis may be more ecologically meaningful, it is much more difficult and less accurate than quantifying it on a weight-specific basis. Therefore, dredged material assessment of wood debris will be accomplished on a dry-weight basis, then converted to a volumetric basis by multiplying the weight-based number by two (example: 25% by weight is approximately 50% by volume). The dry-weight fraction of debris is estimated by quantifying the organic fraction. Dredged material containing an organic fraction greater than 25% dry weight will be required to undergo biological testing to assess the suitability of the material for unconfined in-water discharge. Likewise, dredged material containing an organic fraction less than 25% dry weight will be considered suitable for unconfined in-water discharge without further testing unless one or more COCs exceed chemical SLs.

One method for determining the dry-weight fraction of wood waste is quantification by ASTM D-2974 Method C, with the sample size increased to 100 – 300 grams. Other methods may be proposed by the dredging proponent in lieu of this approach but must be included in the SAP and approved by the Agencies. For additional information see 18 AAC 60.480.

If bioassays are triggered by wood waste, additional information must be obtained in preparation for biological testing. Sediment grain size is an important consideration when selecting the species to be used in the amphipod test and choosing appropriate reference sediments. However, the presence of wood waste in the sediment sample would bias the results of standard grain-size analysis. Therefore, in addition to the standard grain-size testing, dredging proponents should conduct grain-size analysis on the residue left over after the wood-waste analysis. This "organic-free" grain-size distribution should be used in conjunction with the standard grain-size distribution in selecting the appropriate amphipod species and reference sediment. Aliquots selected for bioassay analysis in wood waste areas must be representative of the in-situ conditions since wood waste, itself, can cause toxic effects (i.e., hydrogen sulfide, suffocation) that must be assessed to determine suitability of material.

8.3.4. Aquaculture and Seafood Processing Waste

Dredged sediments influenced by aquaculture operations or seafood processing facilities may require additional site-specific parameters or COC evaluation to determine suitability of in-water discharge. For example, potential use of pesticides at aquaculture facilities may trigger inclusion of site-specific parameters and COCs related to the specific uses. In general, additional conventional analyses (e.g., Chemical Oxygen Demand [COD], Biological Oxygen Demand [BOD]) associated with increased organic loading for both seafood waste streams and aquaculture will need to be included as part of the sediment characterization evaluation. These site-specific parameters or COCs will need to be identified and approved in consultation with the Agencies during the SAP development.

8.4. Sediment Data Quality

The quality of chemical data submitted to characterize dredged material proposed for in-water discharge at a project or ADMEF site must be assessed before it may be used for regulatory decision-making. This section provides general QA guidelines.

8.4.1. Laboratory Accreditation

Laboratories are required to be accredited by the ADEC or an accrediting body approved by the Agencies for sediment methods used to generate chemical data for ADMEF projects. A current list of ADEC-accredited labs may be found at https://dec.alaska.gov/spar/csp/lab-approval/list-of-approved-labs.

8.4.2. Sample Detection Limits and Reporting Limits

The analytical method used must have MDLs (a type of DL) that are below the SLs. Ideally, the reporting limits (e.g., LOQ/PQL) for all COCs will also be below the SLs. In cases where matrix interference elevates DLs above the SL or high concentrations require sample dilution, dredging project proponents must consult with the lab and Agencies to determine the next steps. If sufficient information exists to determine that a COC with a DL exceedance is likely not present, the Agencies may be able to make a Suitability Determination. However, failure to bring reported non-detects for an analyte below the SL could result in the Agencies requiring the re-extraction and re-analysis of archived sediment, or biological toxicity testing, to verify the suitability of sediments for in-water discharge. The Agencies will review all relevant information (historical testing, sediment conventional parameters, context) to determine the appropriate path forward, in coordination with the dredging proponent, in the event the reporting limits of COCs are above the SLs.

The following guidelines must be followed when reporting results of chemical analysis:

- Laboratories must report estimated concentrations that fall between the sample DL and reporting limit. Such estimated concentrations should be accompanied by a "J" qualifier.

- Laboratories must report both the reporting limit and the sample DL for any COC analytical result that is accompanied by a “U” flag.
- For mixtures of chemicals, such as Total PCBs, the reported values of detected constituents - including “J” values falling between the sample DL and the reporting limit - will be summed (Section 8.2.2.1.). In the event that all constituents are undetected, the single highest constituent’s reporting limit will be used as the value for the mixture in a given sample and will be accompanied by a “U” qualifier.

The following scenarios are possible and need to be understood and handled appropriately:

- **Scenario 1:** One or more COCs have non-detects exceeding SLs while all other COCs are quantitated or reported as non-detects at or below the SLs: the requirement to conduct biological testing or re-extraction/re-analysis may be triggered solely by the non-detects. In this case the chemical testing subcontractor should do everything possible to bring sample DLs down to or below the SLs, including additional cleanup steps, re-extraction, etc. Selected ion monitoring or other more sensitive analytical methods may be used, if necessary. All such actions must be documented in the lab report. If non-detects cannot be brought below the SLs, the Agencies must be contacted immediately to determine the proper path forward. The Agencies will use BPJ to determine the next steps and the decision will be based on the significance of the COC in the context of the environment, the SL associated with the exceedance, the reported concentrations of other analytes in the tested sediment, and other factors. Major COCs with non-detect exceedances above the SL and the presence of other analytes in low or moderate concentrations will likely require corrective action, re-extraction, or biological testing.
- **Scenario 2:** One or more COCs are reported as non-detects above the SLs for a lab sample, but below respective BT, and other COCs have quantitated concentrations above SLs: The need to do bioassays is based on the detected exceedances of SLs and the non-detects above SL become irrelevant. No further action on the part of the chemical testing subcontractor is necessary.
- **Scenario 3:** One or more COCs are reported as non-detects above the SL and BT, and other COCs have quantitated concentrations above SLs: the need to do bioassays is based on the detected exceedances of SLs but all other non-detects must be brought below BTs to avoid the requirement to do bioaccumulation testing. As in the first scenario above, everything possible should be done to lower the sample DLs.

In all cases, to avoid potential problems and leave open the option for retesting, sediments or extracts should be kept under proper storage conditions until the chemistry data are deemed acceptable by the Agencies.

8.4.3. Data Quality Objectives

Data quality objectives are the quantitative and qualitative terms used to describe how good the data need to be to meet the project’s objectives. Typical data quality objectives include precision, accuracy, representativeness, comparability, and completeness.

Precision is evaluated using the Relative Percent Difference (RPD) values between duplicate sample results and/or matrix spike duplicates.

$$RPD = \frac{ABS(R1 - R2)}{\left(\frac{R1 + R2}{2}\right)} X\ 100$$

R1 = Results for Matrix Spike (MS) or Duplicate 1
R2 = Results for Matrix Spike Duplicate (MSD) or Duplicate 2

Accuracy: For parameters analyzed in the laboratory, accuracy will be evaluated using percent recovery (%R) of the target analyte in spiked samples and, where applicable, the recoveries of the surrogates in all samples and QC samples.

$$\%\,Recovery = \frac{SSR - SR}{SA}\,x\,100$$

SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added

Representativeness is the degree to which data from the project accurately represent a particular characteristic of the environmental matrix which is being tested. Representativeness of samples is ensured by adherence to standard field sampling protocols and standard laboratory protocols. The design of the sampling scheme and number of samples should provide representativeness of each matrix being sampled.

Comparability is the measurement of the confidence in comparing the results of one sampling event with the results of another achieved by using the same matrix, sample location, sampling techniques, and analytical methodologies.

Completeness is the percentage of valid results obtained compared to the total number of samples taken for a parameter. Percent completeness may be calculated using the following formula:

$$Percent\ Completeness = \frac{\#\ of\ valid\ results}{\#\ of\ samples\ taken}\,X\,100$$

8.4.4. General Quality Assurance Guidelines

The chemistry QA/QC samples summarized in **Table 8-5** must be analyzed to assess the usability of the data for dredged material characterization and Suitability Determinations.

Table 8-5. *Laboratory QA/QC Requirements for Conventional Parameters and COCs*

Analysis Type	Method Blanks[1]	Duplicates[1, 8]	MS/MSD[1]	Surrogates[2]	CRM/SRM[7]
Semivolatiles[3,4]	X	X[5]	X	X	X
Pesticides[3,4]	X	X[5]	X	X	X
PCBs[3,4]	X	X[5]	X	X	X
Metals	X	X	X		X
Ammonia	X				
Total Sulfides	X				
Total Organic Carbon	X				X
Total Solids					
Total Volatile Solids					
Grain Size					
Tributyltin[3,4]	X	X[5]	X	X	
Dioxins/Furans	X	X		X[6]	X

CRM = Certified Reference Material.
[1] Frequency of Analysis = 5 % or 1 per batch, whichever is more frequent.
[2] Surrogate spikes required for every sample, including matrix spiked samples, blanks, and reference materials.
[3] Initial calibrations required before any samples are analyzed, after, each major disruption of equipment, and when ongoing calibration fails to meet method criteria.
[4] Ongoing calibration verifications required at the beginning of each work shift, every 10 to 12

samples or every 12 hours (whichever is more frequent), and at the end of each shift.
[5] MSD may be used.
[6] Labeled compounds are spiked into each analytical sample.
[7] CRM/SRM frequency is project-specific and should be determined in coordination with the Agencies during SAP development.
[8] Follow QA/QC requirements for the analytical method
[9] The Puget Sound Standard Reference Material (PS-SRM) is generally acceptable for projects in Alaska where the use of an SRM is required by the SAP. Other SRMs may be considered on a case-by-case basis.

Laboratories performing ADMEF chemical analyses must follow the standard QC procedures published in the respective method and/or laboratory standard operating procedure and must have ADEC and/or an Agencies-approved accrediting agency accreditation for each method.

The Agencies recommend that all chemistry data undergo a minimum of Stage 2B validation to ensure that all chemistry QA/QC requirements are met and to assign appropriate final data validation flags consistent with ADEC reporting requirements. As defined by EPA (2009), a Stage 2B validation consists of verification and validation based on completeness and compliance checks of sample receipt conditions and both sample-related and instrument-related QC results. Higher stages of data validation may be required if data quality issues are present and the Agencies recommend the preparation of a Level IV pdf to support higher stages of review, if necessary.

Data validation is typically conducted using the EPA Contract Laboratory Program (CLP) National Functional Guidelines (NFG). Other guidance for data validation can be used; e.g., Department of Defense General Data Validation Guidelines. The SAP should provide the proposed data validation procedures and citations for any guidance to be used. Measurement performance criteria should be provided for each analytical method. **Table 8-6** provides measurement performance criteria that are recommended for ADMEF projects.

Table 8-6. *Recommended Measurement Performance Criteria*

Analysis Type	Precision	Accuracy	Surrogate Limits	Completeness	CRM/SRM[2]
Semivolatiles	±35% RPD	50 – 150 %R	Lab Limits	95%	Certified limits
Pesticides	±35% RPD	50 – 150 %R	Lab Limits	95%	Certified limits
PCBs	±35% RPD	50 – 150 %R	Lab Limits	95%	PS-SRM Advisory limits
Metals	±20% RPD	75 – 125 %R	NA	95%	Certified limits
Ammonia	±20% RPD	75 – 125 %R	NA	95%	NA
Total Sulfides	±20% RPD	75 – 125 %R	NA	95%	NA
Total Organic Carbon	±20% RPD	75 – 125 %R	NA	95%	Certified limits
Total Solids	±20% RPD	NA	NA	95%	NA
Total Volatile Solids	±20% RPD	NA	NA	95%	NA
Grain Size	±20% RPD	NA	NA	95%	NA
Tributyltin	±35% RPD	50 – 150 %R	Lab Limits	95%	NA
Dioxins/Furans	±30% RPD	Method limits[1]	Method Limits[1]	95%	PS-SRM Advisory limits

CRM = Certified Reference Material, NA = Not Applicable, %R = Percent Recovery.
[1] Method 1613B (EPA 1994).
[2] When CRM/SRM analysis is required

9. TIER 3 BIOLOGICAL TESTING: BIOASSAYS

Tier 3 biological testing of dredged material is required when chemical testing results indicate the potential for unacceptable adverse environmental or human health effects. Results of bioassay tests are more informative of potential resource impacts than exceedance of numeric chemical sediment standards (DMMP/RSET 2015). Thus, bioassay results always take precedence over chemical results. Biological testing could include:

- **Bioassays** (sometimes called "toxicity tests"): used to evaluate potential toxicity effects on benthic invertebrates – discussed in this section.
- **Bioaccumulation tests**: used to evaluate the bioavailability of certain chemicals which are known or suspected agents affecting human or ecological health in the marine environment– discussed in Section 10.

The standard suite of bioassays for either marine or freshwater sediment in Tier 3 evaluations is triggered by exceeding one or more SLs for COCs in the dredged material (see **Table 8-2**).

There is no State of Alaska accredited laboratory for providing biological effects data for ADMEF projects. Nonetheless, laboratories providing biological effects data for ADMEF projects should be accredited by an entity recognized by the Agencies, such as the State of Washington, e.g., a laboratory listed on https://apps.ecology.wa.gov/laboratorysearch/Default.aspx. It is recommended to use a laboratory familiar with ADMEF testing procedures as they will be able to provide technical support for the decisions that must be made on a case-by-case basis. The Agencies will review and approve the selected laboratory during the SAP review.

9.1. Bioassay Tests: Marine

A suite of three bioassays is used in the ADMEF program to characterize toxicity of whole sediment and includes both acute and chronic tests. Bioassays used for marine/estuarine evaluations, with recommended species, are shown in **Table 9-1**. If recommended species are not available, please contact the Agencies prior to initiating testing with a non-recommended species.

The protocols for the required bioassays can be found in the PSEP guidelines (1995), with updates since 1995 found on the DMMP Program Updates webpage at https://www.nws.usace.army.mil/Missions/Civil-Works/Dredging/Program-Updates/. Updates through 2020 are summarized in this section. The protocols describe field collection and processing methods, bioassay specific QA/QC, and data reporting procedures.

Table 9-1. *Marine Bioassay Tests and Recommended Species*[1]

Test	10-Day Amphipod Mortality Test	20-Day Juvenile Infaunal Polychaete Growth Test	Sediment Larval Development Test
Tests for:	acute toxicity	chronic toxicity	acute larval toxicity
Species used:	• *Eohaustorius estuarius* • *Ampelisca abdita* • *Rhepoxynius abronius* • *Leptocheirus plumulosus*[2]	• *Neanthes arenaceodentata* (Los Angeles karyotype)	• *Mytilus galloprovincialis* • *Dendraster excentricus*

[1]Species selection is based on availability and on sediment characteristics. See text for further details.

[2]Alternate amphipod species, requires Agency approval.

9.1.1. 10-day Amphipod Mortality Test

This bioassay is an acute test that measures survival of infaunal amphipods to evaluate the toxicity of sample sediments.

The ADMEF generally recommends using *Eohaustorius estuarius*, as this species is relatively insensitive to salinity changes and grain size effects, except for high clay (>20%) content. *Ampelisca abdita* is also relatively insensitive to the effects of grain size and is the recommended species when testing sediments with relatively high clay content (>20%). *Rhepoxynius abronius* has shown sensitivity to high percent fines in sediments, particularly high clay content sediments, and has exhibited mortalities greater than 20% in clean, reference area sediments (DeWitt *et al.* 1988; Fox 1993). It should only be selected when testing coarser sediments (<60% fines). *Eohaustorius estuarius* can generally tolerate the widest range of salinities (2 to 28 ppt), whereas *A. abdita* and *R. abronius* prefer salinities of 28 ± 1 ppt. *Leptocheirus plumulosus* may be an acceptable alternate amphipod species, subject to Agency approval, due to grain size and/or availability of standard test species.

Proposed species must be coordinated through the Agencies and the rationale for species selection must be documented in the SAP for the proposed dredging project.

Appropriate negative control sediment (Section 9.2.2.1.) must be used for the test species selected.

9.1.2. 20-day Juvenile Infaunal Polychaete Growth Test (*Neanthes*)

This bioassay is a sublethal bioassay, testing for chronic rather than acute (lethal) toxicity to the nereid worm *Neanthes arenaceodentata.* The growth of this worm is used as an indication of sublethal toxicity. Testing results must be reported on an ash-free dry-weight (AFDW) basis. The AFDW procedure eliminates weight from sediment in the gut, thereby providing a more accurate measurement of the change in biomass during the exposure period.

