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Wisconsin Water Science Center

Capabilities Summaries

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Wisconsin Water Science Center, Middleton, Wisconsin

Surface- and Ground-Water Monitoring

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Surface Water and Ground Water Monitoring

The USGS Wisconsin Water Science Center (WI WSC) office in Middleton, Wisconsin has significant expertise monitoring quantity and quality of surface-water and ground-water systems.

Surface-Water Quantity Monitoring

Continuous streamflow data are collected and computed using traditional and state-of-the-art acoustic methods and the data are posted on the web in real time. These data are used for flood forecasting and emergency flood response, understanding and modeling hydrologic systems, defining flood plains for planning developments, designing and operating hydroelectric, flood control, water supply, and wastewater facilities, designing and sizing bridges and culverts, managing lakes and wetlands, abating and preventing pollution, determining trends in floods and low-flows, and determining the occurrence and distribution of water.

Surface-Water Quality Monitoring

Water samples are collected to describe occurrence and distribution, trends, and modeling of certain pollutants and their relationships between natural factors, land use and water quality, and the relationship between ecological responses and water quality. The WI WSC has developed innovative monitoring capabilities associated with PCB, organics, virus, and pathogens sampling as well as in the areas of flow-composite auto sampling, small plot agricultural sampling, and urban source area sampling.

Ground-Water Quantity Monitoring

Water levels are collected from a statewide monitoring well network to provide information to determine water-level trends and their relationship to water use, climate changes, and land-use changes, and to support modeling efforts to support water use and water availability needs.

Ground-Water Quality Monitoring

Water samples are collected for describing occurrence, distribution and trends of naturally occurring compounds and certain pollutants and their relationships to natural and anthropogenic factors.

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Aquatic Toxicity Assessments

Contact Steve Corsi (608 821-3835, srcorsi@usgs.gov) or Barbara Scudder (608 821-3832, bscudder@usgs.gov) for more information.

Aquatic Toxicity Assessments

The USGS Wisconsin Water Science Center (WI WSC) office in Middleton, Wisconsin includes staff with expertise in conducting field-and laboratory-based studies evaluating aquatic toxicity. These studies include aquatic toxicity due to single point-source contributions to receiving waters, due to diffuse nonpoint sources of contamination that may cause aquatic toxicity, or even due to low levels of dissolved oxygen. Techniques used in the WI WSC to evaluate aquatic toxicity include:

In-situ, *Flow-through Chambers*

Long term *in-situ* exposures of organisms to a water body have a distinct application in evaluation of water quality and aquatic toxicity. Continuous exposure can be used as a method to accumulate composite effects of contaminants over a specified period of time. Flow-through fish chambers were developed at the WI WSC for this purpose and can be used to study numerous different situations, including:

Mortality

For strong aquatic toxicity signals, fish are exposed to a water body with potential for toxic effects (the test site) and survival of the fish is compared against a parallel exposure in a site with relatively good water quality and little potential for toxic impact (the reference site). Reduced survival in the test site as compared to the reference site indicates toxicity. Identification of water bodies with toxic impact can then be studied in more detail with further in-situ testing or with location and time-specific sampling and subsequent laboratory-based toxicity evaluation to determine sources of toxicity.

Reproduction

To measure effects on reproduction to Fathead minnows, pairs of the minnows are exposed to the water body at the test site in flow through chambers during periods with ideal water temperature and light cycle. The number of eggs produced by each pair is counted and compared against a parallel exposure at a reference site.

Bioaccumulation

To measure the extent to which a contaminant bioaccumulates in fish, they are exposed to a water body of interest for extended time periods. Fish tissues are then analyzed for the contaminant of interest and contamination levels are compared to fish tissues from a parallel reference site exposure or laboratory exposure.

Laboratory-based toxicity evaluation

Water bodies with potential for toxic impact are evaluated by time- and location-specific sampling and sent to a range of possible laboratories for bioassay testing using various different organisms and test methods depending on the specific toxic effect under study. Sampling is targeted at specific time periods such as baseflow conditions or runoff conditions, or in reference to specific locations with potential toxic impact.

Semi-Permeable Membrane Devices (SPMDs)

Semi-permeable membrane devices (SPMDs) mimic biological membranes, such as the gills of fish, and the devices contain a synthetic lipid solution similar to that found in fish. SPMDs are deployed for approximately four weeks in streams and are used to provide time-integrated information on the presence of dissolved (biologically available) hydrophobic organic contaminants in water. Toxicity tests followed by chemical analyses are done using the lipid solutions extracted from the SPMDs. Staff at the WI WSC have experience in interpretation of SPMD results as well as SPMD deployment.

