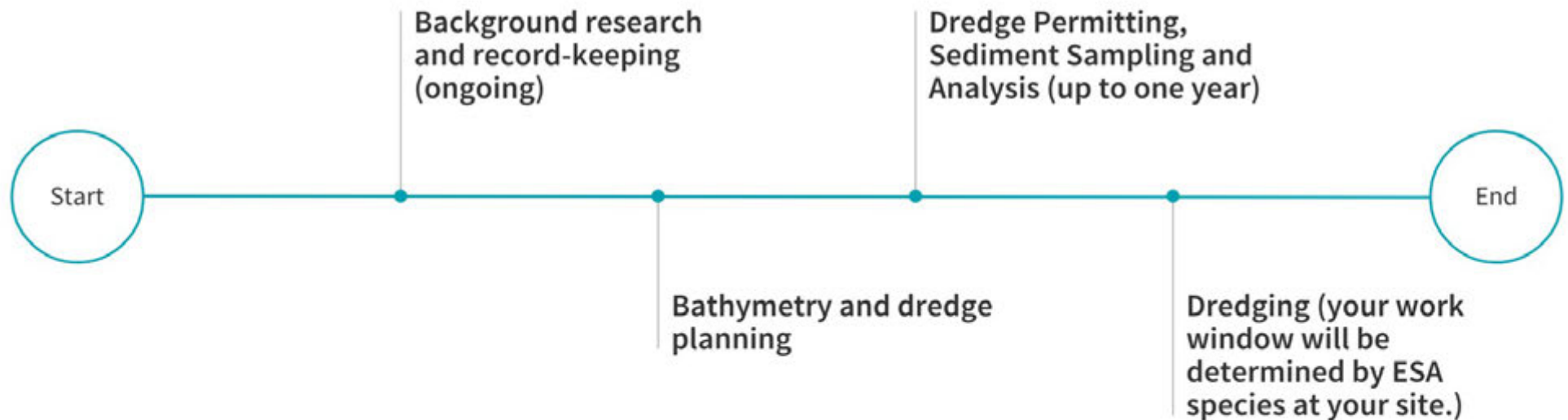




What to Know Before You Dredge

Jenny Liou, Marine Surveys & Assessments

Scheduling Your Dredge



The Team for Your Dredge



Dredged Material Management Office (includes the US Army Corps, the WA Department of Ecology, WA DNR, and the EPA)