9.1.3. Sediment Larval Development Test

The sediment larval test uses the planktonic larval form of a benthic invertebrate to test for acute toxicity to this life stage. Larvae are introduced into chambers of test sediment and overlying water directly after fertilization. Development and survival are tracked for the 48 to 60 hours of larval growth.

This test uses larvae of either an echinoderm or bivalve species. *Dendraster excentricus* is the recommended echinoderm species, and *Mytilus galloprovincialis* is the recommended bivalve species. If both species are unavailable, laboratories may propose use of alternative species such as the bivalve *Crassostrea gigas.* Use of alternative species should proceed only after coordination with and approval from the Agencies.

Because the larval stage is a sensitive one, care must be taken during the test to ensure that non-treatment factors for larval survival and development are controlled. The PSEP Protocols (1995) must be followed carefully to ensure that useable data are collected.

For the sediment larval test, adults must be collected in spawning condition or must be induced to spawn in the laboratory. Therefore, seasonality plays a role in selecting a test organism for this bioassay. Viable test organisms are most difficult to obtain in the fall and early winter and the probability of performance problems increases during that time. The Agencies recommend that biological testing be avoided late in the calendar year if possible.

When testing dredged material with high concentrations of fines, wood waste or other flocculent material, dredging proponents may elect to use the resuspension protocol (see DMMP/SMS 2013) in lieu of the standard PSEP protocol termination procedure, in order to reduce false positives from normally developing larvae being entrained in the flocculent material. The decision to use the resuspension protocol must be made in coordination with the Agencies for approval before use. For routine testing of sediments with lower fractions of fines, wood waste, or flocculent material, the standard PSEP protocol should be used.

Recent work has shown that low potential of hydrogen (pH) in the larval bioassay test is a confounding factor in the interpretation of bioassay results (DMMP 2020). Therefore, the Agencies have established a recommended range for pH in the larval bioassay test of 7.5 to 9. If the pH drops below 7.5 at any point in the test, it may be cause for the bioassay results to be evaluated with caution.

9.2. Quality Assurance/Quality Control in Marine Bioassays

The following QA/QC guidelines apply to the standard suite of marine bioassays.

9.2.1. Replication

For marine bioassays, five (5) replicates are run for each test sediment, as well as for the control and reference sediments.

9.2.2. Negative Control and Reference Samples

For the amphipod and juvenile infaunal polychaete species bioassays, a negative control sediment is run with each test batch. The negative control sediment for the amphipod test is taken from the test organism collection site. The juvenile infaunal polychaete growth test, using laboratory-cultured *Neanthes arenaceodentata*, requires collection of negative control sediment from an appropriate area. For the sediment larval test, a negative seawater control is required. The negative control provides an estimate of test organism general health during the test exposure period.

In addition to the negative control, at least one reference sediment must be run with each test batch for each bioassay. The primary purpose of the reference sediment is to control for non-treatment effects due to grain size. The reference sediment is also collected and homogenized for direct comparison to the DMMU composites regarding physical, chemical, and biological testing results. The fines content (silt plus clay) of the reference material should ideally fall within 10% of the fines content of the test sediments. For dredged material with relatively coarse-grained sediments (> 80% sand), the dredging proponent can opt to rely solely on the control sediment (see guidance below on when it is appropriate to use control sediments as a reference).

9.2.2.1. Selection of Negative Control Sediments

All bioassays must be conducted using well-established negative (clean) controls. Such controls are clean, nontoxic seawater and/or sediment samples taken from established control areas.

Rhepoxynius abronius and *Eohaustorius estuarius* typically inhabit well-sorted, fine sand while *Ampelisca abdita* is a tube-dwelling amphipod found mainly in protected areas and is often abundant in sediments with a high organic content. *Ampelisca* generally inhabits sediments from fine sand to mud and silt without shell, although it can also be found in relatively coarser sediments with a sizable fines component (PSEP 1995).

The best way to ensure a good negative control is to collect the control sediment from the same location at which the test organisms are collected. *Neanthes arenaceodentata* is cultured in the lab rather than field-collected and sand should be used as the control sediment.

Sediments proposed for use as negative controls must be approved before bioassays commence. If an area without a proven track record is proposed for collection of negative control sediment, sufficient data (such as grain size, organic carbon content, chemical data, bioassay results) must be submitted before its use can be approved by the Agencies.

9.2.2.2. Reference Sediment Collection Sites - Marine

Bioassays must be run with a reference sediment with physical characteristics (grain size and organic carbon) that matches the test sediment as closely as possible to ensure that physical characteristics of the dredged material are not the source of any observed toxicity. The dredging proponent may need to take multiple sediment samples from different locations within a reference area to make sure sediments properly match the dredged material. For bioassays reference sediments must also be analyzed in the laboratory for the total sulfides, ammonia, and mandatory sediment conventional parameters from **Table 8-1** as well as the ADMEF COCs listed in **Table 8-2**. The methods and QA guidelines used for analysis of sediment conventional parameters in test sediments should also be used for reference sediments.

The sampling protocol used for the collection of reference sediment can affect its performance during biological testing. The following guidelines should be followed when collecting reference sediments:

1. Use experienced personnel;
2. Follow PSEP 1995 Protocols;
3. Sample from the biologically active zone;
4. Avoid anoxic sediment below the Redox Potential Discontinuity horizon;
5. Use wet-sieving method in the field to target appropriate grain sizes; and,
6. Fix sulfides sample(s) with zinc acetate.

Wet-sieving in the field is imperative for finding a good grain-size match with the test sediment. Wet-sieving is accomplished using a 63-micron (No. 230) sieve and a graduated cylinder; 100 milliliter (ml) of sediment is placed in the sieve and washed thoroughly until the water runs clear. The volume of sand and gravel remaining in the sieve is then washed into the graduated cylinder and measured. This represents the coarse fraction; the fines content is determined by subtracting this number from 100. Because of the wide heterogeneity of grain size in the reference areas, it may be necessary to perform wet-sieving in several places before a reference sediment with the proper grain size is found. It is important that the sediment sample analyzed by wet-sieving is representative of the sediment that will be used for bioassays. Homogenization of the sediment prior to wet-sieving is recommended.

It should be noted that wet-sieving results will not perfectly match the dry-weight-normalized grain size results from the laboratory analysis but should be relatively close (generally within 10%). It is requested that wet-sieving results be submitted along with the laboratory data so that a regression line for each embayment can be developed to predict more accurately the dry-weight fines fraction from the wet-sieving results found in the field. Reference station coordinates should also be reported, with an accuracy of ± 3 meters.

9.2.2.3. Use of Negative Control Sediments as Reference Sediments

In some instances, the negative control (“control sediment”) can be an acceptable substitute for the reference sediment. When reference sediment fails to meet its performance standard, and more than one reference has been collected, statistical comparisons to determine which reference is most similar to the test sediment can be made. If no reference sediments meet performance standards, or if the control sediment is closer in grain size to one or more stations being evaluated than any of the remaining reference sediments, the control sediment could be considered an acceptable substitute for the reference sediment and the data interpreted.

If a control sediment is substantially dissimilar in its physical characteristics (e.g., >25% difference in fines) to the site stations and to a failed reference sediment, the control sediment may still be used as a substitute for the reference station if both the Agencies and the dredging proponent agree that this is appropriate. Otherwise, the data from the bioassay(s) in question will be rejected and tests possibly rerun.

9.2.2.4. Quality Control Limits for the Negative Control

All three bioassays have negative control performance standards (see **Table 9-6** and **Table 9-8**). In the amphipod and juvenile infaunal polychaete (*Neanthes 20-day growth)* bioassay tests, mortality in the control sediment over the exposure period must be less than or equal to 10%. This represents a generally accepted level of mortality of test organisms under control conditions, in which the bioassay (in terms of test organism health) is still considered a valid measure of effects of the test treatments. If control mortality is greater than 10%, the bioassay test will generally have to be repeated, although that determination must be made in consultation with the Agencies.

Additionally, for the juvenile infaunal polychaete growth test (*Neanthes* 20-day growth bioassay) there is a negative control performance guideline of greater than 0.72 mg/individual/day (dry weight) as a target growth rate, with negative control growth rates below 0.38 mg/individual/day (dry weight) considered a QA/QC failure. Laboratories failing to achieve a control growth rate greater than 0.38 mg/individual/day may be required to retest.

For the sediment larval test, the performance standard for the seawater negative control combined development (mortality plus abnormality) is 30% or less.

9.2.2.5. Quality Control Limits for the Reference Sediment

Performance guidelines for reference sediments are listed in **Table 9-6** and **Table 9-8**. The mean amphipod test mortality for the reference sediment must not exceed 20% absolute over the mean negative control sediment mortality. For the juvenile infaunal polychaete growth test, the reference sediment mean mortality must be less than or equal to 20% at the end of the exposure period, and the mean growth rate must be greater than or equal to 80% of the negative control sediment's mean growth rate. The seawater-normalized combined endpoint (mortality plus abnormality) observed in the reference sediment for the sediment larval test must not exceed 35%.

Failure to meet the reference sediment performance standard for a bioassay may require that the bioassay be rerun with a new reference sediment. If a performance guideline is not met for reference sediment, the Agencies should be contacted as soon as possible for coordination regarding a retest.

9.2.3. Positive Control - Reference Toxicant

An appropriate Ref Tox must be run with each batch of test sediments as a positive control to assess test organism sensitivity. Two metrics are used to assess the effectiveness of the Ref Tox: the LC_{50} and the Effective Concentration 50 (EC_{50}). The LC_{50} or EC_{50} must be within the 95% confidence interval of responses expected for the toxicant used.

The selection of Ref Tox is generally subject to Agency approval. If elevated ammonia in the test sediment exceeds the purging trigger (**Table 9-3**), the Ref Tox must be un-ionized ammonia (see Section 9.3.1. for more details if this scenario occurs).

9.2.4. Water Quality Monitoring

Temperature, aqueous salinity, pH, and dissolved oxygen should be monitored on a daily basis for the amphipod and sediment larval tests, and every three days for the juvenile infaunal polychaete growth test (*Neanthes*). Total sulfides and ammonia should be measured at least at test initiation and termination for all three tests (See Section 9.3. for a discussion of non-treatment effects). Porewater salinity should be measured prior to test initiation. The test protocols for each of these bioassays specify acceptable ranges for these parameters. Water quality data can be critical in the interpretation of bioassay results. Water quality test acceptability criteria for marine bioassays are shown in **Table 9-2**.

Table 9-2. *Target Water Quality Test Conditions for Marine Bioassays*

Test Type	Species	Dissolved Oxygen (mg/L) [1]	Temperature (°C)	Salinity (ppt)	pH
10-Day Amphipod	*Ampelisca abdita*	≥4.6 mg/L	20 ± 1	28 ± 1	7 - 9
	Rhepoxinius abronius	≥5.1 mg/L	15 ± 1	28 ± 1	7 - 9
	Eohaustorius esturius	≥5.1 mg/L	15 ± 1	28 ± 1 [2]	7 - 9
	Leptocheirus plumuslosus	≥4.4 mg/L	25 ± 2	28 ± 1 [2]	7 - 9
20-Day Juvenile Infaunal Polychaete	*Neanthes arenaceodentata*	≥4.6 mg/L	20 ± 1	28 ± 2	7 - 9
Sediment Larval	*Mytilus galloprovincialis*	≥5.0 mg/L	16 ± 1	28 ± 1	7.5 - 9
	Crassostrea gigas	≥4.6 mg/L	20 ± 1	28 ± 1	7.5 - 9
	Dendraster excentricus	≥5.1 mg/L	15 ± 1	28 ± 1	7.5 - 9
	Strongylocentrotus purpuratus	≥5.1 mg/L	15 ± 1	28 ± 1	7.5 - 9

If freshwater to saltwater acclimation (see Section 9.4.) is conducted, bioassay laboratories must report temperature, pH, salinity, total sulfides, hydrogen sulfide, total ammonia, and un-ionized ammonia prior to initiation of bioassays and sufficiently early to initiate Ref Tox testing and/or purging as needed. It is highly recommended to discuss water quality results with the Agencies prior to starting bioassays. Hydrogen sulfide and un-ionized ammonia concentrations must be calculated based on the water temperature, pH, salinity, and measured sulfides and ammonia concentrations taken from the bioassay chambers. Approved calculators are available and can be found on USACE Seattle District's website[2] by following these steps:

1. Access the Seattle District website at https://www.nws.usace.army.mil/Missions/Civil-Works/Dredging/.
2. Choose "Program Updates" from the left-hand Menu.
3. Choose "Bioassay Species, Methods, and Guidance" under All Updates to the DMMP Program.
4. Under Year 2020, "Unionized Ammonia and Hydrogen Sulfides Calculator (Excel File)".

9.3. Marine Ammonia and Sulfide Non-Treatment Effects

Ammonia and sulfide can adversely affect test organisms in both marine and freshwater bioassays. USACE Seattle District DMMP has established protocols for addressing non-treatment effects from ammonia and sulfide for marine bioassays. Over the length of that

[2] Direct link to ammonia and sulfide calculators - https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.nws.usace.army.mil%2FPortals%2F27%2Fdocs%2Fcivilworks%2Fdredging%2FUpdates%2FUnionized%2520ammonia%2520and%2520hydrogen%2520sulfide%2520calculator%2520-%2520SMARM%25202020.xlsx%3Fver%3DSKj_uLLCAfSLYBxDdhxVrw%253d%253d&wdOrigin=BROWSELINK

program, multiple clarification papers have addressed issues related to ammonia and sulfides. The paper, "Modifications to Ammonia and Sulfide Triggers for Purging and Reference Toxicant Testing for Marine Bioassays" (DMMP 2015b), addresses data gaps and inconsistencies in the previous guidance and should be consulted for further details and background information on this topic.

The key points in the 2015 DMMP clarification paper are incorporated into the procedures described in this section. In summary, triggers for purging bioassay containers to reduce ammonia and/or sulfides prior to testing are given in **Table 9-3**. The trigger for purging was set to be equal to the No Observed Effects Concentration (NOEC) for the most toxic forms of ammonia and sulfides, un-ionized ammonia and hydrogen sulfide. Un-ionized ammonia and hydrogen sulfide concentrations must be derived from measurements of total ammonia and sulfides using test-specific pH, temperature, and salinity measurements. For ammonia, the trigger for conducting Ref Tox testing is set at half the lowest NOEC. Ref Tox testing is not required for sulfides.

Table 9-3. *Reference Toxicant and Purging Triggers for Marine Bioassays*

Trigger	Bedded Sediment Tests (porewater)				Larval Tests (overlying water)	
	Neanthes	***Ampelisca***	***Eohaustorius***	***Rhepoxynius***	**Bivalve**	**Echinoderm**
Un-ionized Ammonia (mg/L) Ref Tox	0.23	0.118	0.4	0.2	0.02	0.007
Un-ionized Ammonia (mg/L) Purge	0.46	0.236	0.8	0.4	0.04	0.014
Hydrogen Sulfide (mg/L) Purge	3.4	0.0094	0.122	0.099	0.0025	0.01

9.3.1. Determining the Need for Purging or Un-ionized Ammonia Ref Tox Testing

These guidelines are only for marine bioassays; no similar guidance for freshwater bioassays have been developed to date by the Seattle District DMMP nor incorporated into the ADMEF.

The need for purging or Ref Tox testing should be determined prior to the commencement of actual bioassay testing. The following bullets summarize the recommended procedure (See DMMP 2015b and DMMP 2001a for further details):

- **Measure bulk ammonia and sulfides in sediment.** Bulk ammonia and bulk sulfides measurements should be measured by the chemistry lab on composited sediment representing each DMMU. Exceptions to this procedure for total sulfides may be considered for sediment testing performed for cleanup; and for projects where wood waste in new surface material may be an issue. In those cases, total sulfides should be performed on individual samples (e.g., a leave surface sample).
- **Measure ammonia and sulfides in bioassay medium of exposure.** For those DMMUs that will undergo bioassays, ammonia and sulfides must be measured in the medium of exposure (porewater or overlying water) prior to running the bioassays. While bulk measurements made by the analytical laboratory can provide an early warning of potential non-treatment effects in bioassays, these measurements are not always predictive of the ammonia and sulfide concentrations to which bioassay organisms will actually be exposed. Aqueous concentrations measured by the bioassay lab are more meaningful in this regard.

  For bedded sediment tests using *Neanthes*, *Eohaustorius* and *Rhepoxynius*, porewater is the medium of exposure. For the tube-building amphipod *Ampelisca*, as well as the bivalve and echinoderm species used in the larval development test, the overlying water is the medium of exposure.

