Environmental Models

The ability to aptly and accurately apply environmental models is key when it comes to answering both simple and complex site-related questions. Windward has extensive experience in using such models, both to address specific regulatory requirements—such as effluent permit limits—and in support of site-specific evaluations—such as risk assessments.

The benefits of using environmental models are many. These models can be applied to evaluate prospective scenarios at a site, such as using a fate and transport model to identify potential remedial alternatives. Costs savings are another advantage: Rather than studying an entire site, Windward is able to collect input data at select locations within a study area, a much less expensive process than initiating site-wide data collection. Once these select data have been used in the model, the model can be applied to the entire site. Similarly, the use of bioavailability and toxicity models for metals allows for the application of a site-specific evaluation, which is much more cost effective than the toxicity laboratory costs that would otherwise be necessary.

Biotic Ligand Model

The Biotic Ligand Model (BLM) is a tool for predicting the bioavailability and toxicity of metals to aquatic organisms in various water chemistry conditions. For example, water chemistry parameters such as dissolved organic carbon (DOC), pH, and ions like calcium may all influence the bioavailability of metals to varying degrees. Since these parameters may vary greatly among sites, the amount of a metal that is actually bioavailable and potentially toxic to an aquatic organism varies likewise. Ambient water quality criteria (AWQC) for copper in freshwater are based on the BLM, and draft saltwater BLM-based copper AWQC are pending release from the US Environmental Protection Agency (EPA). BLM-based water quality criteria for other metals have also been proposed or are under development. In addition to water quality criteria applications, the BLM is a useful tool for supporting site-specific evaluations, including ecological risk assessments, and determining water quality-based effluent limits.

Windward staff have been instrumental in the development and application of the BLM, working with both the EPA in developing BLM-based AWQC, and the regulated community in applying the BLM. Windward personnel have also been leaders in the development of tools for implementing BLM-based criteria, such as the Fixed Monitoring Benchmark (FMB) approach, and have provided workshops on BLM use and application to a wide variety of stakeholders.

Lower Willamette River Food Web Model

An updated version of the Gobas food web bioaccumulation model was applied to the Lower Willamette River (Oregon) to characterize relationships among the chemical concentrations present in sediment, water, and tissue. The primary purpose of the food web model (FWM) was to derive initial preliminary remediation goals (iPRGs) for hydrophobic organic chemicals (e.g. polychlorinated biphenyls [PCBs]) in sediment. Sediment iPRGs are specific concentrations of chemicals in sediment associated with target tissue concentrations based on human health and ecological target risk estimates. A probabilistic approach was used for general model calibration and for sensitivity and uncertainty analyses. Once all model parameters had been defined, a probabilistic approach was again used to select sediment iPRGs. Sediment iPRGs were selected from distributions of model-predicted chemical concentrations in tissue and the corresponding model input concentrations for chemicals in sediment. Assumptions of relationships (or lack thereof) between water and sediment chemical concentrations were important in determining iPRGs. In some cases, assumed contributions from water alone (i.e., sediment chemical concentration equal to zero) resulted in predicted tissue concentrations in excess of risk-based targets, and iPRGs for sediment could not be determined. Future model applications will focus on characterizing the uncertainty of FWM derived PRG estimates and describing the relationship of water and sediment chemical concentrations.

Effluent Mixing Zone

Windward often makes use of mixing zone studies and environmental simulation models in order to help our clients address their stormwater discharge permitting needs. Such work includes setting up and calibrating three-dimensional mixing zone models to predict dilution factors within acute and chronic mixing zones. Models are selected based on site-specific conditions and, if necessary, are calibrated using available environmental data and the results of dye studies. When obtainable, existing oceanographic data are used in order to minimize the cost of additional data acquisition. The ability to model a range of scenarios helps assure regulators that critical conditions are adequately represented and no additional modeling or field work is required.

Windward also designs mixing zone analyses for special cases that cannot be fully addressed by existing simulations. For example, the analysis of intermittent discharges from a floating dry dock facility required a unique simulation for a variety of reasons, including the intermittent nature of the discharge (during submergence) and the physical configuration of the source component. Windward designed a custom modeling method that provided a calculation of near-field dilution during dock submergence and inputs for the far-field analysis using the Visual Plumes model applications.