

A Partial Summary of 2009 USGS Activities Related to the FHWA and State Highway Agencies

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Introduction

Part of the mission of the U.S. Geological Survey (USGS) is to assess the quantity, quality, and trends of the Nation's water resources, to advance the understanding of natural processes related to these resources, and to provide information that will assist resource managers and policymakers in making sound decisions. The USGS has a long history of jointly funded investigations with the Federal Highway Administration (FHWA) and State highway agencies to provide data and information to address various issues related to water resources and the Nation's transportation infrastructure. These issues cover a wide spectrum and include items such as regional flow statistics, flood documentation, regional stream characteristics, bridge scour, and water-quality assessments.

The following table and text provides a partial summary of current or recently completed USGS activities related to highway issues. Table 1 organizes the current and recent activities into categories and subcategories and gives a quick overview of the USGS programs and the State and (or) Federal agencies that are helping sponsor the programs. The text following table 1 provides more detailed information on the various activities. The text initially describes activities that have been, or are being conducted on a national level and is followed by state activities listed alphabetically by State. If you should have questions regarding this information, please contact Charles Berenbrock (ceberenb@usgs.gov).

Table 1. Partial summary of USGS activities related to the FHWA and State Highway Agencies

Project Type	Sponsoring Agencies/States
Regional Flow Frequency/Statistics Investigations	
- National Flood Frequency Program	USGS
- StreamStats Program/automated basin characteristics	AZ, CA, CT, CO, DE, HI, IL, ID, IN, KS, KY, MA, MD, MN, MS, NC, NH, NJ, NM, NY, OH, OK, OR, PA, RI, SD, TN, UT, VT, WA, WI
- Investigation of rural flow-frequency	AL, CA, CO, FL, GA, HI, IA, KS, MA, MS, NC, NH, NM, NY, OK, OR, PA, SC, SD, TN, UT, VA, WI, WV
- Investigation of urban flow-frequency	AL, KS
- Investigation of small watershed flow-frequency	IA, KS, ME, TX, VA
- Investigation of hydrograph timing, rainfall hyetographs, and rainfall-duration-frequency maps	TX
Bridge Scour and Sediment Transport	
- National Bridge Scour Project	
- Scour at Contracted Bridge Sites	NCHRP
- Near real time scour monitoring	AK, GA, NJ
- Data collection and analysis	AK, AL, ME, MS, MT, NJ, SC, FHWA
- Investigation of Scour in cohesive soils using the EFA	IL, SC
- Channel stability and scour assessment	AK, MO, MT, NJ, SD
- Investigation/modeling of sediment transport	TN, TX
- Investigation of bio-engineered bank protection and A-jacks scour countermeasures	OR
Hydrologic and Hydraulic River Investigations	
- Investigation of bridge site hydrology and hydraulics	AL, GA, MN, MS, MO
- Investigation and modeling of multi-dimensional flows	AK, ND, PA
- Flood documentation	IA, ID, NM, NV, NY, PA, TN
Stream Characteristic Investigations	
- Regional channel characteristics/bankfull discharge	PA, VA, WV
- Investigation of Manning's roughness coefficients	
Gages	
- Tidal gages	
- Crest stage gages to estimate annual peak flows	AK, GA, HI, IA, KS, LA, ME, MI, MN, MS, MO, MT, NV, NJ, NM, NY, ND, OH, PA, SC, SD, TN, VT, VA, WI, WV
- Continuous-record discharge and stage gages	AK, FL, HI, IN, IA, IN, LA, ME, MD, MI, MN, MS, MO, MT, NH, ND, NJ, PA, SC, TN, VT, WV
- Real time monitoring network on hurricane evacuation routes; monitors stage, rain, wind, and traffic count	LA
Water Quality/Environmental Investigations	
- Evaluation of Stormwater Runoff Models	FHWA, MA
- Monitor water quality/quantity at selected sites	HI, MA, ME, MN, MT, NC, NV, SC, TN, VT, WI
- Investigation of wetland impact/remediation	MT, PA
- Investigation of stream restoration	PA
- Investigation of the impact of deicing chemicals	VT
- Investigation of habit impact by bridge pier	PA
- Investigation of BMP	SC, WI
- Investigation of potential impacts of highway construction to the GW aquifer	AR