You



Environmental Consultant



City and County

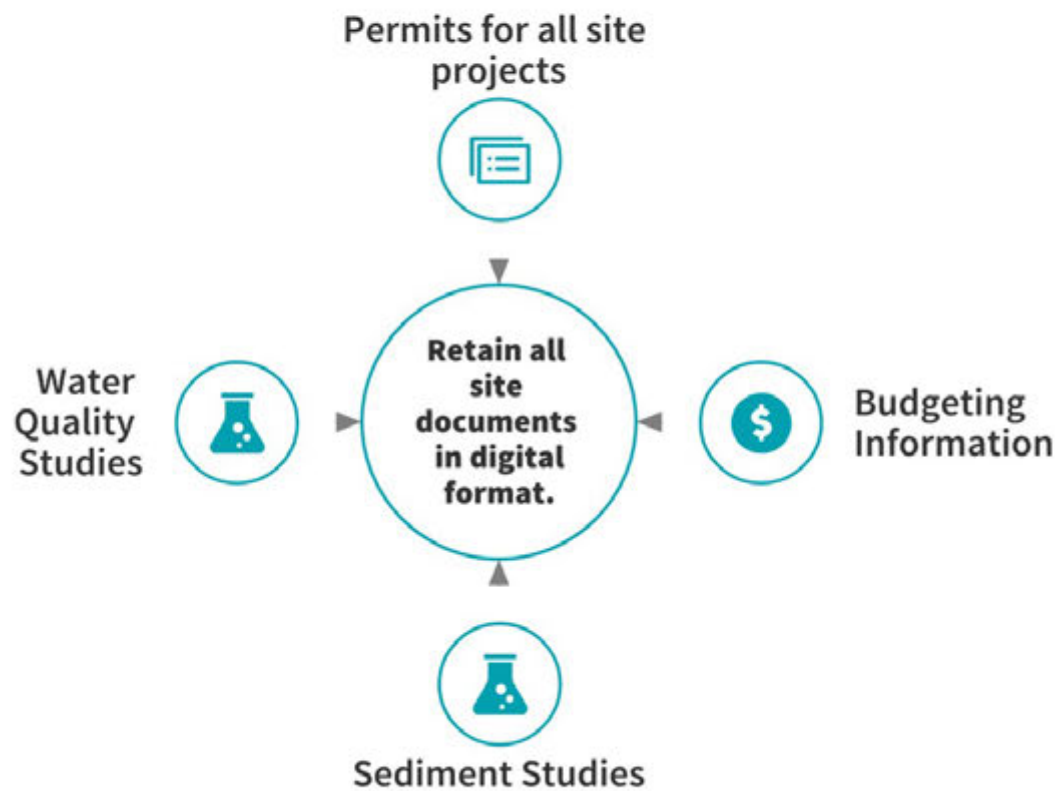


Coastal Geologist



Dredging Contractor

Before You Dredge



Two Years Before You Dredge



**Solicit Proposals from
Environmental Consultants**



**Begin formalizing your budget,
which may impact your dredge
design.**



Begin Planning Your Dredge

What Your Environmental Consultant Will Do



Correspond with you to obtain documents pertaining to your site history.



Consult early and often with the DMMO to ensure that your project follows a streamlined path through planning, sampling and analysis, permitting, and execution.



Begin drafting your Sampling and Analysis Plan (SAP), the first document you will need to submit to the DMMO.

What You Should Do in Advance



Work with your consultant and the DMMO to determine best dredging method, and research dredging companies.



Continue to work on your dredge design.



As your dredge date approaches, complete any additional surveys required by the DMMO.

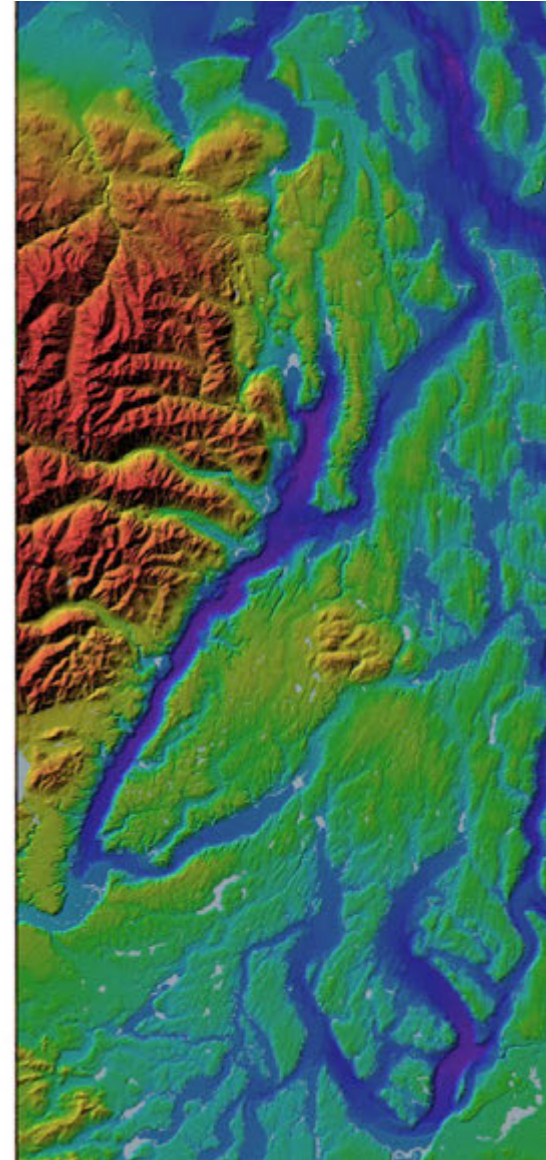
Bathymetry and Dredge Design

○ Bathymetry

This can be provided by the client, by a coastal geologist, or you can contract with your environmental consultant to manage the process. Your bathymetric survey will need to cover the area you intend to dredge, in addition to areas that dredging equipment may need to use to access the dredge.

○ Dredge Design

This will be provided by a civil/coastal engineer. You can work directly with an engineer to produce this, or contract with your environmental consultant to manage the process. You should consult your site's construction and prior maintenance dredge permits and the path to permitting will likely be easiest if you retain the footprint of previous maintenance dredges.

