San Francisco District

PUBLIC NOTICE

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US Environmental Protection Agency

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Construction-Operations Division
333 Market Street
San Francisco CA 94105-2197

Water Division, WTR-8
75 Hawthorne Street
San Francisco CA 94105

DMMO Manager: David Dwinell **e-mail:** ddwinell@spd.usace.army.mil **Phone: (415) 977-8471**

Proposed Guidelines for Implementing the Inland Testing Manual within the USACE San Francisco District

The national sediment testing manual entitled *"Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S.- Testing Manual"* was formally adopted by the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (USACE) and released to the public on February 12, 1998. This document, commonly referred to as the "Inland Testing Manual" (ITM), provides guidance for evaluating whether dredged material may be suitable for discharge into waters of the U.S. (such as at designated disposal sites in San Francisco and Monterey Bays). In particular, the ITM includes national guidance for conducting physical, chemical, and biological testing on sediments proposed for dredging and disposal into waters of the U.S. (Proposals for ocean disposal under the Marine Protection, Research, and Sanctuaries Act will continue to be evaluated by EPA and USACE in accordance with the testing guidelines in *"Evaluation Of Dredged Material Proposed For Ocean Disposal – Testing Manual."*

Before the ITM was adopted, dredged material testing in Northern California and the San Francisco Bay had been conducted according to guidance contained in Public Notice (PN) 93-2 (issued jointly by the EPA, USACE, the San Francisco Bay Conservation and Development Commission [BCDC], and the San Francisco Bay Regional Water Quality Control Board [RWQCB]). The ITM substantially updates the sediment testing requirements of PN 93-2, and use of the ITM is being phased-in as follows.

As described in joint San Francisco District USACE and EPA Region 9 Public Notice 98-2, currently permitted dredging projects may continue to follow the testing required at the time of their permit issuance until those permits expire. New permit proposals will begin using the ITM.

Project proponents temporarily proceeding under older testing requirements, as well as new projects using the ITM, should coordinate their proposed SAPs in advance with the EPA Region 9 and USACE San Francisco District (project proponents proposing disposal in San Francisco Bay should contact the Pilot Dredged Material Management Office [DMMO] at the address listed above on the left of the header .)

Nationwide, EPA Regional offices and USACE Division or District offices are expected to prepare local guidance for implementing the ITM in their areas. It is expected that detailed Regional Implementation Manuals (RIMs) will be developed by late 1999. In the meantime, local EPA and USACE offices have been directed to establish "initial local guidelines" for projects that will start using the ITM according to the above schedule. The "initial local guidelines," at a minimum, are expected to identify which bioassay species and which chemical "contaminants of concern" are appropriate to the local situation.

In order to develop appropriate guidelines for implementing the ITM in the San Francisco District, EPA, USACE, BCDC and RWQCB (who, along with the California State Lands Commission, make up the San Francisco Bay DMMO) held two public workshops in San Francisco during the month of May 1998. Staff from the Central Coast Regional Water Quality Control Board (CCRWQCB), the Monterey Bay National Marine Sanctuary (MBNMS), and the California Department of Fish and Game also participated in these workshops. Based in part on comments received at these public

workshops, this Public Notice provides the "initial local guidelines" that EPA Region 9 and the USACE San Francisco District are proposing for dredged material testing and evaluation throughout the San Francisco District. These proposed guidelines, that include the attached pages, also constitute the joint proposal of the Federal and State agencies represented on the DMMO and of the California Coastal Commission, CCRWQCB, and the MBNMS (the latter three organizations are the agencies directly involved in regulating dredged material disposal in the Monterey Bay Area).

These local guidelines *supplement* the much more detailed information in the ITM. Questions about any perceived inconsistencies between the ITM and these local guidelines should be directed to the San Francisco District USACE, EPA Region 9, or (for projects in San Francisco Bay) to the DMMO. Nothing in the ITM or in these local guidelines affects the existing authority of any of the signatory agencies or other resource agencies, or their ability to comment on proposed projects. Similarly, the ITM and these guidelines do not alter current policies governing management of established disposal sites (e.g., monthly and yearly discharge volume targets), or the need to consider alternative disposal sites and methods. Meeting these testing guidelines does not by itself guarantee that a permit to discharge dredged material will be issued, and does not eliminate the need to obtain any other applicable local, state, or federal permits or authorizations.

Copies of the ITM may be obtained by contacting the DMMO. In addition, the ITM may be viewed online via a link at the following World Wide Web location:

http://www.spn.usace.army.mil/conops/dmmo.html

Comments concerning these proposed initial guidelines will be accepted until **August 10, 1999** and should be addressed to the DMMO manager listed on the header of this Public Notice.

Peter T. Grass
Lieutenant Colonel, Corps of Engineers
District Engineer

Alexis Strauss
Acting Director, Water Management Division
Environmental Protection Agency, Region 9

Will Travis
Executive Director
San Francisco Bay Conservation
and Development Commission

Loretta K. Barsamian
Executive Officer
California Regional Water Quality Control Board
San Francisco Bay Region (Region 2)

Roger Briggs
Executive Officer
California Regional Water Quality Control Board
Central Coast Region (Region 3)

Peter Douglas
Executive Officer
California Coastal Commission

William J. Douros
Superintendent
Monterey Bay National Marine Sanctuary

DREDGED MATERIAL MANAGEMENT OFFICE

GUIDELINES FOR USING THE INLAND TESTING MANUAL WITHIN THE USACE SAN FRANCISCO DISTRICT

June 11, 1999

U.S. Environmental Protection Agency, Region IX
75 Hawthorne Street
San Francisco, CA 94105-3919

San Francisco Bay Conservation and Development Commission
30 Van Ness Avenue, Suite 2011
San Francisco, CA 94102-6080

U.S. Army Corps of Engineers San Francisco District
333 Market Street
San Francisco, CA 94105-2197