Partial Summary of USGS National Activities

National Streamflow Information Program (NSIP)

NSIP—This USGS program is an umbrella over all streamflow information activities of the USGS. The program has five major goals - (1) a stable streamgauge network to provide federally needed streamflow information, (2) to provide better understanding of floods and droughts, (3) to perform periodic regional and national assessments of streamflow information, (4) to enhance the delivery of streamflow information and products, and (5) to develop and evaluate new technologies and methods for obtaining streamflow information. NSIP received a \$5M increase for 2009, which put the program at about 20% of full planned funding. The increase will be used to help stabilize the streamgauge network, speed implementation of StreamStats, and help pilot a hazards warning system for flood and debris flows and maintain a mobile storm-surge network for the Gulf Coast. The NSIP program description and list of proposed NSIP streamgages are on-line at <http://water.usgs.gov/nsip/>. A general information product on the mission and goals of NSIP is on-line at <http://pubs.usgs.gov/gip/70/>. It also includes internet links to streamflow data and information.

The National Water-Quality Monitoring Network

Another network effort is now taking form in response to recommendations of the Presidents Commission on Ocean Policy and the President's Ocean Action Plan. This is a coordinated effort led by the National Ocean and Atmospheric Administration (NOAA), the Environmental Protection Agency (EPA), and the USGS working through the National Water Quality Monitoring Council (NWQMC) to develop an integrated system of long-term streamgages, water-quality and ecological monitoring sites with standardized monitoring techniques, parameters, and data-dissemination portals. The network will link elements of Federal, State, and local monitoring networks to reduce duplication and strengthen coverage. The network design will focus on water and ecological issues affecting coastal waters and ocean environments. Pilot projects are anticipated in FY2008. The NWQMC report describing the network is available at <http://acwi.gov/monitoring/network/index.html>.

Flood-Frequency Analysis Using Bulletin 17B Guidelines

Flood-frequency analysis provides information about the magnitude and frequency of selected flood discharges. Bulletin 17B of the Hydrology Subcommittee of the Interagency Advisory Committee on Water Data (1982) defines procedures recommended to provide a consistent approach for determining flood-flow frequency from peak-flow records. The procedures include methods for improving skew estimates using regional skew information, tests for high and low outliers, adjustments for low outliers and zero flows, and methods for incorporating historic peak-flow information. The Peak flow Frequency analysis program (PeakFQ) implements the Bulletin 17B recommended procedures for flood-frequency analysis of streamflow records. The program has been updated and now provides an interactive Windows interface to PeakFQ. Also the program can be run from a batch-style processing on DOS, UNIX and Linux operating systems. The PeakFQ program is available at <http://water.usgs.gov/software/peakfq.html> and documentation is available at <http://pubs.usgs.gov/tm/2006/tm4b4/>. PeakFQ is being currently modified to include the Expected Moments Algorithm (EMA). EMA is a highly efficient approach for capturing the information contained in historical flood data, particularly paleoflood data. EMA provides a way to incorporate historical information, paleoflood information, truncated data sets, censored data, low and (or) high outliers, and zero flows into flood-frequency analysis.

National Streamflow Statistics

The National Streamflow Statistics (NSS) Program is a Microsoft Windows-based computer program¹ written in Visual Basic programming language that has been created by the USGS to provide an easily accessible graphical user interface (GUI) to estimate high and low streamflow statistics for ungaged sites across the United States. NSS is a replacement for the National Flood Frequency (NFF) Program. The name change from NFF to NSS is the direct result of enhancements to the program, which now provides estimates for low-flow duration/frequency in addition to flood-frequency estimates such as the 100-year flood.

The NSS program has four components—a GUI, an equation calculation routine, a database, and a help feature. The GUI allows users to control the operation of the software and present results. The equation calculation routine computes streamflow statistics using basin and climatic characteristics entered by the user and provides tabling and graphing capabilities that graph frequency and hydrographs. The database contains all the information needed, such as the regression coefficients and standard errors, to solve more than 3,000 regression equations. The help facility contains the NSS Program User's manual, a link to the NSS program Web page, and version information.

