

Hydrology and Hydraulic Engineering



The interaction between humans and the water in their environment has presented engineering challenges since ancient times. Those challenges continue today in a variety of contexts, whether we are trying to restore habitat, improve commerce and recreation, generate power, grow crops, dispose of waste materials, build infrastructure, clean up pollution, or develop land. All these endeavors may lead to engineering problems related to the occurrence and movement of water, which are addressed by the practice of hydrology and hydraulic engineering.

Successfully facing the challenges and solving the problems related to hydrology and hydraulic engineering requires expertise, experience, and judgment. While some common problems are well understood and can be solved with conventional engineering, others require a multi-disciplinary approach involving collaboration between water resource engineers, hydrologists, geologists, computer modelers, and others.

LimnoTech specializes in solving unique water resource problems by applying the appropriate mix of technical skills and tools to develop custom solutions that meet the client's needs.

LimnoTech's Services

LimnoTech offers expertise and experience in the following areas of hydrology and hydraulic engineering:

- Hydrologic and Hydraulic Studies
- Hydrologic, Hydraulic and Hydrodynamic Modeling
- Dam Capacity Analysis
- Stormwater Management
- Groundwater Hydrology and Modeling
- Floodplain Mapping
- Floodway Determination
- Hydrologic Frequency Analysis
- Erosion Analysis and Mitigation Design
- Sediment Transport Analysis
- Stream Bank and Shoreline Stabilization
- Lake Level Studies
- Channel Design
- Wastewater Outfall and Diffuser Design

LimnoTech Experience

For more than 30 years LimnoTech has been providing water resources consulting services to clients across the country. Our record of successfully completing hundreds of projects involving hydrologic and hydraulic analysis has given us the experience necessary to tackle most problems, from the ordinary to the unique. This experience includes:

- Projects on water bodies around the country including the Great Lakes, the Gulf of Mexico, the Mississippi River, the Pacific Ocean, Chesapeake Bay, and dozens of smaller lakes, rivers and estuaries.
- Conceptualization and development of data collection and monitoring programs.
- Development of innovative custom sediment transport modeling approaches.
- Hydrologic modeling using TR-20, TR-55, HEC-1, HEC-HMS, SWMM, HSPF and others.
- Hydraulic modeling using HEC-2, HEC RAS, RMA, WASP, EFDC and others.



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These project descriptions offer a sample of LimnoTech's experience in helping our clients resolve the challenges of hydrologic and hydraulic engineering.

Sewer Flood Protection Study for Federal Triangle. A June 2006 rain event in the Washington, D.C. area produced 14 inches of rain in a four-day period. This rainfall resulted in severe flooding in the downtown Federal Triangle area that caused basement flooding and the closing of streets. Federal Triangle, east of the White House and north of the National Mall, is a low-lying area that is home to many prominent federal buildings, including the national headquarters of the Internal Revenue Service and the Department of Justice. LimnoTech has been directed by WASA, on behalf of several federal and municipal agencies, to evaluate the extent of the Federal Triangle flooding and to identify and evaluate alternatives that would reduce the probability of future flooding.

LimnoTech is using DHI's Mike Flood two-dimensional surface flow modeling software, coupled with the existing Mike Urban model of the Washington, D.C. collection system, to evaluate the flooding in the Federal Triangle area. The surface flow model will be populated using the finest-resolution DEM (digital elevation model) data available. LimnoTech will use WASA pump station and regulator operations logs, video of the June 2006 event as captured by security cameras in Federal Triangle, and available flow monitors to calibrate the coupled surface flow and collection system models. LimnoTech will evaluate alternatives within the context of WASA's existing sewer system master plan and tunnel network, to determine if the deep tunnel system or other control alternatives can be altered or expanded to provide relief to Federal Triangle.

Ellerbe Creek Watershed Management Implementation Plan. The Ellerbe Creek watershed is a predominantly urban tributary to the upper Neuse River Basin in Durham County, NC. Ellerbe Creek is on the 303 (d) list for biological impairment and is expected to be listed for fecal coliform. The creek drains to the nutrient-sensitive waters of Falls Lake and the Neuse River. A local watershed plan was produced by watershed stakeholders, State resource managers, and City of Durham staff in 2003; however, limited resources at the time precluded a detailed assessment, particularly in the area of implementation. LimnoTech was

contracted to provide professional watershed planning and design services to assist the City in completing the watershed management plan. LimnoTech's evaluated best management practice impacts, and assessed benefits from adoption of low-impact development (LID) in pilot study areas. LID practices were evaluated through hydrologic and water quality modeling using XP-SWMM. The modeling results indicate that water quality improvements—at different levels of effectiveness—are feasible in the Ellerbe Creek watershed, and that compliance with bacteria and nutrient standards can be achieved.