San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612-1413

California State Lands Commission
100 Howe Avenue, Suite 100-South
Sacramento, CA 95835-8202

1. INTRODUCTION

1.1. The pilot Dredged Material Management Office (DMMO) agencies will apply these guidelines when determining the dredged material testing that will be required for dredging projects proposing disposal at designated sites in waters of the U.S.within the San Francisco District, USACE (see Figure 1), until such time as these guidelines are upgraded or replaced (e.g., by a final Regional Implementation Manual (RIM)). Specifically, the disposal sites include SF9, SF-10, SF-11, SF-12, and SF-14 (see Figure 1.)[1]

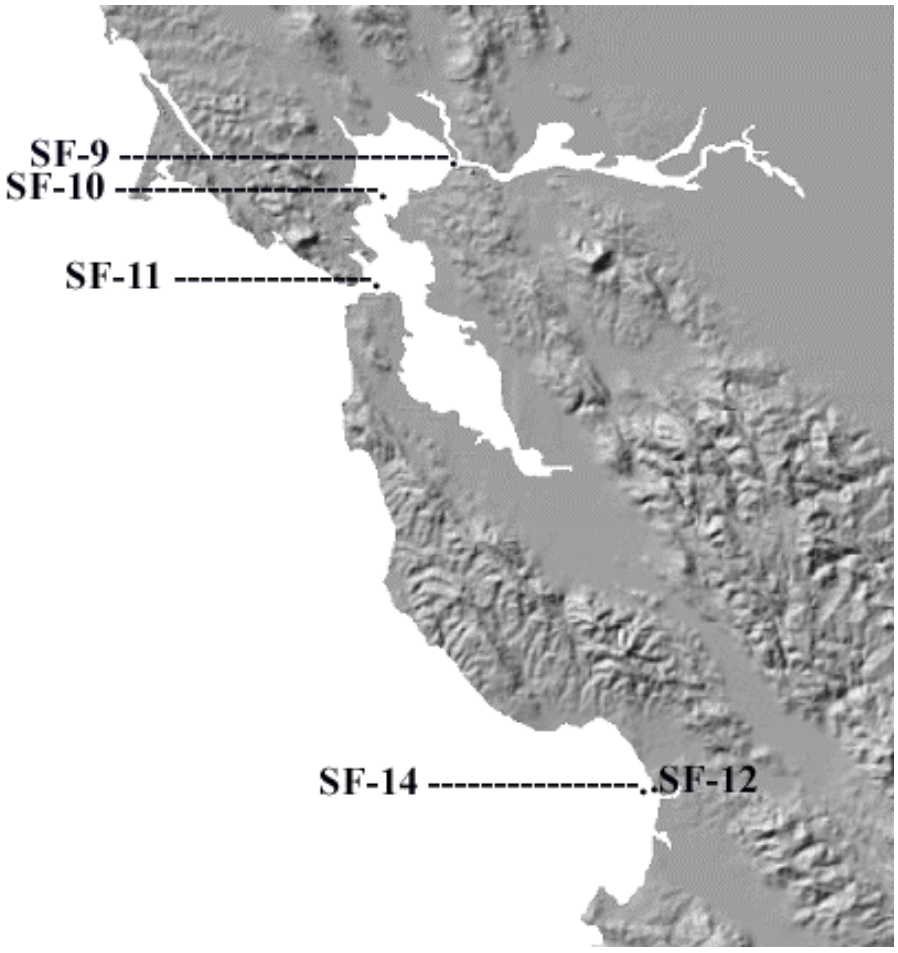

Figure 1. Multi-User Disposal Sites

1.2. These local guidelines *supplement* the much more detailed information in the Inland Testing Manual (ITM), and are not intended to be used on their own. These guidelines do not repeat the detailed descriptions of each of the four tiers that make up the ITM's approach to dredged

[1] The USACE San Francisco District, EPA Region 9, California Coastal Commission, and Central Coast Regional Water Quality Control Board are responsible for regulating proposed discharges of dredged material in Monterey Bay. These agencies will also apply these guidelines and the ITM to such projects.

material evaluation (Chapter 3 of the ITM should be consulted for an overview of the tiered testing and evaluation framework). These guidelines also do not provide technical details about laboratory testing protocols. The ITM, its referenced literature, and any other agency guidance (such as any RIM published in the future) should be consulted for the most up-to-date technical information. Questions about any perceived inconsistencies between the ITM and these local guidelines should be directed to the USACE San Francisco District or to EPA Region 9 (or for San Francisco Bay projects to the DMMO).

2. EXEMPTIONS FROM TESTING, "TIER I" (see ITM, Chapter 4)

2.1 The ITM, and the federal regulation on which it is based, provide for the possibility of an exemption from the need to conduct testing on proposed dredged material in certain specific circumstances. The regulatory agencies will determine whether the following potential exemptions may apply in individual cases.

2.2. First, material may be excluded from testing *"¼ where it is composed primarily of sand, gravel, or other naturally occurring inert material ¼ in areas of high current or wave energy such as streams with large bed loads or coastal areas with shifting bars and channels."* [40 CFR §230.60(a)] Such material is unlikely to be a "carrier of contamination", especially when it is isolated from sources of pollution. Examples include material from the San Francisco Channel Bar and pre-industrial deposits of Merritt Sand in San Francisco Bay that have not been exposed by previous dredging projects. Unfortunately, much of the area's dredged material is composed of very fine particles and does not qualify for this exemption.

2.3. Second, even if the material does not meet the regulatory exclusion noted above due to either grain size or proximity to possible sources of pollution, additional testing may not be needed. This can be true if adequate data from previous testing in the area are available to establish that discharge of the material is unlikely to result in an unacceptable adverse impact on the aquatic ecosystem. For example, where several years of past data show that the material has consistently met current suitability guidelines, the agencies may determine that additional testing is not needed. Consistent with the tiered testing approach, on which the ITM is based, the agencies may require limited "confirmatory" testing before making such a determination.