Regression equations for estimating flood-frequency statistics of peak flows for rural and naturally flowing rivers are available for all 50 U.S. States including the Commonwealth of Puerto Rico and the island of Tutuila, American Samoa. Regression equations for estimating flood-frequency statistics of peak flows for urban streams are available in NSS for 20 U.S. States. Regression equations for estimating low-flow duration and (or) frequency are also currently available in NSS for 23 U.S. States. All equations contained in NSS were reviewed by USGS and were generally prepared in cooperation with state and local transportation, environmental, and/or water resource management agencies in each state.

The NSS program and documentation can be downloaded from the Internet at <http://water.usgs.gov/software/nss.html>. A fact sheet that describes the NSS program was published in 2007 and can be downloaded at <http://pubs.usgs.gov/fs/2007/3010/>. If you should have questions regarding this information, please contact Dr. Robert Holmes (bholmes@usgs.gov)

StreamStats Program

StreamStats (<http://streamstats.usgs.gov>) is a Geographic Information Systems-based Web application that was developed by the U.S. Geological Survey (USGS) Office of Surface Water (OSW) that greatly reduces the time needed for users to obtain streamflow statistics, basin characteristics, and other information for USGS data-collection stations and for ungaged sites. This information is needed for use by engineers, land and water-resource managers, biologists, and many others to help guide decisions in their everyday work. Users can select data-collection station locations shown on a map interface in a Web browser window to obtain previously published information for the stations. Users can also select any location along a stream to obtain the drainage-basin boundary, basin and climatic characteristics, and estimated streamflow statistics for that location. The estimates for ungaged sites are determined from USGS regional regression equations and usually can be obtained in only a few minutes.

As of October, 2009, StreamStats was available to the public in 18 states, Washington, Oregon, Idaho, Utah, Colorado (partial), Tennessee, North Carolina (partial), Indiana, Illinois, Ohio, Pennsylvania, Maryland (partial), Delaware, New York, Connecticut, Massachusetts, New Hampshire, and Vermont. The application also was implemented and undergoing quality assurance in preparation for public release in California, New Jersey, Hawaii, New Mexico (partial), and Kentucky. Plans for fiscal year 2009 include implementing these five states, plus Minnesota, Rhode Island, Mississippi, South Dakota, Wisconsin, and Oklahoma. In addition, major updates to regression equations and/or supporting GIS datasets will be made to the applications for Oregon, Idaho, Pennsylvania, and Tennessee, and the areas of availability will be expanded for Colorado and Maryland.

StreamStats Version 2 was released a year ago, and provides several enhancements, including the abilities to (1) navigate the stream network to locate upstream or downstream streamgaging stations, dams, point discharges and other water-related features and get information about those features, (2) estimate flows at ungaged sites based on the flows at nearby streamgaging stations, (3) change the basin characteristics for an ungaged site and obtain new estimates of flow statistics that reflect the changed basin characteristics, (4) obtain graphs of land-surface and stream-channel elevation profiles, (5) trace the path of a drop of water or a hazardous-waste spill from a point on the land surface to where it reaches a stream, and then downstream through the stream network, and (6) access StreamStats functionality from other Web or desktop GIS applications remotely by use of Web services. Applications have been converted from Version 1 to Version 2 for 6 states, although not all added functionality is working yet for most states. It is planned that all applications will be operating on Version 2 with full functionality by the end of September 2010.

Evaluation and Update of the Federal Highway Administration (FHWA) Pollutant Loadings Model for Highway Stormwater Runoff

Valid, current, and technically defensible stormwater runoff models are needed to (1) interpret data collected by field studies, (2) support existing highway and urban runoff planning processes, (3) meet National Pollutant Discharge Elimination System (NPDES) requirements, and (4) provide methods for calculation of Total Maximum Daily Loads (TMDLs) in a systematic and economic manner. The FHWA formulated a model to predict pollutant loadings and impacts from highway stormwater runoff in 1990. Unfortunately, the 1990 FHWA model has several limitations that affect the use of the model; defensibility and representativeness of model results, and documentation of model results. The 1990 FHWA model was written for the DOS operating system, and does not always work on more recent (Windows 2000/XP) operating systems. The model was based on data collected from the mid 1970's through the mid 1980's. Changes in materials used to build roads and vehicles, the advent of vehicular emission controls, and changes in the formulation of fuels and lubricants have substantially changed the composition of runoff in the last 20 years. Research also indicates that water-quality monitoring methods may substantially effect measurements of concentrations, flows, and the resultant calculation of runoff loads.

