

3.0 REFERENCE ENVELOPE TOLERANCE LIMITS FOR SEDIMENT TOXICITY

3.1 Statistical Analysis in Support of Program Goals

Monitoring and assessment data are generally collected and analyzed to provide information necessary for resource management, with the selection of study designs and statistical analyses based on program objectives. One of the primary objectives of the Bay Protection and Toxic Cleanup Program (BPTCP) is to identify and prioritize toxic hot spots, localized areas where pollution impacts are greater than in surrounding water bodies. To accomplish this objective in San Francisco Bay, the program has sought to characterize potential hot spot sites, to characterize the optimal ambient condition of the surrounding water body, and to develop a statistical approach to determine whether conditions at test sites are significantly worse than those expected in less affected areas of the Bay. Using reference site toxicity data to characterize optimal ambient conditions in the San Francisco Bay, we have investigated the use of Reference Envelope tolerance limits to determine which test sites were significantly more toxic than expected of Bay reference conditions. The tolerance limits based solely on reference site data were used as a relative standard against which to compare the mean toxicity test result from test samples. The mechanics of this approach are described in Methods Section (10.4).

This approach is distinct from those used for other monitoring objectives. For many objectives, such as determining the general state of an entire water body, or to simply determine whether a test sediment will have an adverse effect on test organisms, sample toxicity test results can be compared to those from control sediments using simple t-tests or other standard statistical methods (e.g., Schimmel et al., 1994). These tests often consider only the variance among laboratory replicates in determining the statistical significance of differences between samples and controls. The reference envelope method considers variance from all factors that might affect test results, including anything affecting differences among sites and among sampling events. If reference sites can be assumed to be free of anthropogenic chemicals at concentrations affecting test results, then any difference between test sites and reference sites detected by this approach should be due to pollution effects at test sites. For this reason, selection and evaluation of reference sites is critical to the usefulness of the Reference Envelope approach.

3.2 Evaluation of Factors Affecting Tolerance Limit Calculations

Tolerance limits varied widely depending on the toxicity test protocol, the tolerance limit "p" value, the mean and variance in the reference site data set, the distribution of variance (among space, time, interaction and replicate components), the exclusion of outliers, and the number of data points (n) included in the analysis (Figures 27 through 39). Many of these factors are interconnected, as in cases where certain protocols produced more highly variable data and lower