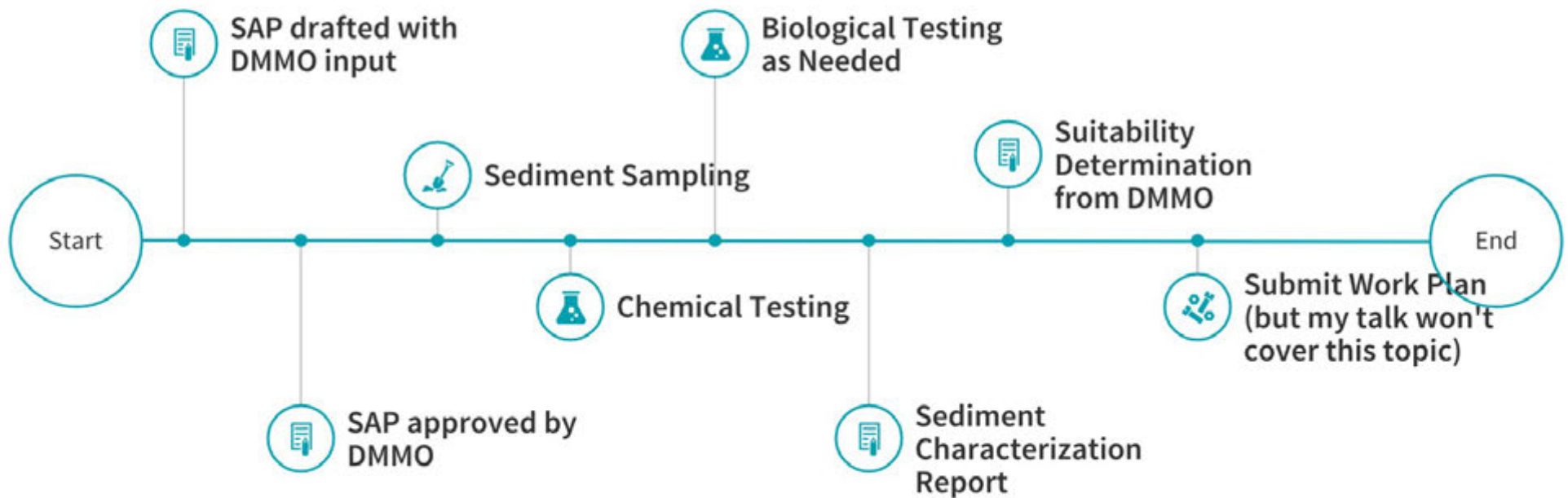


The Sampling and Analysis Plan (SAP)

- The Sampling and Analysis Plan is a document required by the Dredged Material Management Office. It includes the following:
 - A site history and project description.
 - A characterization plan based on dredge volume.
 - Detailed protocols for sediment sampling.
 - A plan for chemical testing tailored to your specific site.
 - A plan for biological testing.
 - A health and safety plan for your site during sampling.

