Using Rapid Sediment Characterization Technologies To Expedite the Marine Site Characterization Process

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Rapid sediment characterization (RSC) technologies are field-transportable analytical tools that provide real-time or near real-time data and reduce the time and cost of marine sediment characterization. RSC technologies (including x-ray fluorescence (XRF) for metals, ultraviolet fluorescence (UVF) for polycyclic aromatic hydrocarbons (PAHs), immunoassay for polychlorinated biphenyls (PCBs) and QwikSed bioassay for biological effects) have been refined and implemented by the Navy to delineate areas of concern, fill information gaps and assure that expensive, certified laboratory analyses are targeted in areas where they will have the greatest possible value. Field analytics (often labeled screening tools) do not totally replace standard laboratory analyses, but more efficiently guide placement of the limited number of expensive laboratory samples that are generally available. RSC analyses allow better delineation of contaminant distribution by providing higher data density in a time- and cost-effective manner, without relying solely on costly laboratory analyses. The ability to integrate, interpret and present screening results in an effective manner is critical to successfully using these tools to assist with the site characterization process. Screening results from several Navy sites will be presented to demonstrate the range of utility of these techniques.

Traditional sampling and analysis approaches do not always provide all of the information necessary to support the site assessment process in a cost- and time-effective manner. This process is further hindered at sediment sites because of their complexity and heterogeneity. Typical site investigations involve the collection and analysis of samples with little if any prior knowledge of the nature and extent of contamination. In doing so, zones of contamination can be missed or the extent of contamination can be over- or under-estimated. Additionally, sites must often be sampled in an iterative manner to collect sufficiently detailed information on the extent of contamination. This approach can be costly, slow, and labor-intensive. A well-designed RSC protocol, paired with laboratory validation, can provide a more efficient and effective plan to characterize the nature and extent of contamination at a site and facilitate the decision-making process. The benefits and limitations of RSC methods and traditional analytical techniques are summarized in Table 1. Additional sources of information regarding these tools and their role in the risk assessment/site characterization process can be found at websites devoted to field analytics and sediment assessment (http://fate.clu-in.org/, http://erb.nfesc.navy.mil/restoration/technologies/invest).

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Table 1 - Benefits and limitations of RSC and standard laboratory analysis methods.

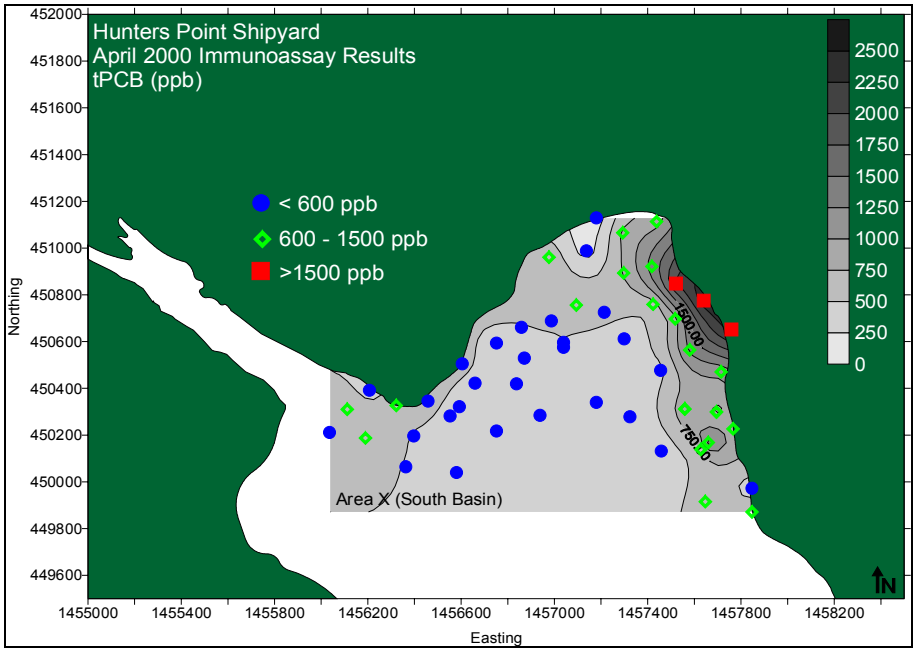
RSC Analysis	Standard Laboratory Analysis
Benefits ▪ Rapid results guide sampling locations ▪ Potential for high data density for mapping ▪ Reduced cost per sample	Benefits ▪ Quantitative, with high accuracy ▪ Often can remove interferences
Limitations ▪ Often non-specific ▪ Semi-quantitative ▪ Matrix sensitive	Limitations ▪ Often blind sampling ▪ Delayed results ▪ Costly
Cost per Sample ▪ XRF (metals): $25 ▪ UVF (PAHs): $50 ▪ Immunoassay (PCBs): $25 ▪ QwikSed: $200	Cost per Sample ▪ ICP/MS (metals): $300 ▪ GC/MS (PAHs): $ 400 ▪ GC/ECD (PCBs): $400 ▪ Amphipod bioassay: $1200
Throughput ▪ XRF: 40 samples per day ▪ UVF: 20 samples per day ▪ Immunoassay: 50 samples per day ▪ QwikSed: 6-12 samples per day	Throughput ▪ Metals, PAHs, PCBs, Bioassay: 30-45 days