Measurement of ammonia and sulfides in the medium of exposure can be accomplished by the bioassay lab by making measurements on two beakers for each DMMU, the first of which is set up in the manner that would be done for the amphipod bioassay and the second of which is set up as would be done for the larval bioassay. Since the juvenile infaunal polychaete growth bioassay is set up in the same way as the amphipod bioassay, the amphipod beaker is also predictive of ammonia/sulfides in the juvenile infaunal polychaete growth bioassay. In addition to ammonia and sulfides, pH is measured. Un-ionized ammonia and hydrogen sulfide concentrations are calculated using the measured pH, plus the temperature and salinity that will be maintained during the bioassays.

- **Prepare bioassays without purging.** If un-ionized ammonia and hydrogen sulfide concentrations are below the purging triggers in **Table 9-3**, or if any of the COCs exceeding SL are subject to significant loss or alteration of bioavailability during purging (to be determined in consultation with the Agencies), set up the bioassays normally, without sacrificial beakers or purging. Run a water-only ammonia Ref Tox LC_{50} test concurrently with a bioassay if the un-ionized ammonia Ref Tox trigger in **Table 9-3** is exceeded for the test organism being used (DMMP 2001a).
- **Prepare bioassays with purging.** If a purging trigger is exceeded for the species being used – and contaminant loss or alteration of bioavailability due to purging has been determined not to be a significant issue – prepare for purging. If the purging trigger for ammonia is exceeded, run the ammonia Ref Tox test concurrently.

9.3.2. Purging Methods

For sediment toxicity testing, there are a variety of approaches used by regulatory agencies, dredging proponents, and laboratories to purge samples. Purging is most often performed either by replacing overlying water twice a day plus continuous aeration, or by aeration alone. Once the un-ionized ammonia and/or hydrogen sulfide concentrations are below the trigger levels in **Table 9-3** for all test samples (labs should use the minimum purging required to bring concentrations below the trigger levels), the bioassay may be initiated. Each batch of test sediments must have associated and similarly purged control and reference sediments.

9.3.3. Case-by-Case Determination to Allow Purging

The purging process may cause loss of more volatile/less hydrophobic COCs while less volatile compounds with a higher log octanol-water partition coefficient (K_{ow}) remain associated with particles and dissolved organic matter. In addition, metals bioavailability and toxicity can be influenced by purging. Limited testing provided evidence that contaminant loss due to volatilization may not be an issue for the purging methods described above (DMMP 2015b). The Agencies will therefore continue to consider the specific contaminants triggering biological testing in decisions regarding purging. If contaminants may potentially be lost or their toxicity altered while purging for ammonia or sulfides, then purging may be disallowed or restricted in duration. Also, in some cases, ammonia or sulfides themselves may be COCs (e.g., new surface material containing wood waste) and purging may not be allowed. Purging is also not allowed for cleanup evaluations. For projects that include both cleanup and ADMEF evaluation, side-by-side testing of both purged and non-purged sediments may be required.

9.3.4. Application of Purging Recommendations

The dredging proponent assumes the risk of dredged material being found unsuitable for in-water discharge if potential effects of ammonia and sulfides are not proactively addressed. Proactively addressing ammonia and sulfides requires advanced planning. Sufficient volumes of sediment must be collected for sacrificial beakers; the pretesting and purging procedures must be included in the SAP; and holding times must be considered. The dredging proponent will need to balance the cost of these procedures against the cost of upland disposal of dredged material that fails toxicity testing due to non-treatment effects from ammonia/sulfides.

Ammonia and sulfides are more likely to be present in deeper sediments or sediments containing a significant fraction of organic material such as wood waste. Therefore, the type of sediment being tested will need to be assessed to determine the likelihood for elevated ammonia and sulfides. Initial bulk ammonia and sulfides testing by the analytical lab will also provide valuable information in this regard.

Alternative procedures from those described in this user manual may be proposed on a project-specific basis. Justification for the selected procedures must be clearly articulated in the SAP.

Close coordination with the Agencies must be maintained throughout the process, from development of the pre-bioassay testing procedures in the SAP, to decision-making about purging and details of the purging procedure itself. All procedures must be approved by the Agencies before the procedures may be performed.

9.4. Saltwater Acclimation

Some projects evaluate freshwater sediments for marine disposal. Confounding factors caused by testing freshwater, estuarine, upland, or deeply buried sediments in aerated saltwater with marine organisms can lead to toxicity independent of contaminant-related effects. The confounding factors include increased ammonia concentrations caused by disruption or elimination of microbial communities adapted to terrestrial or freshwater conditions, and salinity and pH levels within sediments or overlying water that are outside the recommended ranges for the test organisms. Detailed information is provided in the “Sediment Acclimation and the Larval Bioassay Test Issue and Clarification Paper” (DMMP 2020).

The possible need for acclimation should be discussed with the Agencies during project planning. In general, acclimation is recommended prior to conducting marine bioassays when one of the following conditions are proposed (**Table 9-4**):

- Freshwater sediments are proposed for discharge in a marine environment.
- Project activities (e.g., dam removal, habitat creation) will result in inundation of previously fresh waters with brackish waters and/or the movement of freshwater sediment downstream to a marine environment.
- Estuarine sediments with porewater salinity[3] less than 10 ppt (and/or from an area dominated by freshwater flow or significantly upstream from marine receiving waters) are proposed for discharge in a marine environment.
- Estuarine or brackish sediment with porewater salinity between 10-25 ppt is proposed for discharge in a marine environment. Brackish sediment (porewater salinity around 10–25 ppt) may not need acclimation as marine microbial communities may already be established. If the material in question is in a tidally influenced zone that routinely receives flushes of marine waters, the sediment is

[3] It is highly recommended to collect porewater salinity in advance of bioassay test initiation if there is any uncertainty in porewater salinity of site sediments.

likely sufficiently acclimated even if the porewater salinity is lower than test salinity (28 ppt for marine bioassays).

- Deeply buried sediments at depth that have been isolated from the marine environment in space and/or time are proposed for discharge in a marine environment. Deeply buried sediments can have confounding factors such as extremely low TOC, anoxia, and elevated ammonia and sulfides.

Table 9-4. *Acclimation Considerations for Material to be Evaluated for Aquatic Toxicity*

Matrix	Destination	Recommended Process
Marine Discharge	Shoreline cutback material	Acclimate
	Freshwater Sediment	Acclimate
	Deeply Buried, Anoxic, or Low TOC Sediment/Soil	Case-by-case decision to acclimate
	Brackish/Estuarine Sediment with salinity <10 ppt	Acclimate
	Brackish/Estuarine Sediment with salinity 10-25 ppt	Case-by-case decision to acclimate

9.5. Marine Bioassay Interpretive Guidelines

The response of bioassay organisms exposed to the sediment sample representing each DMMU will be compared to the response of these organisms in both control and reference treatments. This comparison will determine whether the material is suitable for unconfined, in-water discharge.

The determination of an environmentally significant response involves two conditions: first, that the response in the tested DMMU must be greater than 20% different from the control response; and second, that a comparison between mean test and mean reference responses be statistically significant. For the latter determination, the following guidelines are to be followed:

1. Multiple comparison tests (e.g., analysis of variance [ANOVA], Dunnett's) are not to be used.
2. A null hypothesis shall be selected that reflects the one-tailed t-test approach and the type of endpoint being evaluated.
3. Bioassay data expressed in percentages should be transformed (if needed) prior to statistical testing using the arcsine square root transformation to stabilize the variances and improve the normality of the data. *Neanthes* growth data may require a square root or log transformation.
4. Bioassay data should then be tested for normality and homogeneity of variances, using the Shapiro-Wilk test (W test) and Levene's test, respectively.
5. Bioassay data passing both tests should be tested for statistical difference using a one-tailed Student's t-test.
6. Data passing the W test but failing Levene's test should be tested for statistical difference using the approximate t-test.
7. Data failing the W test but passing Levene's test should be tested for statistical difference using the non-parametric Mann-Whitney test.
8. Data failing both the W test and Levene's test should be converted to ranks and tested with a t-test.

USACE Seattle District has developed statistical analysis software called BioStat that can be used to facilitate bioassay statistical comparisons with appropriate reference sediments. Submittal of screen shots or statistical output reports from BioStat will provide the documentation necessary to support summarized interpretations of bioassay data in the

Sediment Characterization Report.

9.5.1. Data Format

Data for the reference and test samples may be reported in different formats, including raw counts, raw measurements, and percentages. The choice of format may depend on whether data are transformed prior to performing statistical tests. However, the recommended formats for each of the ADMEF marine bioassays are as shown in **Table 9-5**. For more information on data formats and appropriate transformations, see BioStat 2.0 User's Guide (Fox *et al.* 2007).

Table 9-5. *Recommended Data Formats for Bioassay Interpretation*

Bioassay	Endpoint	Data Format	Comment
10-Day Amphipod	Mortality or survival	Percentage	---
20-Day Juvenile Infaunal Polychaete	Growth rate	Mean individual growth rate in mg/individual/day (AFDW)	Consistent with ADMEF guidance; avoids negative numbers which can result from normalization to the negative control or reference.
Sediment Larval	Normal survival	Control normalized normal counts	In rare circumstances, normalization to the seawater control results in a negative number. Raw counts should be used in these cases to avoid data interpretation problems.

Table is modified from the BioStat User's Guide (Fox *et al.* 2007) to reflect current standard practice.

9.5.2. One-Hit Failure (Major Hit)

Table 9-6 provides the marine bioassay performance standards and evaluation guidelines. A one-hit failure occurs when any one biological test exhibits a large enough toxic response that the DMMU is judged to be unsuitable for unconfined in-water discharge (i.e., a large single "hit" fails the DMMU). This "one-hit failure" involves a test sediment response that exceeds the bioassay-specific guidelines relative to the negative control and reference, and that is statistically significant in comparison to the reference.

10-day Amphipod Mortality. For the amphipod bioassay, mean test mortality greater than 20% absolute over the mean negative control response, and greater than 10% (dispersive) or 30% (non-dispersive) absolute over the mean reference sediment response and statistically significant compared to reference (alpha = 0.05), is considered a "hit" under the one-hit rule.

20-day Juvenile Infaunal Polychaete Growth (Neanthes). Juvenile infaunal polychaete growth test results that show a mean individual growth rate, in AFDW, less than 80% of the mean negative control growth rate, and less than 70% (dispersive) or 50% (non-dispersive) of the mean reference sediment growth rate, and statistically significant compared to reference (alpha = 0.05), constitute a hit under the one-hit rule.

Sediment Larval Development. For the sediment larval bioassay, test and reference sediment responses are typically normalized to the negative seawater control ("control") response. This normalization is performed by dividing the number of normal larvae from the test or reference treatment at the end of the exposure period by the average number of normal larvae in the seawater control at the end of the exposure period and multiplying by 100 to convert to percent. A major hit under the one-hit rule occurs if all the following conditions are met:

- The control-normalized number of normal larvae in the test sediment is less than 80%.
- The control-normalized number of normal larvae in the test sediment is statistically

significant compared to reference (alpha = 0.10). In certain conditions, control-normalization may cause issues, and raw normal counts may be used (see **Table 9-6**).

- The mean control-normalized number of normal larvae in the reference sediment is at least 15% (dispersive) or 30% (non-dispersive) greater than the mean control-normalized number of normal larvae in the test sediment.

A minor hit (two-hit failure) occurs when only the first two conditions above are met.

9.5.3. Two-hit Failure (Minor Hit)

A two-hit failure occurs when the results of any two biological tests (amphipod, juvenile infaunal polychaete growth, or sediment larval) exhibit toxic responses such that taken together their "hits" cause the DMMU to be judged unsuitable for unconfined in-water discharge. These hits, while less than the bioassay-specific reference-comparison guidelines noted above for a one-hit failure, are statistically significant compared to the reference sediment (and less than 70% of the mean reference sediment growth rate for the *Neanthes* bioassay for non-dispersive sites).

Table 9-6. *Marine Bioassay Performance Standards and Evaluation Guidelines*

	For each test to be considered valid, control and reference must meet the following standards:		Test Failure Assessment Guidelines:			
Bioassay	Negative Control Performance Standard	Reference Sediment Performance Standard	Dispersive Site[1] Interpretation Guidelines: 1-Hit Rule	Dispersive Site[1] Interpretation Guidelines: 2-Hit Rule	No-Dispersive Site[1] Interpretation Guidelines: 1-Hit Rule	No-Dispersive Site[1] Interpretation Guidelines: 2-Hit Rule
Amphipod Mortality	$M_C \leq 10\%$	$\lvert M_R - M_C \rvert \leq 20\%$	$\lvert M_T - M_C \rvert > 20\%$ and M_T vs. M_R SD (p=.05) **AND**			
			$M_T - M_R > 10\%$	NOCN	$M_T - M_R > 30\%$	NOCN
Larval Development	$N_C \div I \geq 0.70$	$N_R \div N_C \geq 0.65$	$N_T \div N_C < 0.80$ and N_T/N_C vs. N_R/N_C SD (p=.10) **AND**			
			$N_R/N_C - N_T/N_C > 0.15$	NOCN	$N_R/N_C - N_T/N_C > 0.30$	NOCN
Juvenile Infaunal Polychaete Growth Test *(Neanthes)*	$M_C \leq 10\%$ and $MIG_C \geq 0.38$[2]	$M_R \leq 20\%$ and $MIG_R \div MIG_C \geq 0.80$	$MIG_T \div MIG_C < 0.80$ and MIG_T vs. MIG_R SD (p=.05) **AND**			
			$MIG_T/MIG_R < 0.70$	NOCN	$MIG_T/MIG_R < 0.50$	$MIG_T/MIG_R < 0.70$

M = Mortality, N = Normal Larvae, I = Initial Count, MIG = Mean Individual Growth Rate (mg/individual/day), SD = Statistically Significant Difference, NOCN = No Other Conditions Necessary, R = Reference Sediment, C = Negative Control, T = Test Sediment.
[1] Dispersive and non-dispersive sites are discussed in Section 13.
[2] Dry weight (all other MIG values are evaluated as AFDW).

9.6. Bioassay Tests: Freshwater

Freshwater bioassay tests must meet ADMEF requirements to evaluate freshwater toxicity, utilizing the following:

1. Two different test species: *Hyalella azteca* and *Chironomus dilutus.*
2. At least one chronic and one acute test.
3. A minimum of three endpoints (**Table 9-7**), to include the following:

- Lethal (mortality) endpoint.
- Sublethal (growth) endpoint.

Example 1: 10-day *Chironomus* and 28-day *Hyalella* Tests
- 10-DAY *CHIRONOMUS* (ACUTE TEST) – GROWTH AND MORTALITY ENDPOINTS
- 28-DAY *HYALELLA* (CHRONIC TEST) – GROWTH AND MORTALITY ENDPOINTS

Example 2: 10-day *Hyalella* and 20-day *Chironomus* Tests
- 10-DAY *HYALELLA* (ACUTE TEST) – MORTALITY ENDPOINT
- 20-DAY *CHIRONOMUS* (CHRONIC TEST) – GROWTH AND MORTALITY ENDPOINT

Table 9-7. *Freshwater Biological Tests, Species, and Applicable Endpoints*

Species, Biological Test, and Endpoint	Acute Effects Biological Test	Chronic Effects Biological Test	Lethal Effects Biological Test	Sub-lethal Effects Biological Test
Amphipod: *Hyalella azteca*				
10-Day Mortality	X		X	
28-Day Mortality		X	X	
28-Day Growth		X		X
Midge: *Chironomus dilutus*				
10-Day Mortality	X		X	
10-Day Growth	X			X
20-Day Mortality		X	X	
20-Day Growth		X		X

Bioassays conducted on freshwater sediments must follow the protocols specified below. These tests and parameters were developed based on EPA and ASTM protocols. Other test methods may be added to the list in future revisions or considered on a case-by-case basis during SAP development.

Acute Effects Tests

- *Hyalella azteca* 10-day mortality: EPA Method 100.1 (EPA 2000)
- *Chironomus dilutus* 10-day mortality: EPA Method 100.2 (EPA 2000)
- *Chironomus dilutus* 10-day growth: EPA Method 100.2 (EPA 2000)

Chronic Effects Tests

- *Hyalella azteca* 28-day mortality: EPA Method 100.4 (EPA 2000)
- *Hyalella azteca* 28-day growth: EPA Method 100.4 (EPA 2000)
- *Chironomus dilutus* 20-day mortality: EPA Method 100.5 (EPA 2000)
- *Chironomus dilutus* 20-day growth: EPA Method 100.5 (EPA 2000)

9.7. Quality Assurance/Quality Control in Freshwater Bioassays

9.7.1. Quality Control for Negative Control and Use as Reference Sediment

Negative control sediments are used in bioassays to check laboratory performance. Negative control sediments are clean sediment in which the test organism normally lives, and which are expected to produce low mortality.

