

Tiered Approach to Identifying Acceptable Sediment Contaminant Concentrations
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PROBLEM STATEMENT: Sediment can contain concentrations of contaminants that are or appear to be elevated to levels of ecological and/or human health concern. The objectives of remediation efforts are to reduce the level of contaminants to decrease those levels of concern and to levels that will permit restoration of the sediment environment. Assurance that these levels are attained can be accomplished through a tiered process of sediment contaminant evaluation that permits optional acceptance of strict compliance with conservative estimates of ecological or human health risk or additional testing to demonstrate site-specific alternative sediment concentrations that are higher but which also maintain protection of the environment and human health. The following proposed tiered approach is one method that can incorporate early decisions on any individual project while still permitting more involved assessments and demonstration that alternative site-specific sediment concentrations are protective.

Tier 1: Site evaluation consisting of the history of the site including activities and contaminants that were used on the upland or in-water site, history of spill events, and demonstration that there is little “reason to believe” that contaminants are a potential concern at the site. Verify through minimal sampling that these assumptions are correct and that the concentrations of Chemicals of Potential Ecological Concern (COPEC) from the site are at or below one of the following criteria.

1. Equivalent to pre-industrial background – no further assessment required
2. Equivalent to an area wide reference level (comparison to a watershed derived concentration of contaminants). These watershed concentrations may vary from one watershed to another because of natural reasons (provenance of minerals from various watersheds will differ in metals concentrations); watershed contamination from point or area-wide sources that are not associated with the site activities may elevate the contaminant levels at the site in question; regional atmospheric deposition in the area may contribute to elevated levels of some contaminants and again may not be associated with the site in question, etc. In those case, sites where the specific COPEC from the site are not associated with the observations of contaminant levels that are equal to or higher than the area wide reference then no further assessment is required for that site owner. The area is flagged if the contaminants are a non-natural increase for further, broader scale assessment by the State and Federal resource agencies.
3. Equivalent to a site reference value for COPEC that are also associated with the history of the site operations – further assessment is required under Tier 2 or the site owner can remove the sediment and various disposal options can be considered.

Tier 2: Comparison of sediment values to SL and ML values established by WDOE and that have been used in the past to provide confidence that the concentration levels are appropriate for protection of the ecological resources and human health risk. This may also require the use of ‘trigger values’ (proposed or those that may be adopted) for sediment contamination levels that may not be protective

and require further assessment. Sediment chemistry is compared to these values and if the sediment concentrations are equal to or less than SL or ML; follow the guidance that has already been developed and included in SMS guidance for those types of screening level assessments. If the values for sediment chemistry screens are exceeded then proceed to Tier 3 or remove the sediment and consider various disposal options.

Tier 3: Where the conservative guidance values for sediment are exceeded it is possible that the concentrations of the various contaminants are in a chemical or physical state that alters their bioavailability so that the ecological or human health risk objectives for the site are not impacted. Theoretical models of contaminant availability could be used at this point but historically for both Federal and State Guidance sediments of this type generally undergo a series of acute and chronic bioassay tests with sensitive species that are meant to be surrogate species to estimate potential adverse effects under various in-place or disposal options. Successful demonstration of the lack of adverse effects on a suite of test organisms is an acceptable method for demonstrating that the contaminants are less bioavailable and are acceptable to leave in-place or for disposal in areas that permit only sediments that will not have unacceptable adverse effects (e.g., disposal at dispersive offshore disposal sites). Sediment that is determined to be unacceptable based on these direct biological effects needs to be removed and/or isolated to preclude unacceptable biological conditions in the sediment. Sediment that passes this screen will also need to be evaluated under Tier 4 to demonstrate that any potential bioaccumulative contaminants of concern are unavailable for uptake into tissues of Trophic Level 2 benthic organisms to levels of ecological concern.

