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. If two or more chemicals of concern during a Tier 2 evaluation exceed the maximum level (ML) guidelines, or if any one chemical exceeds the ML by more than 100 percent, the material will be considered unsuitable for unconfined open-water disposal unless a Tier 4 assessment is conducted. Alternative analyses that may be conducted in this tier may include any or all of the following.

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. Tier 4 evaluations of data collected would follow the interpretation guidance specified in Chapter 10.

11.1.1 Time-Sequenced Laboratory Testing

As an alternative to accepting the 45 day exposure as a reflection of steady state conditions, an applicant 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.

The necessary species, apparatus and test conditions for laboratory testing are the same as those utilized for the Tier 3 bioaccumulation test. Tissue sub-samples taken from separate containers during the exposure period provide the basis for determining the rate of uptake and elimination of contaminants. From these rate data, the steady state concentrations of contaminants in the tissues can be calculated, even though the steady state may not have been reached during the actual exposure. For the purposes of conducting this test, steady state is defined as "the concentration of contaminant that would occur in tissue after constant exposure conditions have been achieved."

An initial time-zero sample is collected for each species for tissue analysis. Additional tissue samples are then collected from each of the five replicate reference and dredged-material exposure chambers at intervals of 2, 4, 7, 10, 18, and 28 days. Alternative time intervals may be proposed by the agencies. It is critical that sufficient tissue is available to allow the interval body burden analyses at the specified detection limits for the chemical(s) of concern.

Calculating steady-state concentrations following time-sequenced testing should follow data analysis procedures outlined in the Corps/EPA Inland Testing Manual (Appendix D, Paragraph D3.2.1, pages D-47 to D-51). Bioaccumulation data are very expensive to obtain, because of the extensive number of chemical analyses required, and the data should be carefully and correctly analyzed.

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 sufficient numbers of individuals of the same relative size ranges and biomass of the same species to enable tissue analyses at the reference and dredging site 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 chemical of concern, such as dioxin, mercury, PCBs, etc. In the case of chemicals like dioxin, national guidance is in a rapid 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.

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 DMMP agencies.

Tests considered may include chronic/sublethal tests, field studies such as benthic infaunal studies, experimental studies such as *in situ* toxicity tests or toxicity identification evaluations (TIE procedure; see Ankley *et al*, 1992), and/or no effects levels for aquatic life. In such cases, test procedures have to 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 bracket 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, if deemed appropriate to address a particular concern.