All freshwater bioassays have negative control performance standards that must be met (see **Table 9-8**). In the 10-day and 28-day *Hyalella* bioassay tests, mortality of the test organisms during the entire exposure period must be less than or equal to 20%. For the *Chironomus* 10-

day test, mortality over the exposure period must be less than or equal to 30%, and less than or equal to 32% for the 20-day test. This represents a generally accepted level of mortality of test organisms under control conditions, indicating that the bioassay (in terms of test organism health) is considered a valid measure of effects of the test treatments.

***Table 9-8**. Freshwater Bioassay Performance Standards and Evaluation Guidelines*

Biological Test/ Endpoint[1]	Performance Standard[2]		Screening Level 1 (SL1)	Screening Level 2 (SL2)
	Control[3]	Reference		
Amphipod: Hyalella azteca				
10-Day Mortality	$M_C \leq 20\%$	$M_R \leq 25\%$	$M_T - M_C > 15\%$ and M_T vs M_C SD ($p \leq 0.05$)	$M_T - M_C > 25\%$ and M_T vs M_C SD ($p \leq 0.05$)
28-Day Mortality	$M_C \leq 20\%$	$M_R \leq 30\%$	$M_T - M_C > 10\%$ and M_T vs M_C SD ($p \leq 0.05$)	$M_T - M_C > 25\%$ and M_T vs M_C SD ($p \leq 0.05$)
28-Day Growth	$MIG_C \geq$ 0.15 mg/ind	$MIG_R \geq 0.15$ mg/ind	$MIG_T / MIG_C < 0.75$ and MIG_T vs MIG_C SD ($p \leq 0.05$)	$MIG_T / MIG_C < 0.60$ and MIG_T vs MIG_C SD ($p \leq 0.05$)
Midge: Chironomus dilutus				
10-Day Mortality	$M_C \leq 30\%$	$M_R \leq 30\%$	$M_T - M_C > 20\%$ and M_T vs M_C SD ($p \leq 0.05$)	$M_T - M_C > 30\%$ and M_T vs M_C SD ($p \leq 0.05$)
10-Day Growth	$MIG_C \geq$ 0.48 mg/ind	$MIG_R/MIG_C \geq 0.8$	$MIG_T / MIG_C < 0.80$ and MIG_T vs MIG_C SD ($p \leq 0.05$)	$MIG_T / MIG_C < 0.70$ and MIG_T vs MIG_C SD ($p \leq 0.05$)
20-Day Mortality	$M_C \leq 32\%$	$M_R \leq 35\%$	$M_T - M_C > 15\%$ and M_T vs M_C SD ($p \leq 0.05$)	$M_T - M_C > 25\%$ and M_T vs M_C SD ($p \leq 0.05$)
20-Day Growth	$MIG_C \geq$ 0.60 mg/ind	$MIG_R/MIG_C \geq 0.8$	$MIG_T / MIG_C < 0.75$ and MIG_T vs MIG_C SD ($p \leq 0.05$)	$MIG_T / MIG_C < 0.60$ And MIG_T vs MIG_C SD ($p \leq 0.05$)

M = Mortality, C = Control, R = Reference, T = Test; F = Final, MIG = Mean Individual Growth (AFDW) at time final, ind = Individual, SD = Statistically Significant Difference.

[1] These tests and parameters were developed based on EPA 2000s.

[2] Reference performance standards are provided for times when ADMEF has approved a freshwater reference sediment site(s) and reference results will be substituted for control in comparing test sediments to guidelines.

[3] The control performance standard for the 20-day test (0.60 mg/individual) is more stringent than for the 10-day test and the Agencies may consider, on a case-by-case basis, a 20-day control has met QA/QC requirements if the mean individual growth is at least 0.48 mg/individual.

If control mortality is greater than the performance guidelines, the bioassay test will generally have to be repeated, although that determination must be made in consultation with the Agencies. Additionally, there are negative control performance guidelines for the *Hyalella* 28-day and *Chironomus* 10-day and 20-day growth bioassays (see **Table 9-8**).

Laboratories failing to achieve the control growth rate performance guidelines may be required to retest. Since the negative control is used for test comparisons with freshwater bioassays, it is also advised to compare the grain size distribution of the control sediments to the test sediments.

9.7.2. Replication

For freshwater bioassays, eight replicates are run for each test sediment, as well as for the control and/or reference sediment.

9.7.3. Positive Control – Reference Toxicant

A positive control, or Ref Tox test, will be run for each bioassay. Positive controls are chemicals known to be toxic to the test organism. The positive control provides an indication of the sensitivity of the particular organisms used in a bioassay. Positive controls are performed on freshwater spiked with the Ref Tox and compared with historical laboratory reference toxicity test results.

9.7.4. Water Quality Monitoring

Water quality monitoring of the overlying water should be conducted for freshwater bioassays. Daily measurement of temperature and dissolved oxygen should be conducted for the amphipod and midge tests. Conductivity, hardness, and alkalinity should be measured at test initiation and termination for the amphipod and midge tests. Monitoring of ammonia and total sulfides should be measured at test initiation and termination if either of these chemicals is suspected as being a problem. Ammonia and sulfides sediment quality standards (SQS) and CSL values were developed as part of the FPM for freshwater sediment guidelines and are used by the ADMEF only to inform the need for bioassay purging. These values are:

1. Ammonia: SL1/SQS = 230 mg/kg; SL2/CSL = 300 mg/kg
2. Total Sulfides: SL1/SQS = 39 mg/kg; SL2/CSL = 61 mg/kg

If ammonia and sulfides exceed these levels, the dredging proponent should coordinate purging and reference toxicity test protocols with the ADMEF (see Section 9.3.).

9.8. Freshwater Bioassay Interpretive Guidelines

Freshwater biological tests are based on a comparison to control or reference sediments. Dredging proponents may collect a freshwater reference, but would want to ensure that the physical characteristics (e.g., grain size and organic carbon) are similar to the material to be dredged. Dredging projects wishing to use a reference sediment must have the location approved by the Agencies prior to collection of the reference sediment. A project-specific reference area will require the full suite of freshwater COCs be tested.

The response of bioassay organisms exposed to composited sediment representing each DMMU will be statistically compared to the response of these organisms in the control and/or reference sediment. **Table 9-8** specifies the bioassay performance guidelines used for freshwater bioassays.

When any freshwater biological test exhibits a test sediment response that fails to meet the SL1/SCO criteria, the DMMU is judged to be unsuitable for unconfined in-water discharge in freshwater. The “one-hit/two-hit” interpretive guidelines associated with marine sediments do not apply to freshwater sediments.

9.9. Elutriate Bioassay Testing

The Tier 3 evaluation of dredged material in some cases may include bioassay testing of dredging elutriates to estimate water quality impacts. Elutriate testing for biological effects is not routinely required for regulated or Federal dredging projects evaluated under CWA Section 404 for ADMEF in-water discharge. This test may be conducted when the Agencies require it for assessment of potential water column toxicity effects relative to a particular COC.

If elutriate testing is required for marine sediments at a dredging site, the echinoderm/bivalve larval test will be conducted to evaluate water column effects. The appropriate assessment is described in the SEF (RSET 2018). More specificity on the serial dilution bioassay tests performed on the elutriate water can be found in the ITM (EPA and USACE 1998). In the event that freshwater sediments at a dredging site require elutriate testing, and where salmonid species are present, elutriate testing should be conducted with rainbow trout (*Oncorhynchus mykiss*). The following species may be used for the larval water column bioassay test:

1. (Marine) Echinoderm: *Dendraster excentricus*
2. (Marine) Bivalve: *Mytilus galloprovincialis*
3. (Freshwater) Rainbow trout: *Oncorhynchus mykiss*

10. TIER 3 BIOLOGICAL TESTING: BIOACCUMULATION

Bioaccumulation is the accumulation of chemicals in the tissues of organisms through any route, including respiration, ingestion, or direct contact with contaminated water, sediment, or dredged material. Tier 3 bioaccumulation testing of dredged material is required when results of sediment chemical analysis for BCOCs indicate the potential for unacceptable adverse ecological or human health effects.

The potential for adverse effects is screened for in the ADMEF using BTs for BCOCs. Exceedance of one or more BTs results in a requirement to conduct bioaccumulation testing. Currently, BTs only exist for projects in marine waters. The chemicals to be evaluated for bioaccumulation potential in freshwater will vary based on location and site history.

When bioaccumulation testing is conducted, the tissue concentrations of BCOCs resulting from laboratory exposure of test organisms to dredged material are assessed for potential human- and ecological-health related effects. This assessment is done through the use of target tissue levels (TTLs) and/or a statistical comparison to tissue residues resulting from exposure to reference sediment. The purpose of the reference sediment in bioaccumulation testing is to represent relatively uncontaminated sediments that are unimpacted by previous discharges of dredged material (EPA and USACE 1998). Reference sediments used in bioaccumulation testing should have physical characteristics that are similar to the discharge area. Important elements of the Tier 3 testing process and data interpretation are described in this section.

If results of the bioaccumulation testing in Tier 3 are found to be equivocal, or there is a concern that steady-state body burdens in test organisms were not achieved and/or cannot be estimated, further testing may be required in Tier 4 before a regulatory decision can be made on the suitability of the dredged material for unconfined, in-water discharge.

10.1. Bioaccumulative Chemicals of Concern (BCOCs) and Triggers for Bioaccumulation Testing in Marine Waters

BCOCs lists were developed by the DMMP agencies for the USACE Seattle District for Puget Sound following a systematic review of potential BCOCs for marine systems that considered multiple lines of evidence for determining the bioaccumulative risk posed by these chemicals (DMMP 2003; DMMP 2007a; DMMP 2009). The ADMEF has adopted these lists as applicable to Alaska's marine environment. Bioaccumulative chemicals are placed on one of four lists, which are described below.

10.1.1. List 1: Primary BCOCs

Chemicals on this list meet the DMMP's weight-of-evidence criteria for defining a contaminant that is of concern for bioaccumulation. List 1 (**Table 10-1**) includes thirteen chemicals (or groups of chemicals) for marine waters. Analysis of eleven of the List 1 BCOCs are required while two List 1 BCOCs are analyzed on a case-by-case basis to determine dredged material suitability for a marine project. The two case-by-case List 1 BCOCs - TBT and D/F – will be tested for marine projects if Tier 1 site historical data indicates they have potential to be present at the site.

When measured sediment concentrations of the List 1 contaminants exceed the BT values presented in **Table 10-1**, bioaccumulation testing must be performed before suitability of the test sediment for in-water discharge can be determined. The BT is set at a sediment concentration that constitutes a "reason to believe" that the chemical would accumulate in the tissues of target organisms. As a general approach, BTs were established for human health COCs at concentrations in the upper 30th percentile of the concentrations allowable for unconfined, open-water discharge (e.g., 70% of the difference between the SL and ML; PSDDA 1988). In

2003, revisions to the BCOC list did not change existing BT values, but interim BT values were developed for new List 1 chemicals using the same algorithm described above.

List 1 chemicals that do not follow this algorithm for BTs include PCBs, TBT, selenium, and D/F. The BT for PCBs is carbon-normalized and was established using a TTL and biota-sediment accumulation factor (PSDDA 1989). The BT for TBT was established on a porewater basis (PSDDA/SMS 1996) but is typically used now on a dry-weight basis (DMMP 2015c). For selenium the BT was developed in consideration of sediment concentrations reported in the literature to be associated with adverse ecological effects from bioaccumulation (DMMP 2003). The BT for D/F was adopted as an element of the updated dioxin guidelines in 2010 (DMMP 2010a).

Table 10-1. *List 1: BCOCs for Projects in Marine Waters*

Chemical	Method Information	Log Kow[1]	BT (Dry Weight[2])	BT Basis
METALS				
Arsenic	SW846 M.6010/6020	N/A	507.1 mg/kg	0.7*(ML-SL)+SL (PSDDA 1989)[10]
Lead	SW846 M.6010/6020/7421	N/A	975 mg/kg	0.7*(ML-SL)+SL (DMMP 2003)
Mercury	SW846 M.7471	N/A	1.5 mg/kg	0.7*(ML-SL)+SL (PSDDA 1988)[9]
Selenium	SW846 M.6010/6020/7740	N/A	3 mg/kg[3]	Ecological effects (DMMP 2003)
ORGANICS				
Fluoranthene	SW846 M.8270	5.12	4,600 µg/kg	0.7*(ML-SL)+SL (PSDDA 1988)[9]
Pyrene	SW846 M.8270	5.11	11,980 µg/kg	0.7*(ML-SL)+SL (DMMP 2003)
CHLORINATED HYDROCARBONS				
Hexachlorobenzene (HCB)	SW846 M.8081	5.89	168 µg/kg	0.7*(ML-SL)+SL (PSDDA 1989)
PHENOLS				
Pentachlorophenol	SW846 M.8270	5.09	504 µg/kg	0.7*(ML-SL)+SL (PSDDA 1989)[10]
PESTICIDES				
Total DDT (sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT)	SW846 M.8081	(5.7 - 6.0)[4]	50 µg/kg	0.7*(ML-SL)+SL (PSDDA 1988)[9]
Chlordane[5]	SW846 M.8081	(5.5 - 6.4)[4]	37 µg/kg	7.3*SL (PSDDA 1988)[8,9]
POLYCHLORINATED BIPHENYLS				
Total Aroclor PCBs	SW846 M.8081/2	(3.6 -11)[7]	38 mg/kg OC	TTL and BSAF (PSDDA 1989)
CASE-BY-CASE BCOCs				
Dioxins/Furans	EPA 1613	5.5 - 13.9	10 ng/kg[6]	Dioxin special study (DMMP 2010a)
Tributyltin (porewater)/ (bulk sediment)	Krone/Unger	3.7 - 4.4	0.15 µg/L 73 µg/kg	*Porewater value* - estimated from sediment value using K_{oc} and TOC (PSDDA/SMS 1996). *Sediment value* - interim SL based on BPJ (PSDDA 1989; DMMP 2015c).

[1] Octanol/Water Partitioning Coefficients (log K_{OW}) for organic COCs for bioaccumulation.
[2] Except where noted otherwise.
[3] Based on review of sediment effect values from the literature and BPJ.
[4] Range of individual chemicals making up the total.

[5] Chlordane includes cis-Chlordane, trans-Chlordane, cis-Nonachlor, trans-Nonachlor, and oxychlordane (DMMP 2007b).
[6] The BT for Puget Sound was established with implementation of dioxin guidelines in 2010. See Section 8.3.1. for details.
[7] Range of individual congeners making up the total.
[8] This chemical did not have an ML value. Therefore, the BT concentration was computed as: (10SL - SL)*0.7 + SL=7.3 * SL.
[9] The BT was calculated using older (1988) SL and ML values from the Phase I MPR (PSDDA 1988). SL/MLs have since been updated, but BT was left unchanged pending more information.
[10] The BT was calculated using older (1989) SL and ML values from the Phase II MPR (PSDDA 1989). SL/MLs have since been updated, but BT was left unchanged pending more information.

10.1.2. List 2: Candidate BCOCs

List 2 defines chemicals of potential concern for bioaccumulative effects but for which definitive data are still lacking; analysis of these chemicals is not routinely required (**Table 10-2**). Analysis of List 2 chemicals will be decided on an as-needed basis depending on the specifics of the project and Tier 1 analysis.

Table 10-2. *List 2: Candidate Bioaccumulative Chemicals*

1,2,4,5-Tetrachlorobenzene	Endosulfan	Parathion
4-Nonylphenol, branched	Ethion	Pentabromodiphenyl ether
Benzo(e)pyrene	Heptachloronaphthalene	Pentachloronaphthalene
Biphenyl	Hexachloronaphthalene	Perylene
Chromium VI	Kelthane	Tetrachloronaphthalene
Chlorpyrifos	Mirex	Tetraethyltin
Dacthal	Octachloronaphthalene	Trichloronaphthalene
Diazinon	Oxadiazon	Trifluralin

10.1.3. List 3: Potential BCOCs

List 3 chemicals have been identified in the scientific literature as potentially bioaccumulative, but their toxicity to humans and/or ecological receptors is unknown or poorly documented (**Table 10-3**). Analysis of these chemicals is not routinely required; List 3 chemicals will only be considered for analysis if there is a project-specific reason to believe that they may be present.