The 1990 FHWA model was framed as a dilution model with the assumption that background concentrations were zero. This approach was chosen to examine the effects of highway runoff on receiving waters and to highlight the potential effects of best management practices (BMPs) on receiving waters. Currently (2006), however, regulators and decision makers will not accept a model with a background concentration of zero, and regulators are focusing on concentrations at low-flows such as the 7Q10 or 4B3, which are included in state and federal water-quality standards. This study will evaluate the 1990 FHWA model and update the model using new information and data. More specifically, the study will implement a Monte Carlo model in a new software platform as a prototype for a new national model, update the existing model with more recent streamflow and water-quality information, and expand the model to address regulatory concerns. This model will provide a "best estimate" (mean or median) and confidence intervals for expected EMCs. The model also will utilize this EMC estimate and estimates of precipitation, and runoff coefficients to produce a population of estimates for loads based on the location and site characteristics of highway sites of interest.

Standard tools and techniques for obtaining and processing information and data about highway runoff quality and quantity and the quality and quantity of upstream flow in the receiving waters were needed to support this new national FHWA model. The USGS in cooperation with the FHWA has developed and tested a highway runoff database as well as computer applications that can be used to automatically download and process water-quality and streamflow data from the USGS National Water Information System (NWIS) Web. The following is a brief summary of each product and its current status:

- **Highway-Runoff Database (HRDB v. 1.0): A Data Warehouse and Preprocessor for the Stochastic Empirical Loading and Dilution Model**

Status: Report Published

The highway-runoff database application was developed to serve as a data warehouse for highway-

runoff data-sets that can be used to facilitate estimation of statistical properties of runoff coefficients, runoff-quality statistics, and relations between water-quality variables in highway runoff. This highway runoff database currently includes over 39,000 event mean concentration values from analysis of more than 100 different water-quality constituents. These EMC values were collected at 100 highway-runoff monitoring sites in the conterminous United States during more than 2,600 storm events as documented in 6 highway-runoff quality data sets. The user may select and export water-quality data in tab-delimited or comma-delimited format. The user may generate water-quality statistics for data with censored values by use of the robust Regression on Order Statistics (ROS) method. The user may export paired water-quality data in a format suitable for regression analysis. Finally, the user may export precipitation, runoff flow, and runoff coefficient data in tab-delimited format. In each case the user may select data from different sites and different data sets based on highway-runoff monitoring site characteristics. The report is available from <http://ma.water.usgs.gov/fhwa/FHWA-HEP-09-004/FHWA-HEP-09-004.pdf>

- **Kendall-Theil Robust Line (KTRLine--version 1.0)--A Visual Basic Program for Calculating and Graphing Robust-Nonparametric Estimates of Linear-Regression Coefficients Between Two Continuous-Variables**

Status: Report Published

The Kendall-Theil robust line program was developed because this nonparametric method is resistant to the effects of outliers and nonnormality in residuals that commonly characterize water-quality data sets. A single-segment model or a multi-segment model may be specified. The program was developed to provide regression equations with an error component for stochastic data generation because nonparametric multi-segment regression tools are not available with the software that is commonly used to develop regression models. The report is available from <http://pubs.usgs.gov/tm/2006/tm4a7/>. Also a Visual Basic Program for calculating and graphing robust nonparametric estimates of linear-regression coefficients between two continuous variables is available from the report's Web site.