2.4. If the agencies determine that Tier I exemption from testing does not apply, project-specific evaluations including both chemical and biological testing should be conducted in accordance with the ITM and the following sampling and testing guidelines.

2.5. Proposals to use results of testing methodologies that differ from those described in the ITM and these guidelines will be considered by the agencies on a case-by-case basis, and should be approved in advance. All applicable Quality Control (QC) procedures should be reported. The ITM discusses these issues in some detail. The DMMO is developing a Sampling and Analysis Plan (SAP)[2] guideline for San Francisco District projects that, when available, will provide additional sampling, testing, and reporting recommendations to further supplement the ITM and these guidelines. Contact the DMMO about availability of the SAP guidelines.

[2] A SAP is also known in current terminology as a Quality Assurance Project Plan (QAPP). We will continue to refer to the document as a SAP until some undetermined time when we will change to QAPP.

3. SAMPLING GUIDELINES (see ITM, Chapter 8)

Chapter 8 of the ITM should be consulted for a detailed discussion of sediment sampling considerations. Additional agency recommendations that are specific to implementation of the ITM in the San Francisco District are provided below.

3.1. *Minimum Sediment Sampling*

Table 1 outlines the *minimum* number of sediment samples that should be collected, and composites that should be analyzed. Generally, a minimum of four samples are needed for one composite. Every dredging project is unique, and this minimum sampling guidance may not be accepted by the agencies as adequate in individual circumstances. Additional samples or analyses may be needed based on the results of past testing or the presence of known or suspected pollution sources. Proposed SAPs should be coordinated with the agencies before any sampling or testing begins. The test results from non-approved SAPs may not provide sufficient information for the agencies to make a determination and may require re-testing that would cause project delays. It is the applicant's responsibility to obtain approval of proposed sediment testing in advance of sampling.

TABLE 1. Minimum Sediment Sampling Guidelines *

DREDGE VOLUME (*in situ* cubic yards)	MINIMUM # OF SAMPLE STATIONS **	# OF COMPOSITES ANALYZED **
5,000 – 20,000	4	1
20,000 – 100,000	8	2
100,000 – 200,000	12	3
200,000 – 300,000	16	4
300,000 – 400,000	20	5
400,000 – 500,000	24	6

- * Contact DMMO for guidance on projects smaller than 5,000cy or larger than 500,000cy.
- ** Numbers do not reflect reference and control sediments, or other QC samples.

3.2. *Core Sample Location and Depth*

3.2.1. In addition to collecting the appropriate number of sediment samples, the locations of the samples and the depths to which they are taken must be appropriate. Samples must be representative of the sediment proposed to be dredged in terms of volume, differences in sediment type, and pollutant sources across the dredging area. Proposed core sample locations should be identified in the proposed SAP and approved by the agencies in advance.

3.2.2. Core samples should be taken to the full project depth, plus the permitted overdepth allowance (generally 2 feet below project depth). The full permitted overdepth allowance must be sampled, even if it differs from the "pay depth" identified in a dredging contract.

3.2.3. SAPs should also describe reference and control sediment sampling locations and methods. Contact EPA Region 9 or USACE San Francisco District (or DMMO for San Francisco Bay projects) for information about reference sediment collection sites for SF-9, SF-10, SF-11, SF-12, and SF-14.

3.3. ***Sediment Sample Compositing***

3.3.1. Compositing, i.e., combining several sediment cores into a single sample, is often allowed for testing purposes. Careful consideration must be given to the compositing scheme for any project. Sediment samples should only be composited together when:

- they are from contiguous portions of the project area,
- there is reason to believe that sediment throughout that portion of the project area is similar and is exposed to the same influences and pollutant sources, and
- the total volume represented by the composited samples is generally in accord with the minimum sampling guidelines in Table 1.

3.3.2. If variability in contamination is suspected with depth in the sediment or where multiple geologic strata are proposed to be dredged, the agencies may direct that core samples be subdivided for compositing and analysis of separate layers. When individual core samples are found to contain distinct layers that were not previously expected, the layers should also be separated for individual testing (or at least sub-samples of each layer should be archived for possible later analysis).

3.3.3. Proposed compositing schemes should be identified in the SAP and discussed in advance with the agencies. Compositing schemes should be reported and the rationale used fully described.

3.3.4. Sediment composites should comprise a sufficient volume for conducting all of the physical, chemical, and biological testing, including any QC analysis.

3.3.5. Table 8-1 in the ITM (*"Type of Samples Which May Be Required Following Tier I to Conduct* Dredged-Material *Evaluations"*) summarizes the types of tests for which water, sediment, and tissue samples may need to be collected. Table 8-2 in the ITM (*"Summary of Recommended Procedures for Sample Collection, Preservation, and Storage"*) lists appropriate collection methods, sample volumes, preservation and storage techniques, and holding times for the various analyses of sediment, water, and tissue samples. Any proposed modification or substitution of the listed methods must be described in detail in the proposed SAP and approved by the agencies in advance.

3.3.6 The amount of material from each core included in the composite sample shall be proportional to the length of the core (or cores if more than one core was necessary to secure adequate volume).

4. SEDIMENT PHYSICAL AND CHEMICAL EVALUATIONS, "TIER II" (see ITM, Chapters 5 and 9)

4.1. Physical and chemical analyses are conducted on each composite sediment sample. Better information is obtained, and can allow for more decision-making options, when individual core samples are also evaluated. When a composite "fails" some aspect of the testing, and individual core data are available, the agencies can sometimes determine that sub-areas are suitable for unconfined aquatic disposal (SUAD) without further sampling and evaluation.