Table 10-3. *List 3: Potentially Bioaccumulative Chemicals*

1,2,3,4-Tetrachlorobenzene	C2-phenanthrene/anthracene
1,2,3,5-Tetrachlorobenzene	C3-chrysenes/benzo(a)anthracene
1,2,3-Trichlorobenzene	C3-dibenz(a,h)anthracene
1,3,5-Trichlorobenzene	C3-fluorenes
1-methylnaphthalene	C3-naphthalenes
1-methylphenanthrene	C3-phenanthrene/anthracene
2,6-Dimethyl naphthalene	C4-chrysenes/benzo(a)anthracene
2-methylnaphthalene	C4-naphthalenes
4,4'-Dichlorobenzophenone	C4-phenanthrene/anthracene
4-bromophenyl phenyl ether	Chrysene
Acenaphthene	Dibenzo(a,h)anthracene
Acenaphthylene	Dibenzothiophene
Aldrin	Dieldrin
Alpha-BHC/Alpha-benzene hexachloride	Di-n-butyl phthalate
Anthracene	Di-n-octyl phthalate
Antimony	Endosulfan sulfate
Benzo(a)anthracene	Ethoxylated nonylphenol phosphate

Benzo(a)pyrene	Fluorene
Benzo(b)fluoranthene	Gamma-BHC/Gamma-hexachlorocyclohexane
Benzo(k)fluoranthene	Heptachlor epoxide
Benzo(g,h,i)perylene	Hexachlorobutadiene
Bis(2-ethylhexyl) phthalate	Indeno(1,2,3-c,d)pyrene
Butyl benzyl phthalate	Methoxychlor
C1-chrysenes/benzo(a)anthracene	Nonylphenol
C1-dibenz(a,h)anthracene	Pentachloroanisole
C1-fluoranthene/pyrene	Phenanthrene
C1-fluorenes	Polybrominated terphenyls
C1-naphthalenes	Polychlorinated alkenes
C1-phenanthrene/anthracene	Polychlorinated terphenyls
C2-chrysenes/benzo(a)anthracene	Pronamide
C2-dibenz(a,h)anthracene	Tetradifon
C2-fluorenes	Toxaphene
C2-naphthalenes	---

10.1.4. List 4: Not Currently Considered BCOCs

List 4 includes chemicals that are not likely to bioaccumulate due to their chemical properties, or that regional data have shown to rarely (if ever) occur in sediments and tissues at levels of toxicological relevance (**Table 10-4**). In 2009, six metals (cadmium, chromium, copper, nickel, silver, and zinc) that were originally placed on List 1 were moved to List 4 because they do not have methylated or organic forms, making them unlikely to biomagnify.

Table 10-4. *List 4: Not Currently Considered Bioaccumulative Chemicals*

1,2,4-Trichlorobenzene	Dimethyl phthalate	Naphthalene
1,2-Dichlorobenzene	Diuron	Nickel
1,3-Dichlorobenzene	Endrin	N-nitroso diphenylamine
1,4-Dichlorobenzene	Ethylbenzene	Phenol
Bromoxynil	Fenitrothion	Silver
Cadmium	Guthion	Tetrachloroethene
Chromium	Heptachlor	Trichloroethene
Copper	Hexachloroethane	Triphenyltin chloride
Dicamba	Methyl parathion	Zinc
Dichlobenil	Methyltin trichloride	---

10.2. Bioaccumulation Test Species Selection

Selection of appropriate species is an important consideration for bioaccumulation tests. Studies have shown that the time required for any given species to achieve a steady-state tissue concentration of a COC may vary (see **Table 10-5**) or is not well known (Windom and Kendall 1979; Rubenstein *et al.* 1983). As such, for a given chemical triggering a Tier 3 bioaccumulation test, the dredging proponent should consider selecting species that will assimilate the target chemical near its steady-state concentration (if known) within the exposure period or consider extending the exposure period. The ITM requires bioaccumulation testing with species from two different trophic niches, including: (1) a suspension-feeding/filter-feeding organism, and (2) a burrowing deposit-feeding organism (EPA and USACE 1998). The Tier 3 marine bioaccumulation test is usually conducted with both an adult bivalve (*Macoma nasuta*) and an adult polychaete (*Nephtys caecoides*). An alternative to using *Nephtys caecoides* is to use *Alitta virens* (formerly known as *Nereis virens*). Contact the Agencies if considering this change. For recommended freshwater species, consult the Section 8.5.2. of the SEF (RSET 2018).

Table 10-5. *Percent of Steady-State Tissue Residues of Selected Metals and Neutral Organics From 10- and 28-day Exposures to Bedded Sediment*

Compound	**% of Steady-State Tissue Residue[1,2]**		**Species**	**Est. By**	**References[3]**
	10-Day	**28-Day**			
METALS					
Copper	75	100	*Macoma nasuta*	G[5]	Lee (unpublished)
Lead	81	100	*Macoma nasuta*	G	Lee (unpublished)
Cadmium	17	50	*Callianassa australiensis*	G	Ahsanulla *et al.* 1984
Mercury	ND[4]	ND[4]	*Neanthes succinea*	G	Kendall 1978
PCBs					
Aroclor 1242	18	87	*Nereis virens*	G	Langston 1978
Aroclor 1254	12	82	*Macoma balthica*	G	Langston 1978
	25	56	*Nereis virens*	K[6]	McLeese *et al.* 1980
Aroclor 1260	53	100	*Macoma balthica*	G	Langston 1978
Total PCBs	21	54	*Nereis virens*	G	Pruell *et al.* 1986
	48	80	*Macoma nasuta*	G	Pruell *et al.* 1986
	23	71	*Macoma nasuta*	G	Boese (unpublished)
PAHs					
Benzo(a)pyrene	43	75	*Macoma inquinata*	G	Augenfield *et al.* 1982
Benzo(b,k) fluoranthene	71	100	*Macoma nasuta*	G	Lee (unpublished)
Chrysene	43	87	*Macoma inquinata*	G	Augenfield *et al.* 1982
Fluoranthene	100	100	*Macoma nasuta*	G	Lee (unpublished)
Phenanthrene	100	100	*Macoma inquinata*	G	Augenfield *et al.* 1981
	100	100	*Macoma nasuta*	G	Lee (unpublished)
Pyrene	84	97	*Macoma nasuta*	G	Lee (unpublished)
TCDD/TCDF					
2,3,7,8-TCDD	6	22	*Nereis virens*	G	Pruell *et al.* 1990
	63	100	*Macoma nasuta*	G	Pruell *et al.* 1990
2,3,7,8-TCDF	43	62	*Nereis virens*	G	Pruell *et al.* 1990
	92	100	*Macoma nasuta*	G	Pruell *et al.* 1990
MISCELLANEOUS					
4,4-DDE	20	50	*Macoma nasuta*	G	Lee (unpublished)
2,4-DDD	31a	56	*Macoma nasuta*	G	Lee (unpublished)
4,4-DDD	32	60	*Macoma nasuta*	G	Lee (unpublished)
4,4-DDT	17	10	*Macoma nasuta*	G	Lee (unpublished)

[1] This table is modified from ASTM E1688-00a, Standard Guide for Determination of the Bioaccumulation of Sediment-Associated Contaminants by Benthic Invertebrates.

[2] Steady-state values are estimates, as steady-state is not rigorously documented in these studies.

[3] See Boese and Lee 1992 for complete citations.

[4] ND = Not Determined. Observed AFs (accumulation factors) for field tissue levels compared with sediment levels (normalized to dry weight) averaged 4 for this species but ranged from 1.3 to 45 among other benthic macroinvertebrate species. Laboratory 28-day exposures to bedded sediment indicated uptake fit a linear regression model over the exposure period and experimental conditions and did not approach a steady-state condition. Tissue levels observed (*N. succinea)* at 28 days amounted to only 2.5% of the total sediment-bound mercury potentially available.

[5] G = Steady-state residue estimated by visual inspection of graphs of tissue residue versus time.
[6] K = Steady-state residue estimated from a 1st-order kinetic uptake model.

10.3. Bioaccumulation Test Protocol

The standard Tier 3 bioaccumulation test utilizes the EPA protocol (Lee *et al.* 1989) and a 28-day exposure period, after which a chemical analysis is conducted of the tissues to determine the concentration of BCOCs identified in the sediments. Protocols for tissue digestion and chemical analysis will follow the PSEP-recommended procedures for metals and organic chemicals. **Table 10-6** contains information on recommended tissue analytical methods and sample quantitation limits for bioaccumulation testing.

Table 10-6. *Recommended Tissue Analytical Methods and Sample Quantitation Limits*

Chemical	Prep Method	Analysis Method	Sample Quantitation Limits (SQL)[1,2]
METALS (mg/kg)			
Arsenic	EPA 3035B/PSEP	EPA 6010/6020	0.05-0.2
Lead	EPA 3035B/PSEP	EPA 6010/6020/7421	0.05-0.2
Mercury	EPA 7471	EPA 7471	0.01-0.02
Selenium	EPA 3035B/PSEP	EPA 6010/6020/7740	0.05-0.2
ORGANOMETALLIC COMPOUNDS (µg/kg)			
Tributyltin (bulk sediment)	EPA 3550B or NMFS	Krone/Unger	10
POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)			
Fluoranthene	3540C, 3541, or 3550B	EPA 8270	1-5
Pyrene	3540C, 3541, or 3550B	EPA 8270	1-5
MISCELLANEOUS SEMIVOLATILES (µg/kg)			
Hexachlorobenzene (HCB)	3540C, 3541, or 3550B	EPA 8081	1
Pentachlorophenol	3540C, 3541, or 3550B	EPA 8270-SIM/8270	25
Pentachlorophenol	3540C, 3541, or 3550B	EPA 8151	5
PESTICIDES (µg/kg)			
Total DDT (sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT)	3540C, 3541, or 3550B	EPA 8081	2
Chlordane[3]	3540C, 3541, or 3550B	EPA 8081	2
PCBs (ng/kg)			
PCB Congeners	EPA 1668C	EPA 1668C	2-20
Dioxin-like PCB Congeners (sum ng/kg-TEQ)	EPA 1668C	EPA 1668C	1
DIOXINS/FURANS (ng/kg)			
Dioxin/Furan Congeners	EPA 1613B	EPA 1613B	0.5-5
Dioxin/Furans (sum ng/kg-TEQ)	EPA 1613B	EPA 1613B	1

[1] All sample quantitation limits are expressed on a wet-weight basis.
[2] SQLs are highly dependent on sample size; details should be confirmed with the laboratory.
[3] Chlordane compounds include cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane; in samples with interference from PCBs, the SQLs for cis- and trans-nonachlor and oxychlordane may be elevated.

For many chemicals in **Table 10-1**, it was originally assumed that the standard 28-day exposure would be sufficient for a steady-state tissue concentration to be reached. However, based on the observed steady-state exposures depicted in **Table 10-5**, it is unlikely that steady-state will have been reached after 28 days for some chemicals. This issue for those BCOCs that had previously been subjected to bioaccumulation testing was addressed by increasing the exposure time from 28 to 45 days for PCBs, TBT, DDT, mercury, and fluoranthene (DMMP 2009). Failure to reach steady-state was also observed for 2,3,7,8-TCDD and 2,3,7,8-TCDF in *Nereis virens* (Pruell *et al.* 1990). Therefore, a 45-day exposure is also required for D/F. If bioaccumulation testing is conducted for any other BCOC, the Agencies will evaluate the need to extend the exposure period beyond 28 days. For 45-day tests, supplemental additions of 175 milliliters of sediment will need to be made once a week to each test chamber, including all test, reference, and control replicates.

Given the holding time limitations (8 weeks) and the large volume of sediment required, it is typically necessary to resample project sediments in order to conduct bioaccumulation testing. Under these circumstances, it is necessary to also reanalyze the newly collected sediment for the COCs that originally triggered the requirement for bioaccumulation testing. If the chemical concentration(s) found in the bioaccumulation test sediment is less than that measured in the original sediment analyzed, the ADMEF may require that the measured tissue concentrations of that chemical be mathematically adjusted to reflect the bioaccumulation that may have resulted from exposure to the original sediment sample.

A considerable volume of sediment would be required to test species individually (**Table 10-7**). Therefore, to conserve laboratory space and reduce the volume of sediment required, dredging proponents may expose *Macoma nasuta* and *Nephtys caecoides* together in the same test chambers. The minimum total sediment volume requirement for co-testing is 31 liters.

Table 10-7. *Species-Specific Sediment Volume Recommendations for Marine Bioaccumulation Testing*

Species	Minimum Sediment Volume[2]
Macoma nasuta	3-7 liters per replicate x 5 replicates = 15-35 liters
Alitta virens[1]	3-7 liters per replicate x 5 replicates = 15-35 liters
Co-testing*: Macoma/Nephtys*	7.5 liters per replicate x 5 replicates = 37.5 liters

[1] Formerly *Nereis virens.*

[2] Sediment volume and organism requirements will vary based on number of COCs required for tissue analysis. Volumes listed here are suggested minimums based on different aquaria sizes and include sediment needed for supplemental feeding during a 45-day exposure.

The EPA protocol requires monitoring of survival, moisture, and lipid content to assess the general health of the test organisms. In addition, for ADMEF bioaccumulation testing, the wet-weight biomass (of a subset of 10 individual organisms per replicate) should be measured at the beginning and end of the bioaccumulation exposure period for each test, control, and reference sample. These data can be used to calculate net individual growth during the exposure period, which provides an additional metric to evaluate the health of the test animals (DMMP 2009).

10.4. Tissue Data Quality

Generally, the analysis and reporting requirements and conventions for tissue data follow the same rules as outlined for sediments in Section 8. For mixtures of chemicals, such as total PCBs, total DDTs, and total chlordane the reported values of detected constituents, including "J" values falling between the sample DL and the reporting limit, will be summed. In the event that all constituents are undetected, the single highest constituent's DL will be used as the value for the mixture in a given sample and will be accompanied by a "U" qualifier. D/F congener analysis and reporting in tissue follows the same methods discussed in Section 8.3.1. TEQs in tissue should be calculated using the World Health Organization (WHO) consensus TEF values for mammals (Van den Berg *et al.* 1998; Van den Berg *et al.* 2006) listed in **Table 8-4**.

10.5. Bioaccumulation Test Interpretation

NOTE: For projects requiring bioaccumulation testing, the interpretive framework for evaluating the analytical results will be determined by the Agencies prior to testing and on a case-by-case basis in coordination with the dredging proponent.

The interpretive approach used by ADMEF includes an evaluation of both human health and ecological effects. These effects are evaluated through comparison of tissue concentrations resulting from exposure to dredged material to TTLs and to tissue concentrations resulting from exposure to a reference sediment. Decision-making is also informed by consideration of PQLs, comparison of dredged material tissue bioaccumulation data to in-situ tissue data from discharge site sediments, and the effect of non-detects on statistical comparisons.

Ten of the thirteen BCOCs on List 1 (**Table 10-1**) have a TTL against which the analytical results of tissue samples are compared. A TTL is defined as the tissue concentration of a BCOC, measured in the tissues of the bioaccumulation test organisms, above which potential harm to the target organism (via bioaccumulative effects) is inferred. The ADMEF TTLs (**Table 10-8**) were derived from human-health risk assessments, United States Food and Drug Administration (FDA) action levels, or (in the case of TBT) ecological effects thresholds derived from the scientific literature.

Table 10-8. *Target Tissue Levels for COCs*

Chemical	TTL (mg/kg ww)		Source	Reference
	For Protection of Human Health	For Protection of Ecological Effects		
Arsenic	10.1	---	Human Health	PSDDA 1988
Chlordane[1]	0.3	---	FDA Action Level (fish)	FDA 2000
Dioxins/Furans	NA[5]	NA[5]	---	---
Fluoranthene	8400	TBD	Human Health	PSDDA 1988
Hexachlorobenzene	180	---	Human Health	PSDDA 1988
Lead	TBD	TBD	---	---
Mercury	1.0	TBD	FDA Action Level (fish, shellfish, crustaceans)	FDA 2000
Pentachlorophenol	900	TBD	Human Health	PSDDA 1988
Pyrene	TBD	TBD	---	---
Selenium	TBD	TBD	---	---
TBT	---	0.6[2]	Benthic Eco-Risk at Harbor Island/Elliott Bay	EPA 1999
Total PCBs	0.75[3]	---	Human Health Risk at Elliott Bay	DMMP 1999
Total DDT[4]	5.0	---	FDA Action Level (fish)	FDA 2000

ww = Wet Weight, TBD = To Be Determined (as needed) on a project-specific basis.
[1] Chlordane includes the chlordane isomers and metabolites cis-Chlordane, trans-Chlordane, cis-Nonachlor, trans-Nonachlor, and oxychlordane.
[2] The TTL for TBT was derived for use at DMMP discharge sites.
[3] The TTL for PCBs is based on site-specific considerations of subsistence human exposure in Elliott Bay, Washington.
[4] Total DDT is determined by summing the p,p'- isomers of DDT and its metabolites (DDD and DDE).
[5] Risk levels are below MDLs so decisions will be based on comparisons to background and PQLs.

