Aquatic Sediment Sampling and Analyses (Newsletter)*

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Collecting sediment samples for analysis of contaminants—particularly in river systems—is not a matter of going out with bucket and shovel. It is much more complex than a water quality survey, aquatic biota survey, or a terrestrial sampling program. Sediment contaminant monitoring determines whether sediments are a sink or a source of the chemicals of interest. Regulators are interested in potential adverse effects of bound chemicals on the aquatic ecosystem.

The presence of contaminated sediments raises the potential for expensive liability payments by bank-side industries, so the sampling/analysis program must be of the absolutely highest caliber; that is, it must be technically sound and legally defensible. Analytical laboratory costs can far exceed material collection costs. Therefore, it is imperative to avoid having to re-do the effort because samples were taken at inappropriate locations or did not adequately represent the area of interest.

Terrestrial soil sampling is less complicated because soils are comparatively stable. Spatial and statistical analyses applied to aquatic sediments can be applied with equal validity to terrestrial soil samples.

To maximize the return on investment in a sediment characterization program, four components must be carefully planned and implemented.

Program objectives should be based on a solid foundation of sediment dynamics in the study area. If there are no data describing the spatial distribution of particle sizes, their movements, and the hydraulics of the water body, the first program objective must be to determine these characteristics. Sometimes the study's objective is to determine the concentration of one (or a few) chemicals in a specific area. In this case, sampling locations can be randomly distributed in areas of fine sediments. If the study is expanded, for example to determine the spatial extent of the contamination, then the sampling locations will need to be revised based on a different set of objectives.

Location of sampling sites for sediment studies depends on current knowledge of the distribution of particle sizes in the study area and particle transport dynamics. In reservoirs, lakes, and ponds the distribution of different size sediment particles is usually predictable and stable. In flowing waters the situation is more variable and dynamic. The dynamism of bottom sediments is demonstrated by the sand waves in the lower Columbia River which can move downriver as much as 3 feet (1 meter) per day during low flow.

The physical and chemical characteristics of sediments vary horizontally across the river channel and vertically in river bed. Mapping identifies homogeneous areas. The most important sediment group is that of fine-grained sediments, silts and clays. Fine-grained particles also include organic food particles for benthic invertebrates.

Determining the appropriate number of samples is a time-consuming, potentially-expensive component of the program. Preliminary samples are collected and analyzed to determine constituent concentration levels and variability. These values are used in a statistical procedure to estimate the number of samples required to produce results within acceptable error limits; economic and pragmatic limits are often imposed on the effort.

Two types of modeling are required to fully document and understand sediment chemical constituent dynamics and inform operational and regulatory decisions: spatial analyses and statistical analyses.

Spatial analyses and modeling apply terrain, hydrological, and fluvial geomorphic processes to understanding the distribution of sediments and contaminants in specific systems. There are multiple approaches to combining these data in meaningful ways so project-specific objectives and goals can be achieved.

Statistical analyses and modeling focus on identifying associations (correlations) and, most importantly, cause-and-effect relationships between constituents, particle sizes, and spatial locations. These chemical constituent analyses must properly include analytical results below detection limits; they cannot be arbitrarily assigned values of zero, the detection limit, or something in between. Improper analyses can have expenseive consequences.