4.2. Routine sediment physical and chemical analyses should be performed for the list of characteristics in Table 2. On a case-by-case-basis, the agencies may determine that additional characteristics of concern must be analyzed. The agencies may also approve the deletion of some of the characteristics listed in Table 2 for individual projects. Proposals to use analytical methods or reporting limits different from those listed in Table 2 must be approved by the agencies in advance. The agencies may otherwise not have sufficient information to make a determination which may then result in expensive re-sampling, re-analysis, or project delays.

- A Word About Limits -

Laboratory reporting limits (RL) must be set to not less than the minimum level (ML) as defined in EPA's draft Guide to Method Flexibility and Approval of EPA Water Methods dated December 1996. The definition of ML is: "The lowest concentration at which the entire analytical system must give a recognizable signal and acceptable calibration point for an analyte. It is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method-specific sample weights, volumes, and processing steps have been employed." Method detection limits (MDL) must be established as defined in 40 CFR Part 136, Appendix B. Values < MDL will be reported as not detected (ND) or < [value of MDL]. Values ≥ MDL and ≤ RL will be qualified with the "J" character as estimates. Values > RL will be reported without qualification unless required because of QC problems.

5. BIOLOGICAL EVALUATIONS, "TIER III" (see ITM, Chapters 11 and 12)

Three types of biological evaluations may be required for routine dredging projects in the San Francisco District: water column toxicity tests, benthic toxicity tests, and benthic bioaccumulation tests. Issues specific to performing each of these evaluations for dredging projects are summarized in the following sections. The need to conduct any of the biological tests will vary from project to project based on factors such as the degree or type of known or suspected contamination. Proposed SAPs should therefore be coordinated in advance with the agencies. The chemical analyses of tissues from bioaccumulation tests are conducted for the list of characteristics listed in Table 3.

5.1. *Water Column Toxicity Testing*

5.1.1. Water column toxicity testing is discussed in detail in Section 11.1 of the ITM. In these tests, an "elutriate" is prepared from dredged material and appropriate sensitive organisms are exposed to four concentrations of the elutriate.

5.1.2. The ITM recommends that three species representing different phyla be tested. This is one area where the agencies have determined that routine sediment testing for San Francisco District dredging projects proposing disposal at the existing sites, may appropriately differ from the nation-wide guidance presented in the ITM. Specifically, the agencies have determined that the water column is not a significant contaminant exposure pathway for typical dredging projects using the SF-9 (Carquinez Strait), SF-10 (San Pablo Bay), SF-11 (Alcatraz Island), SF-12 (Moss Landing [Off end of Sandholdt Pier]), and SF-14 (Moss Landing) disposal sites. This

determination is based on the hydrologic characteristics of the designated disposal sites, and on more than ten years of water column toxicity testing associated with area dredging projects during which acute water column toxicity has rarely been indicated after taking into account initial mixing. Tripling the number of water column toxicity tests required for routine dredging projects would provide little additional meaningful information for decision making, and would not be in keeping with the Long Term Management Strategy (LTMS) goals to conduct dredging and disposal in the Bay area in an economically and environmentally sound manner.

5.1.3. A single water column bioassay will generally be adequate for determining compliance with the State of California's narrative water quality standard. Results of the water column bioassay combined with the results of the benthic and bioaccumulation bioassays, provides for comprehensive characterization of sediment toxicity and allows for consistent decision making (see "Interpreting Sediment Test Results," below).

5.1.4. In some circumstances, the water column may be determined to be an important exposure pathway of concern. An example is where the discharge is proposed in a location with limited water circulation. It could also be true in the case of a relatively continuous, long-term discharge (e.g., where dredged material is being used for large-scale fill, such as for construction of a new shipping terminal). In such cases, the agencies may require additional species for water column testing, as described in the ITM.

5.1.5. A single water column bioassay must be conducted with one of the national "benchmark" species listed in Table 11-1 of the ITM. The species used should be appropriate to the salinity conditions under which the bioassay is run. For typical area projects, recommended test species include echinoderm or bivalve larvae, larval development tests, or Mysid shrimp. (Note: the echinoderm "sperm fertilization" bioassay is NOT recommended).

5.1.6. Water column toxicity tests are conducted using a minimum of four elutriate concentrations (100%, 50%, 10%, and 1%), in addition to laboratory control water (0% elutriate). Five replicates of each concentration should be tested. Endpoints in this bioassay are mortality and abnormal development (separate counts for each are to be reported). Both LC_{50} and EC_{50} values are to be calculated and reported. Data should be analyzed as recommended in paragraph 11.1.5 of the ITM (see appendix D of the ITM). Counts for abnormal larvae and calculated mortalities are to be added (i.e., it is assumed that abnormal larvae will not survive) when evaluating whether control survival is acceptable (>70 percent) and when calculating LC_{50} concentrations. The abnormality counts are to be used for calculating EC_{50} values. A reference toxicant bioassay must also be conducted at the same time and using the same population of test organisms. To be acceptable, the LC_{50} and EC_{50} values from the reference toxicant bioassay must be documented as being within two standard deviations of the laboratory mean response for that species using the Cusum control chart technique described in *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms*, Fourth Edition (EPA/600/4-90/02F, August 1993).

5.1.7. Results of water column toxicity tests are used to determine whether elutriate concentration outside the mixing zone would exceed 1% of the LC_{50}. If so, the State of California narrative water quality standard is not met, and the material represented by that sample is not suitable for unconfined aquatic disposal (NUAD) at the proposed site (also see

"Interpreting Sediment Test Results", below) without some sort of management action or contaminant control measures. The State and USACE are developing appropriate mixing zone limits. Applicants will use the STFATE model to present data estimating concentration gradients following open water disposal.