- **Methods for Compilation and Interpretation of Data for Development of Transport Curves for Planning-Level Estimates of Water-Quality at Unmonitored Sites in the Conterminous United States**

Status: In Second Stage of Technical Review

This report documents methods for data compilation and analysis of water-quality-transport curves that meet data-quality-objectives for planning-level estimates of stream water-quality at unmonitored sites in the 84 U.S. EPA ecoregions in the conterminous U.S. Transport curves are regression relations used to estimate constituent concentrations from measured or estimated water discharge values. This national synthesis effort was based on data available on the USGS National Water Information System (NWIS) Web. A total of 24,581 surface-water-quality monitoring stations with drainage areas ranging from 0.002 to 1,040 square miles were identified throughout the conterminous U.S. and cataloged for retrieval of water-quality data. A total of 252 regional transport curves were developed for suspended sediment, total phosphorus, and total hardness. Four computer applications were developed to download, process, and build a database of about 1.2 million paired streamflow and water quality measurements for 14 water-quality constituents commonly measured in runoff studies. The user may utilize the regional regression models, or develop their own regional, local, or site-specific estimates with these data and methods.

- **Methods for Compilation and Interpretation of Data for Development of Transport Curves for Planning-Level Estimates of Streamflow at Unmonitored Sites in the Conterminous United States**

Status: In Preparation

This report documents methods for data compilation and analysis of streamflow statistics that meet data-quality-objectives for planning-level estimates of streamflow at unmonitored sites in the 84 U.S. EPA ecoregions in the conterminous United States. This national synthesis effort was based on data available on the USGS National Water Information System (NWIS) Web. Streamflow statistics are available in a database for 2,783 USGS streamflow-gaging stations within the conterminous United States that were selected because they have at least 24 years of daily discharge records during the period 1961-2004 and drainage areas ranging from 10-500 square miles. The streamflow statistics were calculated using standard methods. Four computer applications were developed to download, process, and build a database of summary statistics for USGS streamflow-gaging stations that may be used to estimate a population of streamflows by ecoregion or by using selected gaging stations. The user may choose regional statistics, or develop their own regional, local, or site-specific estimates with these data and methods.

Stochastic Empirical Loading and Dilution Model (SELDM)

Status: In Preparation

The stochastic empirical loading and dilution model (SELDM) is a Monte Carlo model that uses local or regional statistics to generate a population of concentrations and discharge volumes to simulate a large number of storm events. The resulting storm-event statistics can be used to estimate flows, concentrations, and loads of the constituents of concern. SELDM will provide information to assess potential effects of runoff on receiving waters. It will also provide statistical estimates of annual loads from highway runoff and resultant downstream concentrations and loads. The model will use statistical estimates of storm-event precipitation characteristics, upstream discharge, runoff-coefficient statistics by impervious fraction, upstream water quality, the quantity and quality of highway runoff, and modification of highway runoff quality and quantity by BMPs. The project web page is at <http://ma.water.usgs.gov/fhwa/SELDM.htm>.

The SELDM application is being implemented as a database application with a graphical-user interface to facilitate generation of input-data sets from regional data (by ecoregion) or available local data based on the latitude and longitude of the site of interest. This approach also facilitates scenario testing and sensitivity analysis. The graphical-user interface is in the beta test phase. The underlying numerical methods have been developed and tested the components are being integrated with the graphical-user interface to facilitate and documentation is in preparation.

Currently, SELDM is in the Beta-test stage and is undergoing technical review. Technical training materials for model users are also under development. The methods, statistics, and data are documented in the following reports:

Reports:

- Granato, G.E., 2009, Computer programs for obtaining and analyzing daily mean streamflow data from the U.S. Geological Survey National Water Information System Web Site: U.S. Geological Survey Open-File Report 2008–1362, 123 p. on CD-ROM, 5 appendixes. (<http://pubs.er.usgs.gov/usgspubs/ofr/ofr20081362>)
- Granato, G.E., Carlson, C.S., and Sniderman, B.S., 2009, Methods for development of planning-level stream-water-quality estimates at unmonitored sites in the conterminous United States: Washington, D.C., U.S. Department of Transportation, Federal Highway Administration, FHWA-HEP-09-003, 53 p. (<http://ma.water.usgs.gov/fhwa/SELDM.htm>)
- Granato, G.E., and Breault, R.F., 2010, Methods for Development of Planning-Level Estimates of Stormflow at Unmonitored Stream Sites in the Conterminous United States: Washington, D.C., U.S. Department of Transportation, Federal Highway Administration, FHWA-HEP-09-005, XX p. (Approved by FHWA, and in USGS Editorial Review)