- Sediment that demonstrates an adverse effect that does not appear to be associated with contaminants of concern may be influenced by other Contributing Factors (CF) to adverse responses of test organisms. It may be important to determine whether those effects are the result of laboratory artifacts or presence of biologically adverse conditions that are associated with non-COPEC materials. Under these conditions it may be appropriate to demonstrate the actual cause of the effect not only for this project specific assessment but also to eliminate those potential issues in the future on other projects. Demonstrating that the hypothesized contributing factor produced the observed effect and that a modification to test procedures can eliminate that effect would be the purpose of a CF assessment under this Tier. Demonstrating that an adverse effect was not associated with COPEC but with a different CF would indicate that the COPEC did not cause the observed responses and that the sediment would be acceptable, assuming the CF was not a substance that was to be controlled.

Tier 4. There are two methods for assessing potential bioaccumulative contaminants of concern. In the first case the concentration of the contaminants can be compared to published Biota Sediment Accumulation Factors (BSAF) for non-polar organic compounds or Bioaccumulation Factors (BAF) for polar compounds to determine the potential for various bioaccumulative contaminants of concern to attain levels that are harmful to Trophic Level 2 organisms. In the second case, body burdens on acceptable representatives of the benthos would be examined. This could be performed on collection of individuals from the field or by performing bioaccumulation tests over acceptable time frames for

the bioaccumulative contaminants of concern in a manner that is consistent with USACE/USEPA guidance developed for assessment of dredged materials for open-ocean and inland water disposal. Either method will provide a direct site-specific assessment of the availability contaminants (providing site-specific BSAF and/or BAF for the selected chemicals). These predictions or direct measurements of contaminant concentrations can then be compared to effects based data (ERED provides summaries of peer reviewed literature on numerous compounds). Uptake to levels that are protective of 95% of the LOED and NOED levels in the ERED data base would be considered protective of direct contaminant related adverse effects to the benthos. Sediment that demonstrates unacceptable uptake of contaminants into these organisms would be expected to have adverse effects on the benthos and would need to be removed or isolated to preclude unacceptable biological conditions. Sediment that passes this screen would also need to be evaluated in Tier 5 to determine potential risk for consumption of prey items with the attained body burdens.

Tier 5. This tier consists of an assessment of the potential for contaminants that bioaccumulate to the level observed or predicted for Trophic Level 2 organisms provided under Tier 4. Because this Tier will be a model between trophic levels it seems reasonable to develop guidance for Tier 2 body burdens that would be acceptable and unacceptable for various trophic and consumption levels. These would be specific for each chemical and provide for levels of home range for the consumer ranging from 100% used of a particular contaminant level to other home ranges based on the particular consumer. Sediment bioaccumulation assessment that provides an acceptable level of body burden for protection of the benthos and associated food webs from unacceptable contaminant levels would be acceptable to leave in place. Sediment that has bioaccumulative substances that are demonstrated and modeled to attain unacceptable levels in the tissues of the benthos and associated food webs would need to be removed or isolated from contact with those biological resources.

Tier 6. Tier 6 is somewhat separate from examining the sediment responses on a project by project basis and is designed to examine the potential source of tissue burdens in higher trophic levels. Tissue body burdens in higher trophic levels would be compared to the bioaccumulation assessments from sediment. The predicted concentration of tissue burdens obtained in higher trophic levels from the Tier 4 and 5 assessment categories may be higher or less than those observed in field captured organisms. The presence of elevated body burdens that exceed the experimentally derived values may be due to a sign that the sediment is only a part of the uptake relationships for the contaminant. Significantly higher tissue levels in the field captured organisms, especially with those of high site fidelity may mean that the sediment contaminants are a small component of the total burden. It may also mean that we have not factored in the expected body burden from longer term exposure or the decreased growth rates observed in older predators. These factors still need to be assessed in order to determine whether we are concentrating on the most appropriate sources of contamination to food webs. It is possible that other sources (water from permitted and non-point sources, atmospheric fall out to the water, etc.) may be the more important pathway for bioaccumulation and food web contamination while the sediments are a more important pathway for direct toxicity to the benthos.

Tier 7. This is a final Tier of assessment that will permit documenting the success of remediation efforts, the level of remediation required to attain a pathway that will eventually succeed in restoring

the ecological 'health' of damaged benthic environments, and to demonstrate the efficacy or lack of improvement resulting from sediment cleanups on decreasing the body burden and reducing higher trophic level and human health risks from exposure to contaminants of concern.