5.2. ***Benthic Toxicity Testing***

5.2.1. Benthic toxicity testing, as described in ITM Section 11.2, involves exposing test organisms to the bulk (or solid phase) dredged material, as well as to the appropriate reference and control sediment for comparison. Table 11-2 of the ITM lists a number of appropriate species for use in benthic toxicity tests. As discussed in Section 11.2 of the ITM, benthic toxicity tests are to be conducted using a minimum of two species. Two species are adequate if, together, they represent the following three "life history stages:"

- Filter feeder
- Deposit feeder
- Burrower

5.2.2. For example, the amphipod crustaceans listed in ITM Table 11-2 are both burrowers and deposit feeders, while the Mysid shrimp listed are filter feeders. Therefore, the use of an amphipod and a Mysid shrimp could satisfy the benthic bioassay species requirements. Use of the amphipod *Ampelisca* (also a filter feeder) coupled with a polychaete worm such as *Neanthes* or *Nephtys* (which are both burrowers and deposit feeders) would also satisfy the benthic bioassay species requirements.

5.2.3. An amphipod must be one of the species tested in all cases. For typical San Francisco District area projects, the agencies specifically recommend that either *Rhepoxynius abronius, Ampelisca abdita*, or *Eohaustorius estuarius* be used, depending on the specific sediment conditions encountered (each species has different requirements and tolerances for salinity, grain size, etc.), along with a polychaete worm or Mysid shrimp. Proposals to use alternative amphipod species will be considered and must be approved by the agencies in advance. Table 11-2 of the ITM lists only a single polychaete species (*Neanthes arenaceodentata*). The species *Nephtys caecoides* has also been used extensively in sediment bioassays throughout the West Coast, including the San Francisco District. Either species may be proposed for use in dredged material benthic acute toxicity bioassays in this region.

5.2.4. When conducting benthic toxicity tests, special care must be taken to ensure that confounding factors (including anomalous ammonia and sulfide toxicity) do not influence the results. Direct measurement of *interstitial* concentrations of ammonia, salinity, and sulfides must be made prior to the initiation of the benthic bioassays and, if necessary, adjusted to below the species-specific thresholds given in the ITM on page 11-13. The agencies strongly recommend that interstitial total ammonia be no more than 15 mg/L at test initiation whenever possible. Water in the laboratory aquaria above the sediment must also be monitored for the characteristics listed in Table 4.

5.2.5. The number of replicates for the species listed in Appendix E of the ITM should be tested for each composite sediment sample, and for reference and control sediments. The endpoint in benthic acute toxicity testing is mortality (in the case of amphipods, mortality, and reburial).

Results are compared to reference sediment results tested at the same time and using the same population of test organisms. Data should be analyzed as recommended in paragraph 11.2.4 of the ITM (see appendix D of the ITM). When acute toxicity is indicated, the material represented by that sample is normally NUAD at the proposed site. Generally, acute toxicity is indicated when mortality in the test sediments is both statistically significant and at least 10% absolute (20% absolute for amphipods) greater than that in the reference sediment (see "Interpreting Sediment Test Results," below).

5.3. *Benthic Bioaccumulation Testing*

5.3.1. Section 12.1 of the ITM describes bioaccumulation testing procedures. Routine bioaccumulation testing involves 28-day exposures of appropriate benthic organisms to the bulk (or solid-phase) dredged material. The degree to which contaminants accumulate in the tissues of the test organisms is compared to similar results for exposure to reference and control sediments and other indicators of risk. Bioaccumulation testing will be required by the agencies when concentrations of potentially bioaccumulative or biomagnifying compounds are known or suspected to be present in the sediments at concentrations of concern. Where there is sufficient existing information or confirmatory chemistry data to indicate that such compounds are unlikely to be present at concentrations of concern, the agencies may determine that bioaccumulation testing is not needed. One tool that the agencies use to determine if bioaccumulation testing is required is Theoretical Bioaccumulation Potential (TBP; see ITM Section 10.2). TBP provides an indication of the magnitude of bioaccumulation of potential contaminants that might result from exposure to the proposed dredged material. TBP is calculated using bulk sediment chemistry results and total organic carbon measurements and assumptions regarding organism lipid content and biota sediment accumulation factors. TBP usefulness is limited in that it can only be calculated for non-polar organics, such as chlorinated hydrocarbons, PCBs, and many PAHs. TBP cannot be estimated for metals, metal compounds, organic acids, salts, or organometallic complexes.

5.3.2. Not all contaminants that are routinely measured in dredged material samples (Table 2) are of concern for bioaccumulation. Fewer still have the potential to biomagnify. As discussed in the ITM, highly lipophlic organic compounds (defined as those having a log octanol-water partition coefficient [K_{OW}] > 3.5) may be of concern for bioaccumulation. When organic compounds with a K_{OW} of 3.5 or higher (e.g., see ITM Table 9-5) are present at elevated levels in dredged material samples, the agencies may require bioaccumulation testing. For inorganic compounds, the ITM recommends bioaccumulation evaluation when compounds have calculated bioconcentration factors (BCFs) greater than 3 are present at elevated levels (e.g., ITM Table 9.6). More information about contaminants of concern for bioaccumulation is contained in ITM Section 9.5.

5.3.3. Table 3 of these guidelines lists a number of bioaccumulative compounds that are often found in area sediments, and that the agencies would typically identify as contaminants of concern for bioaccumulation testing. The agencies may require analysis of additional compounds or only a subset of this list, based on project-specific factors such as proximity to past or present pollutant sources or previous testing data in the area.

5.3.4. When bioaccumulation testing is determined to be necessary, a minimum of two species will normally be required. Table 12-1 of the ITM lists appropriate species for benthic

bioaccumulation tests conducted under various salinity conditions. For typical San Francisco District projects, the agencies recommend that either of the polychaetes *Neanthes arenaceodentata* or *Nereis virens* be used, along with the deposit-feeding clam *Macoma nasuta*. Other species from ITM Table 12-1 may be proposed but must be approved by the agencies in advance. The number of replicates in Appendix E of the ITM should be tested for each composite sediment sample, and for reference and control sediments. Routine bioaccumulation tests use 28-day exposures; however, for some compounds the 28-day results are adjusted to estimate steady-state bioaccumulation levels.