The ability to integrate, interpret and present screening results in an effective manner is critical to successfully using these tools to assist with the site characterization process. RSC tools were used at three Navy sites in San Francisco Bay (Hunters Point Shipyard, Alameda Point, and Treasure Island) to accomplish various objectives. At Hunters Point Shipyard, RSC tools were used to help verify the site conceptual model and support the development of a statistically based design for a more detailed study. Surface sediment samples were collected in a grid pattern from 94 locations in five offshore areas of concern. The samples were screened for PCBs and heavy metals using the immunoassay technique and XRF spectrometry, respectively. The screening results for PCBs in one of the five offshore areas are shown in Figure 1. These results indicated two areas of elevated PCBs: one on the northeast side and one on the west side of the embayment. The screening results were used to identify and delineate strata with similar chemical characteristics. These strata were the basis for a stratified random sample design for a more detailed study of sediment chemistry, toxicity, and bioaccumulation. Ten percent of the sediment screening samples was submitted to the analytical laboratory for confirmatory quantitative analysis.

At Alameda Point, sediment screening was conducted adjacent to a navigation channel to determine if previously identified contaminated sediment had been removed in maintenance dredging operations or if it remained on site. Additionally, existing data for the site were more than 7 years old and were not likely to be representative of current conditions. Sediment samples were collected and analyzed for metals, PAHs and PCBs using RSC methods. Screening results indicated that chemical concentrations in

sediment were not elevated except in two localized areas near outfalls. By conducting the screening survey, the Navy was able to quickly reduce and focus the potential area of concern from about 45 acres to the two smaller areas.

Figure 1. Immunoassay Screening Results for PCBs at Hunters Point Shipyard, CA



At Treasure Island, an onshore site adjacent to the shoreline is contaminated with lead and the regulatory agencies were concerned that lead-contaminated material had been pushed into the offshore sediment in the past. No data had been previously collected in this area. Composite core samples were collected and analyzed by XRF for select metals. The screening survey was used to determine whether lead contamination was present and whether it was present at levels of concern. No significant contamination was identified. The use of screening tools allowed the entire area of concern to be screened in a quick, cost-effective manner and allowed for quick decisions to be made on the future course of the site.

RSC methods expedite the marine site characterization process because they are able to provide greater data density in a time- and cost-effective manner. Screening results can be used to accomplish a variety of objectives including developing and confirming conceptual site models, delineating areas of concern, identifying potential source areas, filling data gaps and facilitating more efficient use of certified laboratory analyses. Consequently, funds can be more efficiently spent on fixed laboratory analyses and bioassays.