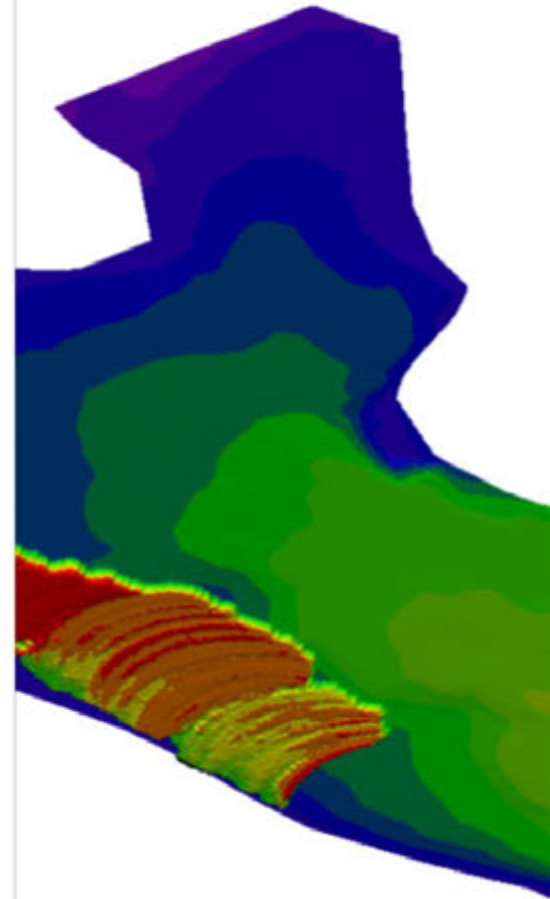


Overview of DMMO Component of Permitting Process



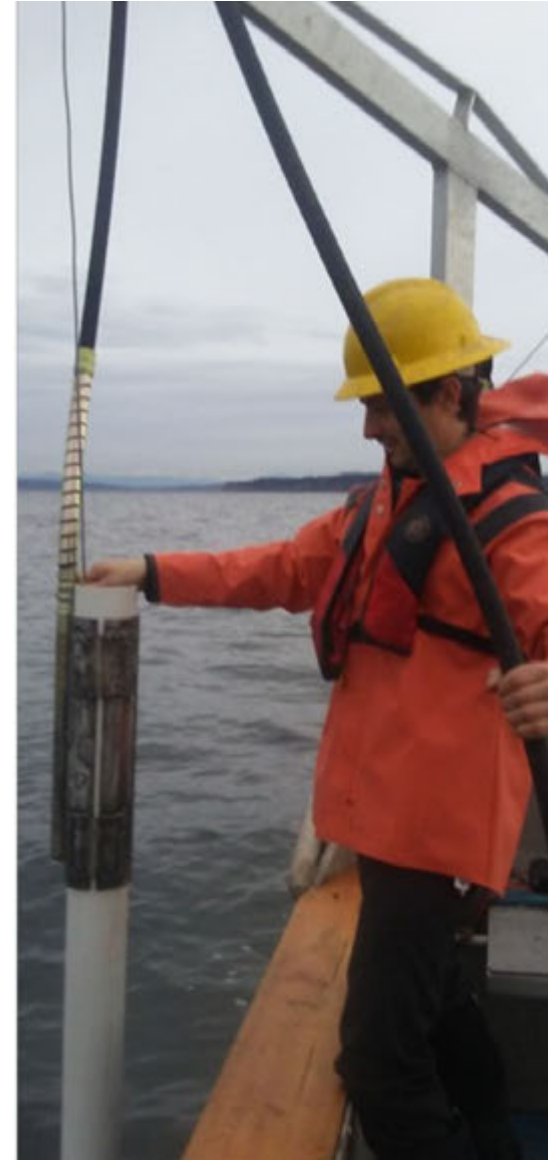
Characterization Plan Based on Dredge Volume

- Calculate your total site volume from dredge designs plus contingency calculations.
- Determine how many Dredged Material Management Units (DMMUs) your project will require.
- Determine how many samples will need to be taken within each DMMU.
- Plan exact sampling locations using GPS coordinates.

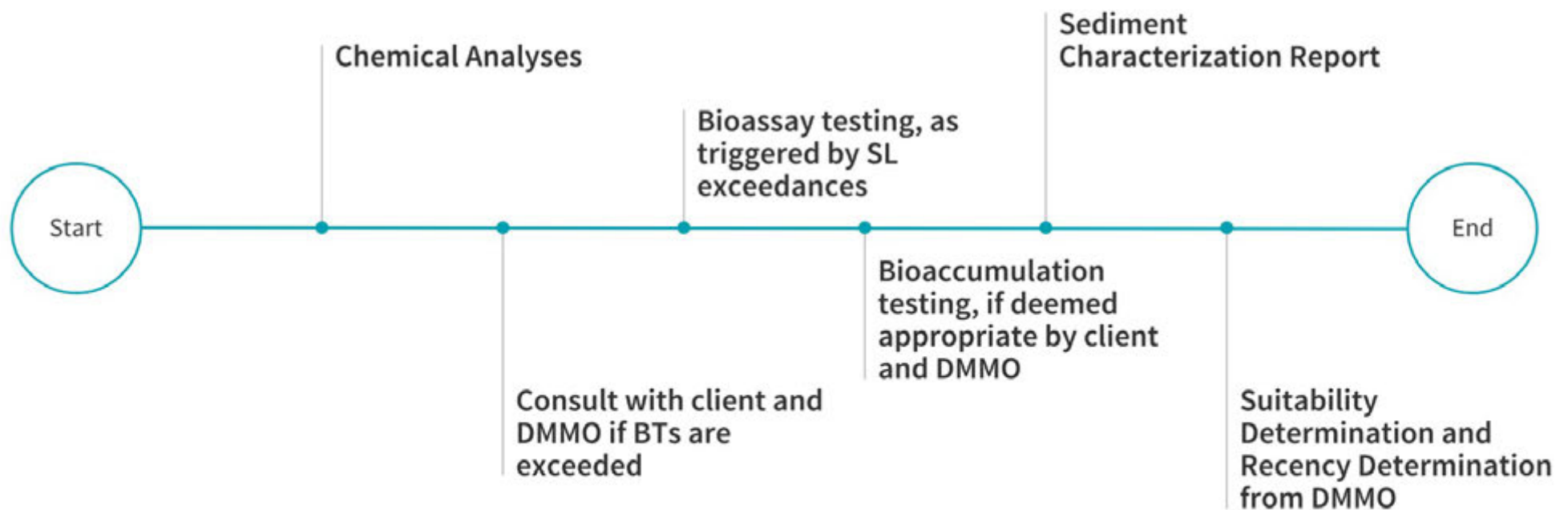


Sediment Sampling

- Sediment sampling will likely occur by boat, using a device called a Vibracore to collect material at specified locations throughout the site.
- The material will be transferred to the chemical analysis lab, where samples will also be archived for potential biological testing.
- The exact amount of sediment needed will vary depending on your predicted biological testing needs. Your environmental consultant will work closely with the DMMO to estimate these needs based on the history of contamination at your site and on adjacent properties.