5.3.5. Bioaccumulation testing is expensive and time consuming, and the agencies' intent is to require it only where elevated levels of bioaccumulative compounds are known or suspected. To reduce costs and increase predictability while remaining environmentally protective, the agencies hope in the future to develop numeric "bioaccumulation trigger" values, similar to those used in the Pacific Northwest, to identify when bioaccumulation testing must be conducted. Absent such numeric values for the San Francisco District, bioaccumulation testing costs may still be minimized by careful design of the SAP and close coordination with the agencies and the testing laboratory.

5.3.6. Ideally, a separate confirmatory physical and chemical survey would be conducted throughout the dredging area first, to serve as the basis for up-front decisions both about the most efficient compositing scheme for the toxicity bioassays, and about which composites need bioaccumulation testing. The area would then be re-sampled and only the necessary biological tests run. When a staged sampling program of this type is not feasible, it may be possible to expedite completion of the bulk sediment chemistry results and discuss them with the agencies prior to *initiating* the bioaccumulation bioassays. (For this to work, however, the chemical analyses must be completed and the results discussed with the agencies within the maximum 8-week sediment holding time for initiating the bioassays. Otherwise, the areas for which bioaccumulation testing is indicated would have to be re-sampled.)

5.3.7. When these approaches are not possible, the agencies recommend that the bioaccumulation tests be initiated at the same time as the other bioassays, using one of the following approaches. The choice of approach depends on the dredging project proponent's plans and priorities, and the laboratory's capability to expedite data availability. These approaches can still reduce testing costs, by avoiding analysis of tissues from bioaccumulation tests of sediment composites that do not have elevated levels of contaminants or that may have already "failed" other aspects of the testing program.

- Initiate the bioaccumulation tests on all composites concurrent with the other bioassays, and expedite completion of the bulk sediment chemistry results. Review the chemistry results with the agencies prior to completion of the bioaccumulation tests, completing the tests and analyzing tissues only for those composites indicated by the agencies.
- Initiate the bioaccumulation tests on all composites concurrent with the other bioassays, and complete the exposures but preserve (freeze) the tissues for possible later analysis at the direction of the agencies, after the results of the sediment chemistry and other bioassays have been reviewed.

5.3.8. Results of benthic bioaccumulation tests are reported as wet weight tissue concentrations

of the contaminants of concern. Percent lipid content of the test organisms must also be measured. Bioaccumulation test results are compared with the results of the reference sediment bioaccumulation exposure, as well as with other indicators of human health or environmental risk (see "Interpreting Sediment Test Results," below).

6. CASE-SPECIFIC EVALUATIONS, "TIER IV" (see ITM, Chapters 7, 11 and 12)

6.1. For the majority of San Francisco District dredging projects, the routine physical, chemical, and biological evaluations described above that comprise Tiers I, II, and III of the ITM's testing framework will provide adequate information to evaluate the potential effects of a proposed discharge. In unusual cases where routine testing does not generate sufficient information, more comprehensive case-specific evaluations may be required by the agencies. "Tier IV" case-specific evaluations may entail, for example:

- More intensive (high resolution) sampling and analysis;
- Project-specific computer modeling;
- Steady-state bioaccumulation testing;
- Bioassays using additional species or endpoints (such as chronic endpoints);
- Field surveys of biological communities;
- Project-specific risk assessment; or
- Other case-specific assessments as directed by the agencies

6.2. Tier IV involves case-specific, state-of-the-art evaluations. In all cases where Tier IV assessment is required, the details of the proposed assessment (such as field and laboratory methodologies, sampling locations, and model inputs) must be approved in advance.

7. INTERPRETING SEDIMENT TEST RESULTS

7.1. The sediment testing program outlined above provides for a comprehensive, environmentally protective, yet cost effective evaluation of potential adverse effects that may be associated with the routine discharge of dredged material at established open water disposal sites within the San Francisco District. Sediment samples should "pass" each of the applicable physical, chemical, and biological tests in order to be considered SUAD. Unlike the previous testing program for the District under joint Public Notice 93-2, this ITM-based testing program is more comprehensive and allows for decision making to be somewhat more flexible. Specifically, this ITM-based program fully considers all relevant contaminant exposure pathways of concern by incorporating results from multiple benthic bioassays. The agencies can follow a "preponderance of the information" approach to data interpretation, as opposed to the rigid application of the benthic toxicity guideline necessitated by the single-species approach in PN 93-2. A higher degree of response is needed to indicate a "failure" in an individual benthic acute toxicity bioassay if all other test results are within acceptable ranges; whereas lower degrees of response indicate "failure" when there are multiple indicators of potential adverse effect.

7.2. The following sections list the general interpretive criteria the agencies will follow when evaluating sediment test results for routine projects within the San Francisco District. On a project-specific basis, the agencies may deviate from these general interpretation guidelines. This may occur based on project size (greater disposal volumes may translate into a greater risk of

adverse impact), confidence in the test results, unrepresentative sampling, confidence in quality control procedures or results, or when results are not based on a pre-approved SAP.

7.3. *Sediment Chemistry, and Water Quality Standards Compliance*

7.3.1. Numeric water quality standards and criteria must be met in all cases. This requirement is not changed by the results of any of the other tests. Compliance with numeric water quality criteria is confirmed by modeling worst case concentrations (after initial mixing) assuming 100 percent solubility of chemical constituents in the bulk sediment. To date, no final sediment quality standards or criteria have been promulgated that are applicable to dredged material disposal in California. When any applicable sediment quality standards or criteria are established, compliance with them will likely be based on a direct (normalized) comparison with the bulk sediment chemistry values. Even if Sediment Quality Criteria (SQC) are available, compliance with Water Quality Criteria (WQC) must still be demonstrated.