For those BCOCs with a TTL, tissue residues from bioaccumulation testing are compared to the TTL. In addition, for all BCOCs except TBT, a comparison is also made to the tissue residues from a reference sediment exposure to assess potential ecological effects. For TBT, the ecological risk-based TTL is considered a sufficient benchmark for the assessment of potential ecological effects and a comparison to reference is not necessary.

10.5.1. Chemical-specific TTL Considerations

Human Health Effects. Most of the human-health based TTLs were developed during the PSDDA study (EPTA 1988). For those chemicals with FDA action levels lower than the risk-based concentrations, the FDA action levels were adopted. The TTL for total PCBs was revised in 1999 based on an updated human-health risk assessment that considered subsistence seafood ingestion rates of Native American and Asian/Pacific Islander groups (DMMP 1999).

D/F are BCOCs for human health, but a TTL has not yet been established. In the absence of a TTL, comparison to a reference sediment is required. Bioaccumulation testing for D/F is generally necessary to allow consideration of the discharge of dredged material with dioxin levels higher than 10 pptr TEQ or where the volume-weighted average for project DMMUs is greater than 4 pptr TEQ (DMMP 2010a). While the testing approach would be similar to that described for ecological effects in Section 10, the evaluation of testing results is complicated by the fact that 17 congeners are involved, and tissue concentrations may be at or below PQLs. A weight-of-evidence approach can be used to evaluate tissue data from D/F bioaccumulation testing. The weight-of-evidence approach would include consideration of PQLs, the effect of non-detects on statistical comparisons, the magnitude of bioaccumulation, and a comparison to tissue concentrations in comparable species in the vicinity of the discharge site.

Ecological Effects. TBT is the only BCOC with a TTL based on protection of ecological effects. If bioaccumulation testing is conducted for TBT, the test tissue results are compared to the TTL as described in the previous section. A comparison to reference is not needed for TBT.

10.5.2. Data Interpretation and Other Considerations

Table 10-8 shows the current TTLs used by the ADMEF for Suitability Determinations.

Comparison to the TTL. For all chemicals for which a TTL is available, interpretation of bioaccumulation test results is accomplished by a statistical comparison of the mean tissue concentration of contaminants in animals exposed to dredged material to the TTL. The statistic employed is the one-tailed one-sample t-test (alpha level of 0.05):

$$t = \frac{\bar{x} - \mathrm{TTL}}{\sqrt{\frac{s^2}{n}}}$$

where "$\bar{x}$", "s^2", and "n" respectively refer to the mean, variance, and number of replicates associated with a contaminant's tissue concentrations from bioaccumulation testing of the proposed dredged material. For non-detects, a concentration equal to one-half the MDL will be used in the statistical analysis (dredging proponents may also propose a non-substitution method for non-detects where appropriate).

Use of the one-sample t-test is necessary to allow experimental results for bioaccumulation testing to be compared to the TTLs, which are constants. A one-tailed t-test is appropriate since there is concern only if bioaccumulation from the dredged sediment is not significantly less than the TTL. The null hypothesis in this case is that the tissue concentration is greater than or equal to the TTL.

If the mean tissue concentration of one or more COCs is greater than or equal to the TTL, then no statistical testing is required. The conclusion is that the dredged material is not acceptable for in-water discharge. If the mean tissue concentration of a COC is less than the applicable

TTL, a one-tailed one-sample t-test is conducted and the null hypothesis is rejected, then the dredged material is considered acceptable for in-water discharge.

Comparison to Reference. For all BCOCs except TBT, an evaluation of the ecological effects of bioaccumulation is accomplished by comparing the test tissue results to the reference tissue results for statistical significance. Statistically significant bioaccumulation resulting from exposure to dredged material may demonstrate the potential for food web effects.

For non-detects, a concentration equal to one-half the MDL will be used in the statistical analysis (dredging proponents may also propose a non-substitution method for non-detects where appropriate). If the results of a statistical comparison show that the tissue concentration of the COCs in test sediments is statistically higher (one-tailed t- test, alpha level of 0.1) than the reference sediment, the dredged material will be evaluated further to determine the potential ecological significance of the measured tissue residues.

Other Considerations. The factors summarized below will be reviewed as part of the Suitability Determination process when the difference between the tissue concentration of one or more BCOCs resulting from exposure to dredged material and the tissue concentration resulting from exposure to a reference sediment is statistically significant. In reviewing these factors, the best available regional guidance will be used to assess the relative importance of each factor to the regulatory decision.

1. How many contaminants demonstrate bioaccumulation from dredged material relative to reference sediments?
2. What is the magnitude of the bioaccumulation from dredged material compared to reference sediments?
3. What is the toxicological importance of the contaminants (e.g., do they biomagnify or have effects at low concentrations?). In assessing the toxicological importance, ecologically-based TTLs may be established on a project-specific basis by regulatory agencies based on a review of the current residue-effects literature. A statistical comparison will be made to ecologically-based TTLs using the one-sample t-test described under human-health effects.

   One exception to the project-specific nature of ecologically-based TTLs is the TTL for TBT (**Table 10-8**), which was adopted from a CERCLA risk assessment (EPA 1999). The TBT TTL represents a residue that is associated with reduced growth in a number of invertebrate species including polychaetes and crustaceans and is, therefore, broadly applicable.
4. What is the magnitude by which contaminants found to bioaccumulate in laboratory test tissues exceed the tissue burdens of comparable species found at or in the vicinity of the discharge site?
5. Are detected concentrations above or below established PQLs?
6. Are the number of non-detects such that the statistical comparison between test and reference concentrations is affected by artificially low variance?

10.6. Bioaccumulation Reporting Requirements

In addition to the reporting requirements listed in Section 6.6., the following must be included for bioaccumulation results:

1. Day 0 tissue concentrations.
2. Tissue concentrations resulting from exposure to test, reference, and control

sediment.

3. Statistical comparison of tissue results to TTLs (for those BCOCs with TTLs).
4. Statistical comparison of test tissue results to reference tissue results.
5. Tissue concentrations of comparable species found in the vicinity of the discharge site.
6. Evaluation of tissue concentrations relative to PQLs.
7. Evaluation of the role of non-detects on statistical comparisons.
8. Bioaccumulation laboratory report.
9. Evaluation of indicators of test organism health, including biomass and mortality.
10. Summary of water quality data.
11. Discussion of any other factors that may have affected the bioaccumulation testing results.

11. TIER 4 EVALUATIONS

If standard chemical and/or biological evaluations of dredged material are unable to determine suitability of dredged material, a Tier 4 assessment may be required. A Tier 4 assessment is considered a special, non-routine evaluation and will require discussions among the Agencies and the dredging proponent to determine the specific testing or assessment requirements. Alternative analyses that may be conducted in this tier may include any or all of the following: Steady-State Bioaccumulation Test (Section 11.1) and other case-specific studies (Section 11.2).

11.1. Steady-State Bioaccumulation Test

In a Tier 4 evaluation, bioaccumulation testing may be necessary to determine, either by time-sequenced laboratory bioaccumulation testing (Lee *et al.* 1989) or by collection of field samples, the steady-state concentrations of contaminants in organisms exposed to the dredged material as compared with organisms exposed to the reference material. The necessary species, apparatus, and test conditions for laboratory testing are the same as those utilized for the Tier 3 bioaccumulation test. Thus, Tier 4 evaluations of data collected follow the interpretation guidance specified in Section 10.

11.1.1. Time-Sequenced Laboratory Testing

As an alternative to accepting the 45-day exposure as a reflection of steady-state conditions, a dredging proponent may elect to conduct a time-sequenced bioaccumulation test. If organisms are exposed to biologically available contaminants under constant conditions for a sufficient period of time, bioaccumulation will eventually reach a steady-state in which maximum bioaccumulation has occurred, and the net exchange of contaminant between the sediment and organism is zero. By testing tissue residues periodically over the course of exposure, this steady-state concentration can be determined more accurately than relying on a single exposure period.

11.1.2. Field Assessment of Steady-State Bioaccumulation

Measuring concentrations in field-collected organisms may be considered as an alternative to laboratory exposures. A field sampling program designed to compare dredging and reference tissue levels of the same species allows a direct comparison of steady-state contaminant tissue levels. The assessment involves measurements of tissue concentrations from individuals of the same species collected within the boundaries of the dredging site and a suitable reference site. The difficulty in collecting enough individuals of the same relative size ranges and biomass of the same species to enable tissue analyses at the reference and dredging sites can make this type of assessment problematic. A determination is made based on a statistical comparison of the magnitude of contaminant tissue levels in organisms collected within the boundaries of the reference site compared with organisms living within the area to be dredged.

11.1.3. Human Health/Ecological Risk Assessments

When deemed appropriate by the Agencies, a human health and/or ecological risk assessment may be required to evaluate a particular COC, such as dioxin, mercury, PCBs, etc. In the case of chemicals like dioxin, National guidance is in a state of flux, and project-specific risks to human health or ecological health should be evaluated using the best available technical information and risk assessment models.

A case-specific risk assessment must be developed with all interested parties participating. If a risk assessment is the method of choice for a special evaluation, either as a stand-alone task or in conjunction with bioassay tests (Section 9) and/or tissue analysis (Section 10), then it must be accomplished with active participation by the dredging proponent, the Agencies, and a risk assessment expert.

ADEC's *2018 Risk Assessment Procedures Manual* provides risk assessment procedures for use in preparing human health and ecological risk assessments (ADEC 2018). It also provides users with a single resource point for requirements and technical resources necessary to complete risk assessments. Regional or National risk assessment guidance from the EPA must be used where guidance is not provided by ADEC. However, the remoteness of many Alaska sites, the seasonal extremes of Alaska's climate, the diverse geography, and the unique subsistence lifestyles of many Alaskans combine to make Alaska risk assessments different than risk assessments prepared for typical sites in the continental United States.

In addition to the State-specific guidance cited above, the following EPA and USACE documents may also be consulted for additional guidance on risk assessment procedures and parameters:

- EPA. 1998. Guidelines for Ecological Risk Assessment. United States Environmental protection Agency report EPA/630/R095/002F. United States Environmental Protection Agency, Risk Assessment Forum, Washington, DC.
- EPA. 1989. Risk Assessment Guidance for Superfund, Volume 1 – Human Health Evaluation Manual, Part A, Interim Final. United States Environmental Protection Agency report EPA/540/1-89/002. Publication 9285.7-01A. Washington, DC: Office of Emergency and Remedial Response.
- EPA. 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (interim final). United States Environmental Protection Agency report EPA 540-R-97-006. Environmental Response Team, Edison, NJ.
- USACE. 1999. Risk Assessment Handbook Volume I: Human Health Evaluation. United States Army Corps of Engineers report EM 200-1-4.
- USACE. 2010. Risk Assessment Handbook Volume II: Environmental Evaluation. United States Army Corps of Engineers report EM 200-1-4.
- Cura, J.J., W. Heiger-Bernays, T.S. Bridges, and D.W. Moore. 1999. Ecological and Human Health Risk Assessment Guidance for Aquatic Environments. Technical Report DOER-4. U.S. Army Corps of Engineers' Engineer Research and Development Center, Dredging Operations and Environmental Research.

11.2. Other Case-Specific Studies

Biological effects tests in Tier 4 should only be used in situations that warrant special investigative procedures. To address unique concerns, special studies not formally approved for use may be recommended to evaluate a specific dredged material issue. The nature and details of these studies would have to be worked out on a case-by-case basis through discussions with the Agencies.

Tests considered may include chronic/sublethal tests, field studies such as benthic community studies, experimental studies such as *in situ* toxicity tests or toxicity identification evaluations (Toxicity Identification Evaluation [TIE] procedure; see Ankley *et al.* 1992). In such cases, test procedures must be tailored for specific situations, and general guidance cannot be offered. Such studies, when conducted, require design and evaluation specific to the need arising, with the assistance of administrative and scientific expertise from the Agencies and other sources as appropriate.

Prediction of the movement of contaminants from sediment into and through pelagic food webs is technically challenging and should only be dealt with in a Tier 4 evaluation if deemed necessary. General approaches may be explored which estimate likely concentrations of specific contaminants at different trophic levels based on an empirical model derived from a variety of marine food webs (Young 1988; Lachmuth *et al.* 2010). Other methods may be recommended, such as bioenergetic-based toxicokinetic modeling, to address a particular concern, if deemed appropriate.

12. LEAVE SURFACE EVALUATIONS

Characterization of the post-dredge surface (leave surface) is often required to complete the analysis of dredging impacts. The leave surface is collectively composed of undisturbed residuals and generated residuals. Undisturbed residuals are sediments that were previously buried and exposed by the dredging. Leave surface samples are used to predict concentrations of undisturbed residuals in the leave surface. Generated residuals are sediments that are dislodged or suspended during the dredging operations and redeposited in the dredge area and include:

1. Fallback from the excavation head;
2. Fallback from debris removal;
3. Sloughing into the dredge area from adjacent slope failure in undredged areas; and,
4. Deposition of sediments resuspended during the dredging operations.

For the purpose of this framework, the contribution of generated residuals to the predicted leave surface chemistry is usually assumed to be negligible.

Leave surface samples may need to be collected during Tier 2 mobilization. Leave surface samples should be collected from the first 2 feet beyond the proposed project overdepth. These samples represent the leave surface that would be exposed following dredging. It is recommended that samples are archived to prevent increased mobilization costs and delays in the event that testing of leave surface sediments is warranted if leave surface analysis is not included in initial Tier 2 testing. Leave surface evaluations are site-specific and often require BPJ on the part of the Agencies. USACE and EPA have provided guidance documents to address testing of leave surface samples and evaluation of the data (PSDDA 1988; DMMP 2001b, 2008, 2010b).

12.1. When to Analyze Leave Surfaces

Chemical analysis of leave surface samples is required if:

1. The testing results for the overlying dredged material are found to be unsuitable for unconfined in-water discharge;
2. Any other project in the vicinity of the dredged material has subsurface sediments with greater contamination than surface sediments; or,
3. Any other site-specific reason showing evidence that leave surface sediment exposed by dredging may not meet applicable standards.

In a small number of cases, where there is indication that concentrations of COCs increase with depth, the Agencies may require leave surface samples to be analyzed concurrently with analysis of the dredged material; or the dredging proponent may opt for concurrent testing to save time. However, for most projects, a decision about leave surface sample analysis will be made after review of the chemistry and, if applicable, bioassay data associated with the dredged material.

Leave surface collection may not be required if any of the following apply:

1. The project is ranked *very low*.
2. The conceptual site model indicates that the leave surface will not be exposed (as when a cap or cover is placed).
3. The conceptual site model indicates the leave surface is known to be composed of

inert materials such as concrete or bedrock (e.g., if sediments have accumulated over a concrete boat ramp).

4. The Tier 1 and/or Tier 2 analysis indicated there is very low potential for contamination.
5. For projects wherein grab samples are considered adequate to characterize dredge material (Section 5.6.2.) due to rapid or routine shoaling and the sediments are expected to be relatively homogeneous (e.g., for projects dredged frequently, as in every 2 to 3 years). Note, the Agencies may require an initial leave surface characterization before this would apply.

12.2. Determining Analysis Requirements

Leave surface sample analyses will initially consist of sediment conventional and chemical analyses. At a minimum, the conventionals to be analyzed include grain size, TOC, and total solids. If there is a possibility that bioassays will be run, then ammonia and sulfides data will also be important. As for COCs, typically only those chemicals that were elevated in the overlying dredged material will need to be tested in the leave surface samples. However, the overall data set should be considered when determining additional analyses. For example, if two adjacent DMMUs are found unsuitable for in-water discharge, one due to elevated PCBs and the other due to elevated TBT, then the Agencies could require the leave surface samples underlying both DMMUs to be tested for both PCBs and TBT. In general, leave surface samples are analyzed as a composite sample, but if the composite sample indicates exceedance, then individual samples may need to be analyzed to locate extent of contamination within a DMMU.

Bioassays may become necessary if chemistry testing alone does not provide enough information for the evaluation. For example, there have been cases in which DMMUs with no SL exceedances have failed biological testing. In such cases it might be necessary to run bioassays on the leave surface samples to test for toxicity not predicted by the chemistry results. Due to holding time constraints (56 days for bioassays), the leave surface samples may need to be re-collected before bioassays can be run.