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Hydrologic Characterization to Understand the Source and Transport of Pathogens

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Hydrologic Characterization to Understand the Source and Transport of Pathogens

The USGS Wisconsin Water Science Center (WI WSC) staff have extensive experience in developing instrumentation and collecting and processing hydrologic data for biological applications. The WI WSC extends industry-standard approaches to develop hydrologic understanding that is commensurate to the biological drivers that affect pathogen source and transport. The experience of the staff emphasizes application of innovative approaches and best available technologies, and employs a variety of commercial and research instrumentation and data processing procedures. Currently, the WI WSC is involved in projects on a local, regional, and national scope, with cooperators both inside and outside of the USGS. The experience of the WI WSC in this field is evidenced by publication of peer-reviewed reports and scientific journal articles. Specific areas of expertise include:

Hydrologic Instrumentation for Pathogen Source and Transport

The WI WSC has developed several sampling designs for intensive characterization of pathogens in surface water. Techniques are based on consideration of hydrologic conditions and specific sampling protocol for individual pathogens such as *Cryptosporidium, Giardia, E. coli* O157:H7, *Salmonella*, and enteric viruses. Stream cross-section integrated manual sampling can be used under steady stream-flow conditions while automatic sampling systems have been designed for unattended sampling during dynamically changing hydrologic conditions to provide comprehensive coverage throughout runoff events. The automatic sampling systems used range from "clean" adaptations of commercially available automatic samplers to in-house designs developed for filtration of large volume samples over extended time periods. These automatic filtration systems include real-time pH adjustment to improve filtration efficiencies and maximize recoveries of viruses.

Hydrologic Characterization for Beach Pathogen Source and Transport

The WI WSC has extended beach sampling beyond traditional indicator organisms such as *E. coli* and fecal coliform to include pathogens with potential to cause human illness through exposure to recreational waters. Traditional beach evaluations have been augmented using specially designed automatic sampling systems triggered during different environmental threshold conditions based on measurements such as rainfall, wave height, wind speed, wind direction, and solar radiation. Relating pathogen occurrence to environmental conditions is important for source identification. Moreover, continuous measurements of environmental conditions can also predict levels of indicator organisms on a real-time basis, thus reducing the reliance on laboratory methods that commonly take 24 hours to produce results.

Hydrologic Characterization for Virus Source and Transport

The WI WSC has used a variety of approaches to relate understanding of the hydrologic system to virus source and transport. Techniques include state-of-the-art ground-water flow models, source-water characterization using water isotopes, age-dating of water, and concurrent analysis of temperature transport. Traditional age-dating chemical techniques can be problematic in studies involving viruses because viral viability in the subsurface is thought to be less than two years. The WI WSC developed and published innovative methods of processing water isotope and temperature data to better constrain the time of transport of recently infiltrated water.

Non-Point Evaluation Studies

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Non-Point Evaluation Studies

The Non-Point Evaluation Monitoring Team (NPE) in the USGS Wisconsin Water Science Center (WI WSC) office in Middleton, Wisconsin provides expertise in instrumentation, data collection, and data analyses for both rural and urban non-point source research projects. These research efforts are adding to the comprehensive database needed by the non-point research community to help resolve the most pressing non-point issues on both a local and national scale. Data is being collected at plot, field, and whole watersheds scales.

Urban Monitoring

The team is evaluating single practices and end-of-the-pipe treatment devices. These devices are being used in urban areas by municipalities to improve urban storm-water quality and to meet permit requirements mandated by State and Federal legislation. The team is a leader in evaluating street sweeping as one of these practices to improve water quality in urban areas.

Rural Monitoring

The NPE team is evaluating best management practices and their effect on water quality in rural watersheds. Rural watersheds are being monitored for streamflow and water quality during the pre- and post- implementation periods. The data is being used to determine if water quality has improved and if these changes can be attributed to the implementation of BMP's.

Instrumentation

The NPE is a leader in the utilization of equipment for monitoring water quality of urban and rural watersheds. The NPE has used innovative techniques to monitor snowmelt runoff at remote field sites. The NPE is also monitoring storm-water flows in closed storm sewers and collecting water-quality samples at the inlets and outlets of single-treatment devices.

Modeling

The NPE continues to collect data that are used in calibration and verification of the SLAMM model. The SLAMM model is used extensively by consultants for urban non-point evaluation efforts in Wisconsin. The model is continually being enhanced using actual field data collected by the team.