7.3.2. Material represented by any sediment sample that would cause a numeric water quality standard or criterion to be exceeded (after allowing for applicable initial mixing), is by definition NUAD at the existing San Francisco District disposal sites. Any discharge permit for such material must include appropriate management restrictions that adequately address the particular contaminant(s) and exposure pathway(s) of concern.

7.4. *Water Column Toxicity Bioassay, and Water Quality Standards Compliance*

7.4.1. The state's narrative water quality standard (no discharges of "toxic materials in toxic amounts") must also be met in all cases. This need is not modified by the results of any of the other sediment tests. Compliance with the narrative water quality criterion is determined by evaluating whether the elutriate concentration, after initial mixing, would exceed 1% of the lowest of the LC_{50} or EC_{50} from the water column toxicity bioassay.

7.4.2 Material represented by any sediment sample that causes the narrative water quality standard to be exceeded (after allowing for initial mixing) is defined as NUAD. Such material will not be approved for discharge at the existing San Francisco District disposal sites unless appropriate management restrictions that adequately address the particular contaminant(s) and exposure pathway(s) of concern are included in any permit.

7.5. *Benthic Toxicity*

7.5.1. Survival in benthic control sediments must be at least 90% (85% for *Ampelisca)* to be an acceptable point of comparison and assure acceptable test conditions. Survival of less than 90% (85% for *Ampelisca*) in control sediment will result in the agencies rejecting results and requiring re-testing. Mortality in a test sediment composite that is both statistically significant and at least 10% absolute (20% absolute for amphipods) greater than that in the reference sediment is considered to indicate acute toxicity. When acute toxicity is indicated, the material represented by that sample is defined to be NUAD at the proposed site. When reference survival is less than 85% the agencies may require re-testing to confirm the reference results. Applicants should immediately consult with the agencies if survival in reference samples is less than 85%.

7.5.2. This (10% or 20%) acute toxicity threshold is modified somewhat when the agencies determine that none of the other sediment physical, chemical, or biological tests indicates a significant potential for adverse effect. This could occur when the sediment chemistry is not

generally elevated with respect to reference or background conditions, the water column bioassay shows a relatively high LC_{50} or EC_{50}, there is no substantial bioaccumulation (if tested), and survival of the other benthic species is high. In such a circumstance, the sediment tested generally will be considered NUAD when mortality in the one benthic toxicity test showing a positive response is statistically significant and at least 15% absolute (30% absolute for amphipods) greater than that in the reference sediment.

7.6. ***Benthic Bioaccumulation***

7.6.1. Results of benthic bioaccumulation tests are compared first with FDA Action Levels, if available, for the contaminants of concern specified by the agencies for the individual project. Material represented by a tissue sample that exceeds any FDA action limit is defined as NUAD. Where FDA Action Levels are not exceeded, or if the contaminants of concern include compounds for which no FDA Action Level has been established, bioaccumulation test results are compared with reference sediment results, and with other indicators of human health or environmental risk. These indicators may include, but are not limited to, state fish advisories, cancer, and non-cancer risk models, literature concerning tissue residue effects, and local ambient fish data.

7.6.2. Other than FDA Action Levels, there are currently no nationally established numeric criteria for interpreting bioaccumulation test results. Decisions made based on bioaccumulation results are project specific and are based on best professional judgement of agency personnel. Risk assessment concepts may be applied, and in some cases a formal risk assessment may be required, depending on factors such as the particular contaminant of concern, project size, proposed disposal location and timing, and practicability of other alternatives such as ocean or upland disposal or beneficial reuse. Section 6.3 of the ITM discusses interpretation of bioaccumulation in more detail.

8. FURTHER INVESTIGATION OF SEDIMENTS THAT ARE NUAD

8.1. When a sediment sample does not "pass" the relevant testing requirements outlined above, the dredged material represented by it is considered NUAD. When the agencies identify dredged material to be NUAD, the applicant may choose one of the following courses of action:

- Dredge the NUAD material and dispose of or reuse it at an appropriate permitted upland or confined location;
- Dredge only those portions of the project that are SUAD (note: in some circumstances, leaving NUAD material in place may not be appropriate) or
- Propose to conduct a more intensive evaluation of the area identified as including the NUAD material in order to identify the maximum volume of SUAD that may be present.

8.2. More intensive investigation of an identified area of concern does not necessarily imply a Tier IV evaluation. Rather, it is common for project proponents to conduct higher resolution sampling and analysis in areas that "fail" based on the initial testing scheme. This approach is aimed at determining whether the area in question contains a "hot spot" that caused the original composite to fail, and at identifying any SUAD material in the area. Depending on project-specific circumstances, higher resolution sampling and analysis may entail:

- Analyzing sediment chemistry in individual cores archived from the original sampling event.
- Performing sediment chemical analyses based on high-resolution re-sampling near suspected pollutant sources (such as storm drains, other outfalls, or fuel docks) in addition to analyzing cores from original locations.
- Performing higher-resolution biological testing on multiple smaller composites divided (vertically or horizontally) from the original "failed" composite.

8.3. Higher-resolution testing can often be limited to the specific contaminants or bioassay organisms indicated as being of concern based on the original testing. Every project is unique, and what would be considered adequate further evaluation in one case may not be adequate in another. All proposals for higher-resolution testing should therefore be based on a new proposed SAP, and coordinated with the agencies in advance.

REFERENCES.

The following references shall be used in place of the references in the ITM. (See ITM, Chapter 13).

APHA, *Standard Methods* for *the Analysis of Water and Waste Water*, 19th edition.