Chemical and Biological Testing Sequence



Chemical Testing

- Select a laboratory to perform your analyses.
- Test Conventional Parameters and DMMP-listed Chemicals of Concern (COCs).
- Some of the required tests may be site-specific, so this is where it helps to keep detailed records of prior sediment testing, dredges, and site history.
- In particular, dioxin and furan testing is performed based on a “reason to believe,” which is determined on a site by site basis.
- The results of your chemical analyses will determine your path forward.



Reason to Believe

- Location within an urban bay.
- Proximity to current or historical point-sources, such as outfalls.
- Proximity to chlor-oxide bleach pulp mills, chlor-alkali or chlorinated solvent manufacturing plants, former wood-treating sites, phenoxy herbicide manufacture or use and handling areas.
- Proximity to areas with high PCB concentrations.
- Proximity to former hog fuel burners/boilers, and areas with other structural, vessel, or other fire or incineration sources.
- Proximity to areas previously sampled with elevated dioxin level



An Overview of Biological Testing

- A tiered-testing approach will be implemented for biological testing.
- If COCs are detected above DMMP screening levels, bioassay testing will be triggered.
- If a COC exceeds a DMMP bioaccumulation trigger (BT) the DMMO and the client will be consulted before proceeding with bioassay testing.
- If one more more BT is exceeded, bioaccumulation testing may be required.



Biological Testing Terminology

- **Screening Level**

A screening level (SL) is a guideline value determined by the DMMP for each COC, below which there is no reason to believe that dredged material disposal would result in unacceptable adverse affects.

- **Bioaccumulation Trigger**

A bioaccumulation trigger (BT) is the concentration of a bioaccumulative chemical of concern above which there is reason to believe the chemical would concentrate in the tissues of target organisms.



Bioassays vs Bioaccumulation Assays

○ 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: toxicity tests and bioaccumulation tests, or assays. The standard suite of bioassays are toxicity tests.

○ Bioaccumulation assay

A bioaccumulation assay measures the uptake of contaminants into a species' tissue over time. Bioaccumulation testing takes longer than the other bioassays, and requires larger sediment samples. It is therefore much more costly. Bioaccumulation assays may be triggered by COCs in exceedance of BTs.



An Overview of DMMP Bioassays

- **Ten Day Amphipod Mortality Test**

This is an acute test that measures the survival of infaunal amphipods to evaluate the toxicity of sample sediments. The test typically uses *Eohaustorius estuarius*, a marine worm.

- **Twenty Day Juvenile Infaunal Growth Test**

This is a sublethal bioassay, testing for chronic rather than acute toxicity. It uses a nereid worm, *Neanthes arenaceodentata*, and the results are based on the dry weight of biomass.

- **Sediment Larval Development Test**

This test uses the larval form of an echinoderm or bivalve to test for acute toxicity to this life-stage. Development and mortality are both tracked in this assay. The test typically uses *Dendraster excentricus* or *Mytilus galloprovincialis*.



Interpreting Bioassay Results

○ One-hit Failure

A one-hit failure occurs when any one biological test exhibits a test sediment response that exceeds the bioassay specific DMMP guidelines, relative to the negative control and reference, and which is statistically significant compared with the reference, the DMMU is deemed unsuitable for open-water disposal.

○ Two-hit Failure

A two hit failure occurs when two or more biological tests exhibit a test sediment response that is statistically significant compared with the reference, even if the results do not exceed bioassay specific DMMP guidelines. This results in the DMMU being deemed unsuitable for open-water disposa