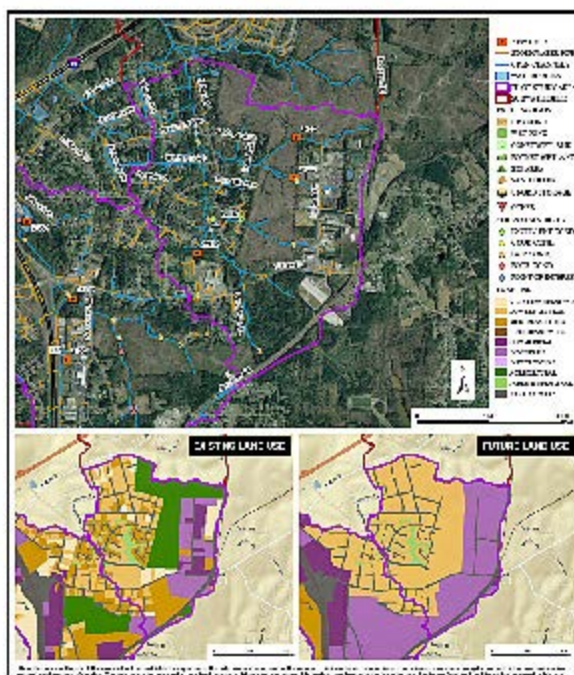
Riverbend Recreational Park Master Planning, Columbus, IN. LimnoTech provided hydrologic and hydraulic evaluation, sediment transport assessment,

and water quality assessment support for the preliminary design of a recreational park located on the waterfront of the Driftwood River in Columbus, IN. The project included a review of local river geomorphology, supporting an assessment of the feasibility of lake construction, and considering the proximity to the river and concerns about river channel stability and sedimentation. The preliminary design describes the construction of three lakes that are configured to provide optimal conditions for recreation use, while also fitting into the geomorphological setting of the Driftwood River and its confluence with the Flatrock River a short distance downstream. Constructed wetlands combined with a hydraulic connection to the river provide a means for directing flow through the lake system while managing the quality and sediment load of

incoming waters. Wetlands and meadow plantings located upgradient of the lakes provide a means for management of sedimentation under flood conditions, minimizing the potential for dredging-related operations costs. The final design balances restoration of local ecology and habitat with the human use requirements of an urban river and floodplain environment.

Pneumatic and Hydraulic Transient Modeling for the Thames Water Authority Tunnels, London, England.

During heavy rains, the City of London's sewer system capacity is exceeded, and diluted combined wastewater is released directly to the River Thames. The Thames Water Authority is completing design for a large tunnel system to



To provide professional watershed planning and design, LimnoTech evaluated best management practice and low-impact development benefits using hydrologic and water quality modeling.

capture and store the diluted sewage for later treatment. Predicting the filling dynamics of this large tunnel system is important to prevent accidental venting of captured sewage, to ensure the safety of tunnel operators and the public, and to prevent damage to London's sewer system and tunnel infrastructure. In collaboration with scholars at the University of Michigan, LimnoTech has developed and is applying a software program titled SHAFT (Surge and Hydraulic Analysis for Tunnels). LimnoTech is coordinating with the designers to reconfigure the SHAFT model to simulate multiple "what if" scenarios to assess transient hydraulic grade lines (HGLs) and air pocket formation for alternative tunnel geometries. Model simulations identified pressurization issues within the proposed tunnel during extreme events, which could create large air pockets and subsequent geysering. The SHAFT model was used to evaluate alternative inflow control scenarios, various control alternatives to prevent air pressurization problems, and high HGLs from adversely affecting sewer infrastructure during the tunnel-filling process. These simulations are also being used to identify further design enhancements.



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Hydrologic and Hydraulic Modeling to Support Combined Sewer Overflow and Sewer System Master Plans for Washington, D.C. The District of Columbia Water and Sewer Agency (WASA) operates a wastewater collection system that includes an MS4 storm sewer system, a separate sanitary sewer system, and a combined sewer system, a substantial number of pump stations and hydraulic control structures, and hundreds of miles of sewer pipes. LimnoTech has provided hydrologic, hydraulic, and water quality modeling continuously for WASA since 1999 to support a variety of needs.

Tasks performed by LimnoTech have included development of a geo-database for the sewer system and construction of GIS coverages to support hydrologic and hydraulic modeling; improvement of the hydrologic and hydraulic model used to develop the CSO Long Term Control Plan; several localized flood studies where storm and sanitary sewer pipes were clogged or undersized; an emergency operations study to assess the ramifications of having various pumping and treatment facilities off line because

of natural disasters or terrorist actions; interpretation of potable water and sewage flow metering data to develop a mass balance of flows to the Blue Plains Wastewater Treatment Plant; identifying capacity-constrained areas of the collection system within DC to predict future capacity needs in the sewer system, and to assess I/I priorities; support facility planning and design efforts for the \$2 billion CSO control and nutrient reduction program; and applying a hydraulic

transient analysis model to investigate the potential surge and geysering in the planned tunnel system.

Development of a Combined Sewer Collection System Model for St. Louis, Missouri. The Blackstone-Clarendon combined sewer system covers a 2.5-square-mile, highly urbanized area in downtown St. Louis, MO. The Metropolitan St. Louis Sewer District (MSD) is conducting a pre-design for relief sewers and infrastructure repair/rehabilitation. LimnoTech is developing a collection system model of the sewershed using XP SWMM and will calibrate the model to flow-monitoring data. LimnoTech will also help develop a preliminary list of alternatives and will apply the model to determine the forecasted improvement in flooding and CSO discharges, and the potential interaction with other CSO controls being considered elsewhere in the system.