Bioaccumulation testing of leave surface samples may also be necessary in some situations. However, it is anticipated that bulk sediment concentrations (or optional porewater results in the case of TBT) could be used in most cases to determine the bioaccumulation potential of the leave surface samples relative to the overlying dredged material. For example, if leave surface chemistry exceeds a bioaccumulation trigger, the dredging proponent has the option to conduct bioaccumulation testing to determine the actual bioaccumulation potential. Leave surface samples undergoing testing for bioaccumulation may be composited.

12.3. Evaluating Compliance of Leave Surface with Applicable Standards

As indicated previously (see Section 5.7.), leave surface evaluations can be complicated and often require BPJ on the part of the Agencies. The following provide some guidelines expected to cover most leave surface evaluations for marine and freshwater projects:

1. The leave surface sediment must meet the regulatory guidelines provided in **Table 8-2**.
2. If leave surface sediments exceed SLs, bioassays may be conducted to inform suitability of that material for exposure.
3. If chemical concentrations are higher in the leave surface samples than in the overlying dredged material and exceed regulatory guidelines, then biological testing may be required to evaluate the material for toxicity in accordance with Section 9.

Evaluation of potential impacts of bioaccumulatives would be on a case-by-case basis.

4. If chemical concentrations are lower in the leave surface samples than in the overlying dredged material, but still exceed regulatory guidelines and/or BT, the Agencies will review the bioassay and/or bioaccumulation results from the overlying dredged material before considering if the leave surface samples must undergo biological testing.

Dioxin and bioaccumulation issues will be addressed on a case-by-case basis as will dredging project sites within an EPA or ADEC cleanup site.

12.4. Non-Compliant Leave Surface Options

If the leave surface layer does not meet applicable standards, three options are available:

1. Dredge deeper until suitable material is reached.
2. Overdredge and place a clean sand cover over the area.
3. Change project design to not expose contaminated sediments, i.e., underdredge.

Case-by-case specifics will drive the option selection and other project design details (e.g., depth of dredging or thickness of a clean sand cover) and whether other coordination may be required.

12.5. Other Considerations

The complexity of dredging projects varies considerably. Following are additional considerations for leave surface sample collection and analysis:

1. Multiple leave surface samples might need to be collected depending on anticipated conditions at the project site. For example, if there is a high probability of encountering elevated chemical concentrations in the newly exposed sediment, the dredging proponent might want to collect leave surface samples from 0-2, 2-4, and 4-6 feet beyond the planned overdepth to reach uncontaminated and/or native material.
2. In some areas, samples may need to be collected from adjacent side slopes that may slough subsequent to dredging.
3. In those cases where the sediment to be exposed by dredging is resampled to collect sediment for biological testing, the resampled sediment must undergo ADMEF chemical testing to provide a synoptic dataset.
4. Due to time or monetary constraints, the dredging proponent may forego biological testing of the leave surface layer and proceed directly to overdredging to a suitable material layer and/or placement of a clean sand layer over the new leave surface.

12.6. Post-Dredge Evaluations

In certain situations, the post-dredge sediment surface (top 10 centimeters) may be subject to sediment quality evaluation at the discretion of the Agencies. This may be necessary if pre-project leave surface samples could not be collected due to the presence of an overwater structure or rip rap; where under-pier sloughing occurs, and the under-pier sediment could not be evaluated prior to dredging; in cases of dredging violations where material that has not been approved for open-water discharge is dredged; or where dredging residuals are of concern. Post-dredge evaluations will be conducted on a case-by-case basis.

13. DREDGING AND DREDGED MATERIAL DISCHARGE

13.1. Discharge Options

Discharge options for dredged material depend upon project location, type of dredging, and results of sediment evaluation. Using this ADMEF, the Agencies evaluate the suitability of dredged material for in-water discharge. Dredged material managed in Alaska under Section 404 of the CWA is predominately discharged in dispersive sites or for beneficial use (see Section 14).

Dredged material discharged at *non-dispersive sites* remains on-site and is the subject of long-term monitoring by the dredging proponent. Appropriate long-term monitoring requirements are determined by the Agencies in conjugation with the dredging proponent. Non-dispersive sites are managed to allow minor adverse effects such as sub-lethal effects to some species after long-term exposure.

Dispersive sites are typically in areas characterized by strong tidal currents wherein dredged material disperses quickly and does not accumulate over the course of consecutive dredging cycles. No adverse effects are allowed at dispersive sites, so dredged material must meet more stringent evaluation guidelines to be eligible for discharge at these sites.

In-water discharge of suitable dredged material is not limited to ADMEF sites: other types of open-water discharge include “flow-lane disposal” and “beneficial use” placement such as contaminated material capping, beach nourishment, coastal erosion mitigation, or habitat creation. The ADMEF evaluates sediment for suitability for in-water discharge. For beneficial use projects the Agencies do not make the final determination on suitability of material; other resource agencies may provide input during their environmental review. See Section 14 for more information.

Material found to be unsuitable for in-water discharge must be disposed of in accordance with Federal and State regulations.

13.2. Preparing to Dredge

Once all necessary permits are obtained, planning for dredging and discharge can proceed. Allowable dredge equipment and barges are determined on a case-by-case basis.

Dredging proponents are responsible for ensuring the following is coordinated:

- At least 30 days prior to the beginning of dredging and discharge work, notify USACE RD.
- Submit a Dredging and discharge Quality Control Plan (QCP) for distribution to the Agencies, at least 30 days prior to scheduled dredging.
- Optionally, if the Agencies deem it necessary, attend a pre-dredge conference (see Section 13.4.) at least 7 days prior to the start of dredging.

Some permits may have additional requirements or earlier plan submission requirements. Dredging proponents should carefully read conditions of all other permits to determine if earlier submittals are required.

13.3. Dredging and Dredged Material Discharge Quality Control Plan

This document helps ensure that the dredging and associated dredged material discharge are in compliance with the ADMEF project Suitability Determination and permits, that the necessary coordination has been done, and that reporting procedures are in place. It is submitted at least 30 days prior to the initiation of dredging and if necessary, reviewed in the pre-dredge conference (see Section 13.4.). The QCP should provide the following information:

1. Project description: including project and vicinity maps, in-situ volume estimate, and bulking factor or tolerance (see Section 13.6.).
2. Figures showing the area to be dredged, dredging depths (including overdredge), side slopes, and discharge site.
3. Dredging and discharge vessels and equipment.
4. Schedule of dredging and discharge activities, and the allowable work windows for the dredging and discharge sites.
5. Dredging and discharge personnel, responsibilities, and contact information.
6. Dredging method and procedures, including:
    - measures to control or minimize potential water quality impacts.
    - separation of contaminated material from sediments suitable for in-water discharge.
    - decontamination of dredging equipment, if required.
    - plan for removal and discharge of floatable and non-floatable debris, i.e., debris control plan(s) (see Section 13.5.).
    - horizontal and vertical controls during dredging (see Section 13.6.).
    - real-time dredged volume estimation method, such as barge measurement or daily bathymetry.
7. discharge method and procedures, including (as applicable):
    - names, types (e.g., bottom dump), and capacities of barges and dump scows.
    - identification of vessel(s) (by name and call letters).
    - vessel operator's name and telephone number.
    - target discharge coordinates.
    - navigation equipment and positioning protocol for discharge.
    - procedure for initiation of dump sequence when on-site.
    - Discharge data recording and reporting procedures.
    - Discharge site, whether in-water or upland.
8. Water quality monitoring plan and contingencies for water quality exceedances when appropriate or required by the Agencies.
9. Coordination procedures with the Agencies, including contact information and notification requirements.
10. Spill control and response measures.
11. Post-dredge hydrographic surveys.

The dredging and dredged material discharge QCP must be approved by the Agencies prior to commencement of in-water discharge.

13.4. Pre-Dredge Notification

Most regulated projects that are evaluated under the ADMEF are required to notify the Agencies at least 30 days prior to dredging, and if deemed necessary by the Agencies, to have a pre-dredge conference call within 7 days to the initiation of dredging. Beneficial use projects may also require a pre-dredge conference call depending on the size, complexity, and project-specific considerations. The need for, and type of, pre-dredge conference will be determined by the Agencies for each project and dredging cycle using BPJ.

If deemed necessary, the conference call will be coordinated by USACE RD. Attendees will include, at a minimum, dredging proponent, the dredging contractor, and representatives from USACE. The ADEC. EPA, ADNR and ADF&G may also choose to attend. The Services (i.e., USFWS and NMFS) may also need to attend if consultations are required due to the applicability of MMPA, ESA, or EFH in the dredging area. The meeting will be used to review the discharge locations, WQC, QCP, and any issued permits with their conditions. Completion of a pre-dredge conference, if deemed necessary, will be documented as part of USACE RD permit file.

Modifications to the QCP that are made at the pre-dredge conference must be incorporated into a final control plan and submitted to the Agencies for approval prior to dredging. A pre-discharge dry run may be required by USACE. At the discretion of USACE RD, the USACE RD Project Manager may attend the pre-discharge dry run for the discharge site, or any discharge run to verify positioning accuracy.

13.5. Debris Management

In general, debris is not allowed to be discharged at the ADMEF in-water sites. This includes all floatable debris, large non-floatable debris such as logs, piling, rip rap and concrete, and all solid waste (e.g., tires, rebar, garbage). Occasionally, suitable dredged material may include smaller non-floatable woody debris (e.g., sawdust, bark, wood chips) which are inseparable from the sediment and represent less than half of the dredged material by volume. In cases where a heterogeneous mix of smaller woody debris and sediment exists, which otherwise meets ADMEF discharge guidelines, in-water discharge may occur if none of the woody debris measures more than 12 inches in its longest dimension. The determination of whether a physical screening mechanism (grid, grizzly, etc) will be required for a given project will be documented in the ADMEF Suitability Determination.

13.6. Dredged Material Volume Estimates for In-Water Discharge

Exceedances of permitted dredging volumes discharged in water may result in work stoppages. In addition to the guidance provided in Section 3, the following guidelines should be followed to reduce the potential for permit violations:

- Additional shoaling may occur between the time of sampling and dredging. It is the dredging proponent’s responsibility to identify the need for a volume adjustment as a result of any post-sampling shoaling. Volume adjustments should be made prior to issuance of the public notice. If significant shoaling occurs after the public notice has been issued, written requests for permit revisions must be made to the permitting Agencies as early as possible and before dredging commences.
- An estimate of the bulking factor, and a justification for its selection, must be included in the QCP.

- A description of the method used to determine the volume measurement must be included in the QCP.
- A description of the procedures to ensure vertical and horizontal dredging control must be included in the QCP. Such procedures prevent overdredging and may reduce the need for confirmatory surveys in areas where suitable and unsuitable dredged materials are in close proximity.
- Once dredging has begun, if the dredging proponent or contractor determines that significant dredging has occurred outside the permitted dredging prism and overdepth, vertical and horizontal control must be re-established immediately, and the Agencies contacted as soon as possible.
- As dredging proceeds, the contractor must closely monitor dredging progress and notify the Agencies as soon as possible if an exceedance of the permitted volume appears likely. Revision of the permits may be made as necessary. Dredging must stop when the sum of the daily barge estimates, corrected for bulking using the revised bulking factor, reaches the permitted in-situ volume. The Agencies must be notified at this time. If the dredging has not been completed, a determination will be made as to the cause of the impending volume exceedance and permit volumes revised as appropriate.
- Post-dredge surveys will be reviewed by the Agencies, as necessary, to ensure that the dredging plan has been followed.

13.7. Post-Dredging Requirements

For all dredging projects, actual volumes of discharged material and post-dredge bathymetry (if collected) must be reported to USACE RD Project Manager and the Agencies. This applies to both in-water and upland disposal. As necessary, post-dredge surveys will also be reviewed by the Agencies to ensure that the dredging plan was followed.

13.8. Discharge Site Information

Figure 13-1 is a schematic delineating the target area and discharge zone within a generic non-dispersive discharge site. In the non-dispersive sites, a barge should open within the target area to ensure dredged material is released within the discharge zone. The zone allows for some difficulties in maneuvering. For dispersive sites, the target area and the discharge zone are one and the same.

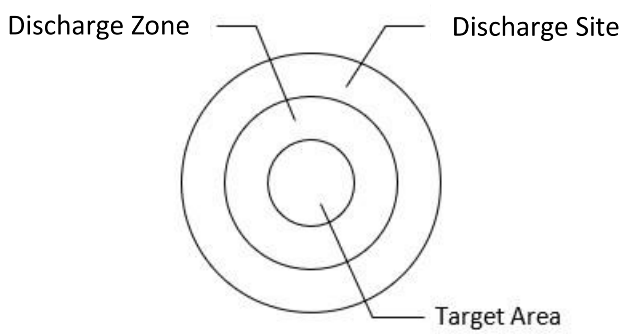

***Figure 13-1**. Discharge Zone vs. Target Area*

13.9. Discharge Positioning

13.9.1. Coast Guard Notification

The United States Coast Guard (USCG) must be notified at least 14 days prior to commencing dredging operations, so the project information can be issued in the Local Notice to Mariners. For Alaska, the USCG 17th District should be notified. The email associated for this type of notification is smb-d17juneau-lnm@uscg.mil.

13.9.2. Dump-site Position Recording Equipment

USACE CW and USACE RD-permitted dredging projects may require the use of monitoring equipment from the National Dredging Quality Management (DQM) program, administered by USACE. Exemptions can be provided by a USACE District Engineer if justified by unusual circumstances or undue hardships to dredging proponents and their contractors. The DQM position recording equipment utilizes differential global positioning to provide a record of discharge events.

For more information about DQM, see https://dqm.usace.army.mil.

13.9.3. Flow-lane Disposal

This disposal method may be used for dispersive disposal. Individual regulatory agencies may have unique requirements that must be fulfilled to select, permit, and use a flow-lane disposal site. As a management example, USACE navigation section must approve any flow-lane disposal proposed for a Federally-authorized navigation channel. This may trigger a Section 408 review (33 USC 408). As a technical example, individual regulatory agencies may require a simulation of flow-lane disposal using a model such as USACE's Disposal from a Continuous Discharge (DIFCD), Computation of Mixing Zone Size or Dilution for Continuous Discharges (CDFATE), or Short-Term FATE (STFATE) models, as appropriate. These various models can provide information on suspended solids/turbidity, plume characteristics, and potential contaminant water concentrations associated with disposal. The characteristics of the material and the results of the model analysis is reviewed to determine whether flow-lane disposal may be authorized on a project-specific basis.

The DIFCD model is designed to predict the descent of the discharge (from a pipeline discharge only) through the water column based on the discharge momentum and density, the entrainment of water into the discharge during descent and impact with the sediment bed, the deposition of dredged material on the sediment bed, the passive transport and diffusion of the discharge plume, and the settling of solids from the plume as a function of material properties. The model predicts suspended solids and dissolved contaminant concentrations spatially as a function of time. For more information about the DIFCD model, see the "User's Guide for Models of Dredged Material Disposal in Open Water" (https://erdc-library.erdc.dren.mil/jspui/handle/11681/4652) or Appendix B of the EPA/USACE OTM (https://dots.el.erdc.dren.mil/guidance/ocean-disposal-gbook.pdf).

The CDFATE model is designed solely to predict the fate and transport of suspended solids and dissolved contaminant concentrations from a pipeline discharge into a receiving environment, assuming a stripped fraction in the water column and resuspended fraction from the sediment bed. The CDFATE module also contains the Dredging – Cornell Mixing Zone Expert System (D-CORMIX) mixing zone model that can provide plume characteristics (concentrations, dimensions, and dilution) as a function of distance from a pipeline discharge location. The characteristics of the material and the results of the model analysis are reviewed to determine whether flow-lane disposal may be authorized on a project-specific basis. For more information about the CDFATE model, see https://dots.el.erdc.dren.mil/elmodels/pdf/cdfate.pdf.

The STFATE model is recommended for predicting deposition and water quality effects of a dredged material discharge from a point source such as a bottom-dump or hopper barge. For more information about the STFATE model, see Appendix C of the EPA/USACE ITM (https://dots.el.erdc.dren.mil/elmodels/pdf/inlandc.pdf). To consider flow-lane disposal, contact USACE for further information. As part of the permitting process, proposals for flow-lane disposal will require coordination with the Agencies, as well as other supporting environmental documentation.