An Overview of DMMP Bioaccumulation Testing

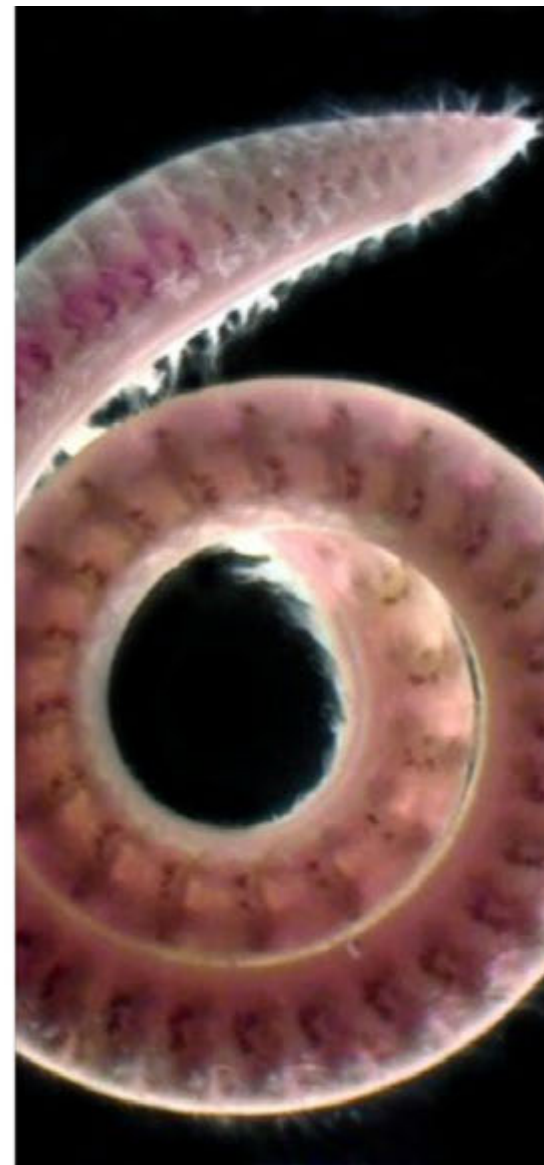
- **Bioaccumulation is the accumulation of contaminants in the tissues of organisms through any route, including respiration, ingestion, or direct contact with contaminated water, sediment, or dredged material.**

Bioaccumulation testing is required when bioaccumulation COCs exceed BTs. Bioaccumulation testing consists of exposing test organisms to sediment for 45 days, then analyzing collected tissue for COCs, which are compared to Target Tissue Levels. Bioaccumulation requires large sediment volumes, and extended trial time. Bioaccumulation testing typically cotests *Macoma nasuta* and *Nephtys caicoides*.



Interpreting Bioaccumulation Testing Results

- The DMMP compares tissue residues from bioaccumulation to Target Tissue Levels (TTLs) derived from human-health risk assessments, FDA action levels, or ecological effects.
- Bioaccumulation test results, especially with respect to dioxin guidelines, are used in a case-by-case decision-making approach.



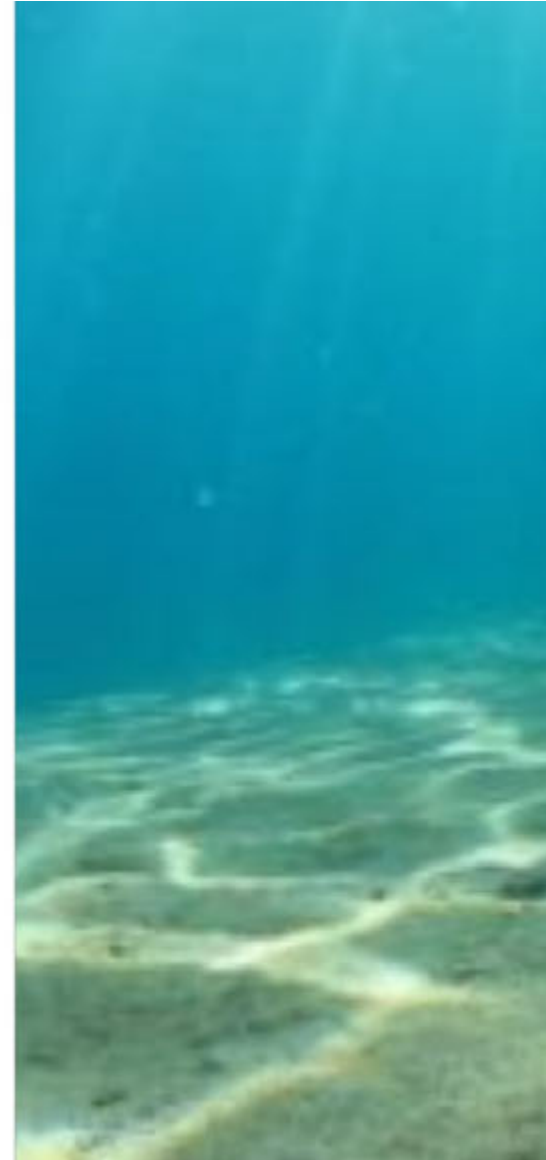
Summary of Bioassays and Bioaccumulation Testing

- If bioassay testing is triggered by COCs exceeding SLs, the bioassay testing process will determine disposal sites for dredged material. This can be a cost-effective way to see if your DMMUs can qualify for less costly disposal options, or if upland disposal at a DMMO-approved site will be required.
- If bioaccumulation testing is triggered by COCs exceeding BTs, you may want to consider whether to proceed with bioaccumulation testing, or proceed directly to upland disposal. There is a less formalized decision-making process for bioaccumulation testing, and decisions will be made through consultation with the DMMO.