ASTM D 2487-93, Standard *Classification of Soils for Engineering Purposes (Unified Soil Classification System)*

ASTM E 724-94, *Standard Guide for Conducting Static Acute Toxicity Tests Starting with Embryos of four Species of Saltwater bivalve Molluscs*

ASTM E 729-96, *Standard Guide for Conducting Acute Toxicity Tests on Test Materials with Fishes, Macroinvertebrates, and Amphibians*

ASTM E 1022-94, *Standard Guide for Conducting Bioconcentration Tests with Fishes and Saltwater Bivalve Mollusks*

ASTM E 1391-94, *Standard Guide for Collection, Storage, Characterization, and Manipulation of Sediment for Toxicological Testing*

ASTM E 1463-92, *Standard Guide for Conducting Static and Flow-Through Acute Toxicity Tests with Mysids from the West Coast of the United States*

ASTM E 1562-94, *Standard Guide for Conducting Acute, Chronic, and Life-Cycle Aquatic Toxicity Tests with Polychaetous Annelids*

ASTM E 1688-97a, *Standard Guide for Determination of the Bioaccumulation of Sediment-Associated Contaminates by Benthic Invertebrates*

ASTM E 1850-97, *Standard Guide for Selection of Resident Species as Test Organisms for Aquatic and Sediment Toxicity Tests*

Table 2. Routine Sediment Physical and Chemical Evaluation

Characteristic		Reporting Limit*
Total Solids [TS](%)		0.1
Total Organic Carbon [TOC](%)		0.1
Grain Size (%)		0.1
Metals (mg/kg)		
Element	CAS No.	
Arsenic	7440-38-2	2.0
Cadmium	7440-43-9	0.3
Chromium	7440-47-3	5.0
Copper	7440-50-8	5.0
Lead	7439-92-1	5.0
Mercury	7439-97-6	0.02
Nickel	7440-02-0	5.0
Selenium	7782-49-2	0.1
Silver	7440-22-4	0.2
Zinc	7440-66-6	1.0
Butyltins (µg/kg)		10 each compound
Monobutyltin		
Dibutyltin		
Tributyltin		
Tetrabutyltin		
Total Butyltins		

Table 2. Routine Sediment Physical and Chemical Evaluation

Characteristic		**Reporting Limit***
PAHs (µg/kg)		
Compound	CAS No.	20 each compound
Acenaphthene	83-32-9	
Acenaphthylene	208-96-8	
Anthracene	120-12-7	
Benzo(a)anthracene	56-55-3	
Benzo(a)pyrene	50-32-8	
Benzo(b)fluoranthene	205-99-2	
Benzo(g,h,i)perylene	191-24-2	
Benzo(k)fluoranthene	207-08-9	
Chrysene	218-01-9	
Dibenzo(a,h)anthracene	53-70-3	
Fluoranthene	206-44-0	
Fluorene	86-73-7	
Indeno(1,2,3-cd)pyrene	193-39-5	
Naphthalene	91-20-3	
Phenanthrene	85-01-8	
Pyrene	129-00-0	
Total PAHs		

Table 2. Routine Sediment Physical and Chemical Evaluation

Characteristic		Reporting Limit*
Pesticides (µg/kg)		
Compound	CAS No.	
Aldrin	309-00-2	2 each compound
α-BHC	319-84-6	
β-BHC	319-85-7	
δ-BHC	319-86-8	
γ-BHC (Lindane)	58-89-9	
Chlordane	57-74-9	
2,4'-DDD	53-19-0	
4,4'-DDD	72-54-8	
2,4'-DDE	3424-82-6	
4,4'-DDE	72-55-9	
2,4'-DDT	789-02-6	
4,4'-DDT	50-29-3	
Total DDT		
Dieldrin	67-57-1	2 each compound
Endosulfan I	959-98-8	
Endosulfan II	33213-65-9	
Endosulfan sulfate	1031-07-8	
Endrin	72-20-8	
Endrin aldehyde	7421-93-4	
Heptachlor	76-44-8	
Heptachlor epoxide	1024-57-3	
Toxaphene	8001-35-2	20

Table 2. Routine Sediment Physical and Chemical Evaluation

Characteristic		Reporting Limit*
PCBs (µg/kg)		20 each Aroclor
Aroclor 1242	53469-21-9	
Aroclor 1248	12672-29-6	
Aroclor 1254	11097-69-1	
Aroclor 1260	11096-82-5	
Total Aroclors	12767-79-2	

*Note: Sediment reporting limits are on a dry-weight basis. To achieve the recommended reporting limits for some compounds in sediment, it may be necessary to use a larger sample size than the method describes, a smaller extract volume for gas chromatography/mass spectrometry analyses, or recommended sample cleanup methods to reduce interference.

Table 3. Bioaccumulative Contaminants of Concern for Routine Tissue Evaluation

Characteristic	Reporting Limit[A]
Total Lipid (%)	0.1
Cadmium (mg/kg)	0.1
Copper (mg/kg)	1.0
Mercury (mg/kg)	0.02
Selenium (mg/kg)	0.5
PAHs[B] (µg/kg)	20
Pesticides[B] (µg/kg)	2
PCBs[C] (µg/kg)	20
Butyltins[B] (µg/kg)	10

A. Tissue reporting limits are on a wet-weight basis. To achieve the recommended reporting limits for some compounds in sediment, it may be necessary to use a larger sample size than the method describes, a smaller extract volume for gas chromatography/mass spectrometry analyses, or recommended sample cleanup methods to reduce interference.

B. Use same list of compounds as in Table 2

C. If bioaccumulation tests are necessary because of elevated levels of PCBs, the agencies expect to require PCB congener analysis rather than Aroclor analysis. The agencies are currently working on the specific list of congeners that will be required. A separate public notice will be issued listing the congeners of concern.

Table 4. Interstitial and OverlyingWater Measurements[JRD1]

Characteristic	Reporting Limit
Salinity (ppt)	0.1
pH (pH units)	0.1
Ammonia (mg/kg)	0.2
Soluble Sulfides (mg/kg)	0.1
Dissolved Oxygen (mg/kg) (DO)	0.1
Temperature (°C)	0.1