14. BENEFICIAL USE

14.1. Beneficial Uses Guidelines

"Beneficial use" is the placement or use of dredged material for some productive purpose. While the term "beneficial" indicates some "benefit" is gained by a particular use, the term has come to generally mean any "reuse" of dredged material. Resource agencies must agree that the proposed reuse will result in physical, chemical or biological benefit. As part of overall sediment management in Alaska, the regulatory agencies responsible for sediment management support the productive reuse of dredged material. Beneficial use of dredged material in conjunction with Federal projects is subject to additional authorization requirements.

Dredged material can be used beneficially for many environmental enhancement purposes, as described on USACE's beneficial use website (https://budm.el.erdc.dren.mil/beneficialuse.html) and in the categories described below on a case-specific basis (USACE 2007):

- **Habitat Restoration and Development:** using dredged material to build and restore wildlife habitat, especially wetlands or other water-based habitat (e.g., nesting islands and offshore reefs). Use of dredged material as a substrate for habitat development is one of the most common and important beneficial uses. In considering habitat development, it is necessary to determine what type of habitat is needed (e.g., habitat to enhance fish or bird communities), whether the constructed habitat will be stable at the proposed location, and whether the new habitat will displace existing unique or valuable habitats.
- **Beach Nourishment:** using dredged material (primarily sandy material) to restore beaches subject to erosion. In the past, beach nourishment has been accomplished by dredging sand from inshore or offshore locations and transporting it by truck, split-hull hopper dredge, or hydraulic pipeline to the beach needing supply. The construction of underwater berms both to decrease erosion by wave action and to supply sand to eroding beaches is a technique for beach nourishment (Richardson 1990).
- **Parks and Recreation:** using dredged material as the foundation for parks and recreational facilities; for example, waterside parks providing such amenities as swimming, picnicking, camping, or boating. Of all types of beneficial uses, recreation on dredged material containment sites is one of the most prevalent land uses in terms of acreage. It is not surprising to find many examples of such use since there is a demand for waterfront recreational sites in urban areas, where many dredging projects occur. In addition, legislation relating to wetlands and flood control promotes this use.
- **Agriculture, Forestry, Horticulture, and Aquaculture:** using dredged material to replace eroded topsoil, elevate the soil surface, or improve the physical and chemical characteristics of soils or sediments. By applying dredged material to farmland, topsoil can be conserved and reclaimed. Dewatered dredged sediment can be applied to farmland to elevate the soil surface, thus improving drainage, and reducing flooding; when incorporated into marginal soils, it can enhance the physical and chemical characteristics of the soils and make water and nutrients available for crop growth.
- **Strip-Mine Reclamation and Solid Waste Management:** using dredged material to reclaim strip mines, to cap solid waste landfills, or to protect landfills. Abandoned strip mines can be reclaimed using dredged material meeting certain chemical and

physical criteria. Fine-grained dredged material can be used in solid waste management as daily and interim sanitary landfill cover.

- **Construction/Industrial Development:** using dredged material to support commercial or industrial activities (including brownfields redevelopment), primarily near waterways; for example, expanding or raising the height of the land base, or providing bank stabilization. In addition, dredged material may be used as construction material.
- **Multiple-Purpose Activities:** using dredged material to meet a series of needs simultaneously, such as habitat development, recreation, and beach nourishment, which might all be supported by a single beneficial use project. For example, a park and recreational area could be built over a closed solid waste landfill that used dredged material as cover. Alternatively, an island development project might provide both wildlife and recreation amenities. Recreational use and wildlife and fish habitat can often be developed simultaneously on a site.

During evaluation and selection of beneficial use options, issues such as potential bioaccumulation of contaminants and introduction of invasive species should be considered.

Dredging proponents considering beneficial use projects are encouraged to coordinate with the Agencies and with other resource agencies early in the dredged material evaluation process. For more information on beneficial uses of dredged material, see EPA's Beneficial Use of Dredged Material page (https://www.epa.gov/cwa-404/beneficial-use-dredged-material-under-cwa-section-404) and USACE technical website Beneficial Uses of Dredged Material (https://budm.el.erdc.dren.mil/). If the sediment proposed for beneficial use is State-owned, contact ADNR early to determine if additional considerations apply.

To ensure a beneficial use project's viability, evaluation of the proposed dredged material is required. Please note standard ADMEF characterization may or may not be sufficient for the proposed beneficial use. Other permitting agencies may require additional testing to ensure the material is suitable for the proposed use. For example, the NMFS, USFWS, or ADF&G may require additional chemical or biological analyses as part of the project's ESA consultation. If the dredged material is proposed to be incorporated into a beneficial upland re-use project (i.e., roadbed fill), a Letter of Non-Objection should be obtained from the ADEC Solid Waste and Contaminated Sites programs (ADEC 2013). Solid Waste program authorization, other than a disposal permit, may be required for beneficial re-use projects utilizing non-exempt dredged material (ADEC 2013).

14.2. Sediment Characterization of Beneficial Use Material

Unconfined aquatic projects (such as beach nourishment, habitat restoration, and in-situ capping) are projects where dredged material may come directly into contact with the surrounding aquatic environment. For most projects, certain sediment conventional parameters (e.g., grain size) and/or detected COCs must fall below regulatory guidelines (see **Table 8-2**) and any bioassays must pass. Material that has levels of chemicals greater than regulatory guidelines (e.g., greater than SL1 but less than SL2) may be appropriate for beneficial use on a case-by-case basis after consideration of site-specific factors (e.g., for instance in some cases receiving site COC concentrations may exceed SL naturally, thus sediment that is exceeding SL may be able to be used in these cases) and coordination with landowners and/or resource agencies. For other projects, additional chemicals may be analyzed, or alternative SLs may be requested by another agency. ADMEF Suitability Determinations will document the sediment quality of each project relative to regulatory guidelines and provide a preliminary assessment of a project's suitability for in-water beneficial use based on this analysis. As always, BPJ may need to be applied in making case-by-case determinations. Dredged material proposed for beneficial use must be approved by the entity receiving the material. Additional coordination with resource agencies may be required.

15. MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT

15.1. Overview

The MPRSA (also called the Ocean Dumping Act, 33 USC 1401 *et seq*.) governs the transportation of dredged material for the purpose of disposal into ocean waters. The EPA has authority under section 102 to designate ocean dredged material disposal sites (ODMDSs). USACE is required to use designated ODMDSs to the extent feasible. Where infeasible, USACE may, with the concurrence of the EPA, select alternative ocean disposal sites using the EPA site selection criteria (see 40 CFR 227–228). USACE must consider project effects to navigation, economic and industrial development, and foreign and domestic commerce and the availability of alternative sites.

USACE issues permits for ocean disposal of dredged material under MPRSA Section 103. After the proposed permit action has been reviewed by the EPA for compliance with the Ocean Dumping Criteria and the EPA's concurrence is received, USACE may issue a permit for ocean disposal. If the EPA determines the criteria are not met, disposal may not occur without a waiver of the criteria by the EPA. The USACE CW program executes a commensurate analysis and requests concurrence from EPA for CW projects with an ocean dumping component.

The criteria for evaluating the environmental impacts of ocean disposal, including disposal of dredged material, is provided in Subpart B of the ocean dumping regulations (40 CFR 227.4–227.13). Unless a proposed dredging project is excluded from requirements for testing based on the criteria in 40 CFR 227.13(b), evaluation of the dredged material would occur in accordance with 40 CFR 227.13(c). General sampling methods are described in Section 5.6. of this ADMEF.

Additional analysis includes some or all of the testing described in Section 8 (Tier 2, Chemical Analysis), Section 9 (Tier 3, Bioassays), and Section 10 (Tier 3, Bioaccumulation). Procedures for performing additional testing related to dredged material liquid and suspended particulates are outlined in 40 CFR 227.32 and further described in the OTM (EPA and USACE 1991). The ADMEF helps ensure that disposal of dredged material in the ocean is compliant with the EPA's Ocean Dumping Criteria. For ocean disposal, the ADMEF follows a similar, but not identical, tier sequence to the OTM (EPA and USACE 1991; **Figure 15-1**):

> **Tier 1:** A comprehensive analysis of all existing and readily available, assembled, and interpreted information on the proposed dredging project, including all previously collected physical, chemical, and biological data. The information collected on the proposed dredged material is first compared to the three exclusionary criteria in paragraph 227.13(b) of the OTM. If one or more of the exclusionary criteria can be satisfied, the limiting permissible concentration (LPC) is met for the dredged material and no further evaluation is required.
>
> **Tier 2:** May include evaluation of marine water quality criteria compliance using a numerical mixing model of the dump-site conditions, and an evaluation of the potential for benthic impact using calculations of theoretical bioaccumulation potential. The purpose of Tier 2 is to provide a reliable, rapid screen for potential impact and potentially eliminate the need for further testing.
>
> **Tier 3:** Bioassays and bioaccumulation tests to assess the impact of contaminants in the dredged material on appropriate sensitive organisms to determine if there is potential for the dredged material to have an unacceptable impact.
>
> **Tier 4:** Case-specific toxicity testing when Tier 2 and Tier 3 assessments are unable to determine the dredged material's suitability for in-water disposal; often focuses on long-term effects (as opposed to acute effects) of exposure to the dredged material.

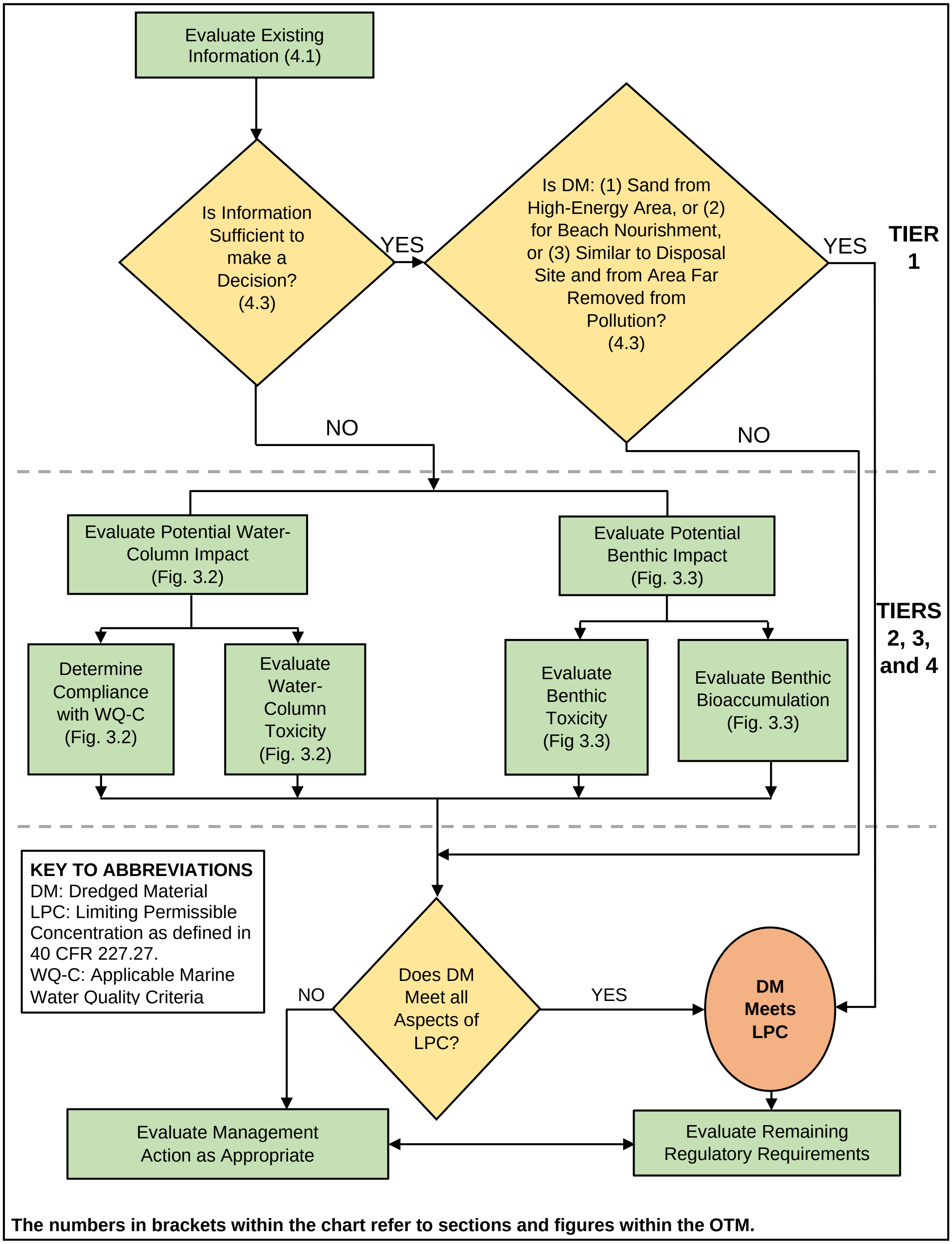

Figure 15-1. *The Basic Tier Sequence of Dredged Material Evaluation for Disposal under the MPRSA (Adapted from Figure 3-1 of the OTM; EPA and USACE 1991).*

15.2. Section 103 Permit Application Process

Transport and ocean disposal of dredged material requires a permit under MPRSA Section 103, which is issued by USACE RD. The general steps in the permitting process are as follows:

1. **Pre-application Consultation**: Early coordination with USACE and the EPA to discuss permit requirements, alternatives that may minimize the amount of material to be dumped in ocean waters, potential beneficial uses of the dredged material, and sediment sampling and testing requirements.
2. **Evaluation of Dredged Material Proposed for Ocean Disposal:** Development and implementation of a SAP and evaluation of the proposal under the EPA's Ocean Dumping Criteria.
3. **Permit Application**: Requirements for DA Permit are generally described within 33 CFR 325.1. In addition to the requirements found at 33 CFR 325.1, the application should also include:
    - An evaluation of dredged material disposal alternatives including an examination of potential beneficial uses of the proposed dredged material;
    - Written documentation of the site dredging history and a general review of other prior or current dredging activities at or near the site; and,
    - References to existing or prior MPRSA Section 103 permits.

As part of USACE's regulatory process, USACE sends a copy of the public notice for the application to the EPA for review. The EPA will review and concur, concur with conditions, or deny the issuance of the permit. EPA applies the following criteria in evaluating permit applications:

- The need for dumping;
- The environmental impact of the dumping, including the effect of dumping on marine ecosystems, shorelines, and beaches;
- The effect of the dumping on esthetic, recreational or economic values;
- The adverse effect of dumping on other uses of the ocean including navigation, scientific study, fishing, and resource exploitation activities; and,
- Land-based alternatives to ocean dumping.

Additional details regarding the process by which USACE evaluates applications and authorizations for Dredged Material Permits under MPRSA Section 103 are provided in 40 CFR 225. Additionally, Part 225 describes the process by which USACE coordinates permit application review with EPA. The full list of criteria used by EPA to evaluate ocean dumping permits is provided in 40 CFR Part 227.

15.3. Other Types of Ocean Dumping Permits

In addition to the permits for ocean dumping of dredged material issued by USACE, the EPA may issue other types of permits for ocean dumping of other material under the MPRSA. Information needed to apply for a Section 102 permit can be found in 40 CFR Parts 221 through 223. These include General Permits, Emergency Permits, Special Permits, and Research Permits, which are described as follows:

- **General Permits:** General permits are issued for the ocean dumping of certain materials that will have a minimal adverse environmental impact and are generally disposed of in small quantities (EPA 2021a). The EPA may also issue general permits for special classes of materials that must be disposed of in emergency situations. General permits cover actions such as burial at sea, disposal of vessels at sea, disposal of marine mammal carcasses, and similar actions.

- **Emergency Permits:** The EPA may issue emergency permits only in situations where the material to be disposed poses "an unacceptable risk relating to human health and admits of no other feasible solution." "Emergency" refers to situations requiring action with a marked sense of urgency but is not limited to circumstances requiring immediate action (EPA 2021b).
- **Special Permits:** The EPA may issue a special permit to an applicant seeking to dispose of materials in the ocean when the proposed disposal satisfies the EPA's Ocean Dumping Criteria. Special permits may be issued for a term not to exceed 3 years (EPA 2021c).
- **Research Permits:** The EPA may issue research permits for the dumping of materials into the ocean as part of a research project, including for marine carbon dioxide removal or solar radiation management, when it is determined that the scientific merit of the proposed project outweighs the potential environmental or other damage that may result from dumping. Research permits may be issued for up to 18 months (EPA 2021c).

These types of permits are described for informational purposes only. They are not typically applicable to projects involving dredging and ocean disposal of dredged sediments; therefore, **they are not discussed further in this ADMEF.**

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