Summary of Biological Testing

- Bioassays are more common and more affordable than bioaccumulation testing.
- Bioaccumulation assays are costly and time-consuming. You will need to decide, based on your dredged material volume, and your budget for the project, whether it is worth proceeding with bioaccumulation testing, or simply proceeding to upland disposal.



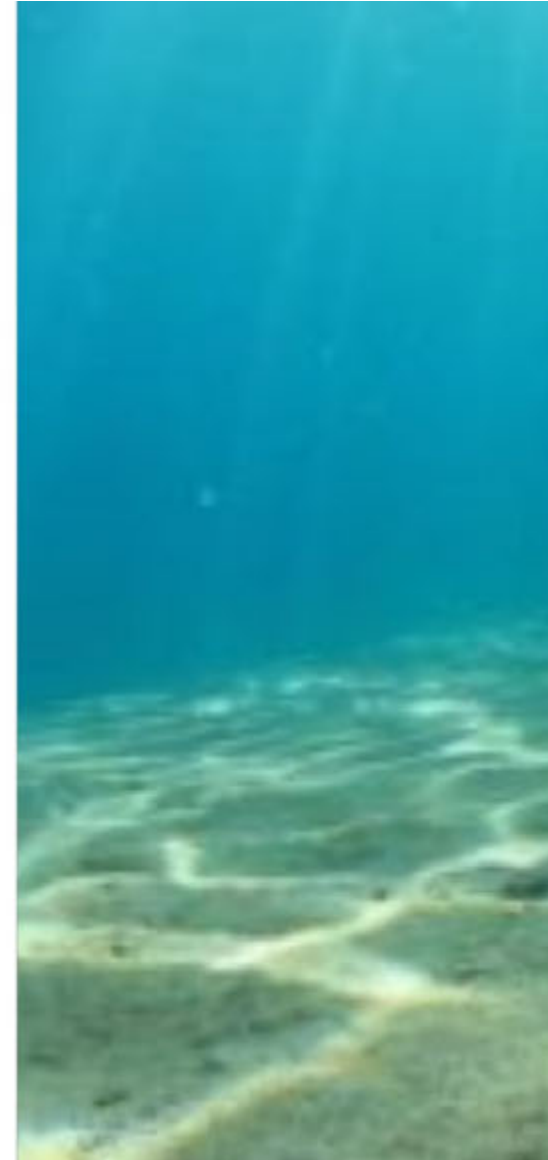
The Sediment Characterization Report

- This is a report that your environmental consultant will prepare, summarizing the results of chemical and biological testing, and including all relevant data and quality control measures.
- The Sediment Characterization Report will be submitted to the DMMO, which will then issue a Suitability Determination.



The Suitability Determination

- The Suitability Determination is a document produced by the DMMO specifying where and how dredged material from each DMMU must be disposed of, as well as any additional required measures. For example, high COC levels in the Z-layer may trigger overdredge, and the placement of required clean sand layer.
- The Suitability Determination will be accompanied by a Recency Determination that will indicate the timespan within which the Suitability Determination will be valid. The recency determination will be dependent upon site characteristics, including which COCs were found to be elevated, and varies from site to site.



Dredged Material Disposal Options

○ Beneficial use

Detected COCs generally must fall below Sediment Quality Standards but can be considered on a case-by-case basis. Sediment size has to be large enough for it to be beneficial, and property ownership issues as well as ESA species on-site will also be considerations.

○ Deep-water disposal

Detected COCs below Sediment Quality Standards, but small grain size, or perhaps no convenient property for beneficial use disposal. The decision between beneficial use and deep-water disposal is site-specific.

○ Upland Disposal

Upland disposal is the most costly option. Upland disposal may be triggered by one-hit or two-hit bioassay results. Opting out of bioaccumulation testing will also result in Upland Disposal. The cost of upland disposal should be weighed against the cost of bioaccumulation testing if chemical analysis shows exceedance of bioaccumulation COC BTs.



Additional Dredging Concerns

- **Contracting with a dredger who best suits your site-specific needs.**

What substrate is present at your site? Will all of the dredging be conducted from the water, or will some be conducted from shore? Do you have docks or other structures that will need to be dredged beneath? Do you have site-specific constraints, like shallow areas in the dredging channel that will limit the kind of dredging equipment that can be used?

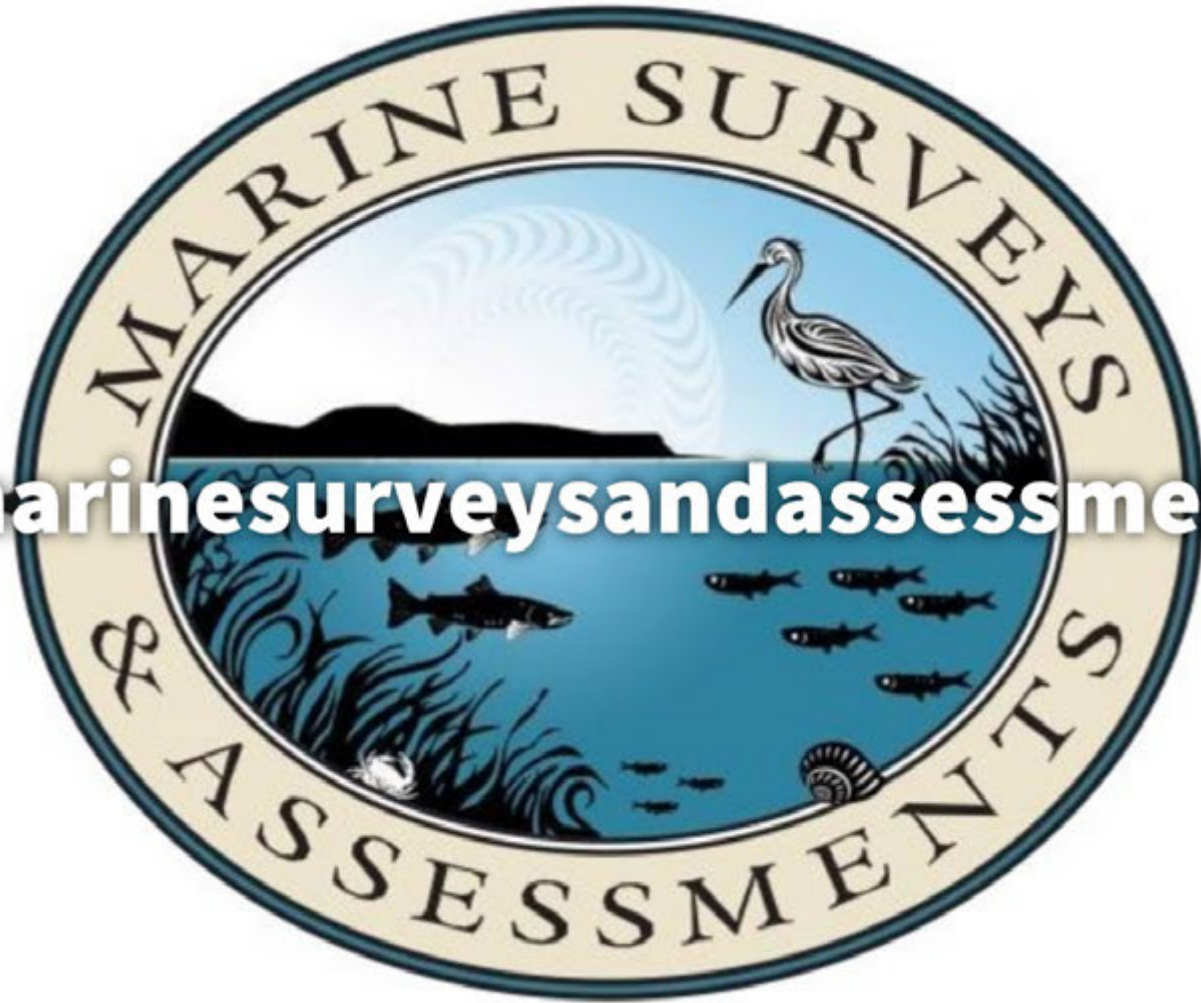
- **Your environmental consultant can also manage your city and/or county permitting processes and the associated documentation and report production.**
- **An coastal engineering firm can design your dredge profiles, and perform bathymetric surveys as required by the DMMO.**



Take-aways

- Choose an environmental consultant early, and work with them to begin planning your dredge several years in advance.
- Consult with the DMMO early and often.
- Retain scientific information and permitting information from all prior dredges.
- Compile information about your site's history, and the land-use history of adjacent areas.
- Ask for XYZ data for all bathymetric and dredge design data, not just images.
- Store all information digitally. Googledrive, or a similar cloud storage system is a good way to retain all relevant documents in an easy-to-share location.





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