Granato, G.E., 2010, Stochastic Empirical Loading and Dilution Model (SELDM). (In preparation)

- **National Synthesis on Potential Sources, Fate and Transport, and Potential Effects of Chloride in Surface- and Ground-Water Resources of the Conterminous United States** (<http://ma.water.usgs.gov/fhwa/Cl.htm>)

Status: Active

The Chloride (Cl) ion is receiving increasing attention as population growth makes increasing demands on available water resources and anthropogenic activities increase solute loads in natural waters. Cl is a growing concern because anthropogenic inputs may increase Cl concentrations to the USEPA taste criterion for potable waters (250 mg/L) and to the USEPA suggested limits of 230 mg/L for chronic aquatic life exposure and 860 mg/L for acute aquatic life exposure in surface waters. The Cl ion is ubiquitous in natural waters, has a wide variety of sources, readily moves through surface and ground waters, and is difficult to remove from runoff and water supplies. This national synthesis is a cooperative effort between the USGS and Federal Highway Administration designed to provide the information necessary for watershed managers to assess all potential sources of Cl in a given watershed as part of a total water and solute budget. This will include information necessary to develop a localized water budget; to develop water-quality transport curves; to estimate natural, agricultural, and anthropogenic sources of Cl; to examine interrelationships among water-quality constituents and to use the National Water Information System Web to identify and interpret available ground-water, surface-water and water-quality data. This effort also will provide a summary of field methods including geophysical techniques and automated monitoring of runoff, streamflow, and ground water. Of 275 reports that have been compiled, about 165 reports have been cataloged and reviewed. Water-quality transport curves for dissolved chloride have been developed for 84 USEPA Nutrient Ecoregions.

- **FHWA/USGS NDAMS web page** (<http://ma.water.usgs.gov/fhwa/>)

Status: On-line and active

We have maintained the FHWA/USGS NDAMS web page (which receives about 130,000 visits per year) since 1996. In 2005 the Stochastic Empirical Loading and Dilution Model WEB page was developed. The Web page posts the 1990 FHWA model, documentation (which was scanned into PDF format), and data on-line.

Partial Summary of USGS Water Science Center Activities Supported by State Highway Agencies

Alabama

- Continuation Completion of analysis and report phases of Urban flood frequency study in 2009. Publication slated for Jan 2010. The Alabama urban flood frequency study is an update of the 1982 study. New regression equations are being published for urban sites in Alabama for flood having the 50% to 0.2% exceedance probability.
- Completion of analysis and report phases of flood depth frequency study in 2009. Publication slated for Sept. 2010. The Alabama depth frequency study is an update of the 1985 study. New depth regression equations are being published for rural streams in Alabama.
- Continuation of hydrologic and hydraulic analyses and data collection at various bridge sites using 1-dimensional and 2-dimensional hydraulic models and indirect/direct measurements.
- Initiation of study investigating the before and after effects of culverts on the natural conditions of streams in the Coastal Plain Physiographic Province of Alabama. This project has recently launched (Nov. 2010) and has a 5-year life span (2010-2014). The results of this investigation will serve as a valuable tool in evaluating culvert impacts on the stream channel geomorphology, sediment concentration, turbidity, and benthic invertebrate communities.

Alaska

A program with Alaska Department of Transportation and Public Facilities (ADOT&PF) that focuses on streambed scour monitoring and modeling had these accomplishments in 2009:

- Collected streambed scour data in response to high flows on the Copper River. Deployed a satellite modem camera to monitor water level and damage from scour.
- Used a multi-dimensional flow model in combination with repeated multi-beam sonar surveys to evaluate streambed scour associated with the installation of a temporary construction causeway at a scour-critical bridge on the Tanana River.
- Monitored pier scour at 19 sites around Alaska in near real time.
- Surveyed channel cross sections at 50 scour-critical bridges
- Developed plans of action (POA) in Google Earth for scour monitoring sites.
- Collected streamflow and tidal data at 37 bridges for hydraulic modeling and scour evaluation.
- Presented "Collection and distribution of real-time streambed scour monitoring data from bridges in Alaska" at the 2009 Hydrologic Collected streambed scour data in response to flooding in August 2008. Scour website was successfully utilized to monitor stage and bed elevation during flooding at the Salcha River and to direct field personnel to areas of flooding. Channel bathymetry data were collected at or near flood peaks at two scour critical sites.
- **Recent Publications**
 - Brabets, T.P. and Conaway, J.S., 2009, Application of the Multi-Dimensional Surface Water Modeling System at Bridge 339, Copper River Highway, Alaska: U.S. Geological Survey Open-File Report 2009 - 1237, 28 p. (<http://pubs.usgs.gov/of/2009/1237/>)
 - Brabets, T.P. and Conaway, J.S., 2009, Geomorphology and River Dynamics of the Lower Copper River, Alaska: U.S. Geological Survey Scientific Investigations Report 2009-XXXX
 - Conaway, J.S. and Brabets, T.P., 2008, Copper River Channel Migration and its Effects on the Copper River Highway, Alaska: in Proceedings of the 2008 World Environmental and Water Resources Congress, May 12-16, 2008, Honolulu, Hawaii, 13 p.
 - Conaway, J.S. and Knapp, M.W., 2008, Comparison of scour evaluations to streambed scour monitoring data at bridges in Alaska: in Proceedings of the 2008 National Hydraulic Engineering Conference, August 25-29, 2008, Portland, Maine, 1 p.
- Alaska streambed scour website: http://ak.water.usgs.gov/usgs_scour/

Arizona

- No highway related projects at this time.

Arkansas

- A 3-year study that began in 2006 is underway in cooperation with Arkansas State Highway and Transportation Department (AHTD). The study is located at Springs National Park in central Arkansas. AHTD and the National Park Service have concerns that the blasting of the hills to make a road in the park might cause cracks deep within the earth that will affect the flow system of the Hot Springs.
- In contact with the AHTD to develop a StreamStats application for the state.

California

- As part of the Multi-Hazards Demonstration Project for Southern California, the USGS is conducting research on fire-related debris flows and producing debris-flow hazard maps for areas recently burned by wildfire. Rapid-deployment streamflow gages and precipitation gages also have been installed in burned areas for hazard-mitigation purposes.
- A state-wide flood frequency study that is aimed at updating flood-frequency at gaged sites and developing prediction equations at ungaged sites is currently underway in California. As part of the flood-frequency study, new values of regional skew determined from a Bayesian Generalized Least Squares (GLS) regression analysis will be produced. The new estimation equations will also be implemented in StreamStats

Colorado

- The USGS Colorado Water Science Center (CWSC), in cooperation with the Colorado Department of Transportation (CDOT) and Colorado Water Conservation Board, is implementing StreamStats in Colorado during fiscal years 2007-2009. Implementation of the state wide database has been completed, tested, and approved for final release. The final web version should be operational in the next week or two. The StreamStats datasets have been developed at the 1:24,000 scale using high resolution National Hydrography Dataset (NHD), 10 meter digital elevation data, and the Watershed Basin Dataset developed by the USEPA.
- The U.S. Geological Survey (USGS), in cooperation with the Colorado Water Conservation Board and the Colorado Department of Transportation, developed regional regression equations for estimation of various streamflow statistics that are representative of natural streamflow conditions at ungaged sites in Colorado. The study results are documented in the USGS Scientific Investigations Report (SIR) 2009-5136 "Regional Regression Equations for Estimation of Natural Streamflow Statistics in Colorado" by Joe Capesius and Cory Stephens. The equations define the statistical relations between streamflow statistics (response variables) and basin and climatic characteristics (predictor variables). The equations were developed using generalized least-squares and weighted least-squares multilinear regression reliant on logarithmic variable transformation. Streamflow statistics were derived from at least 10 years of streamflow data through about 2007 from selected USGS streamflow-gaging stations in the study area that are representative of natural-flow conditions. Basin and climatic characteristics used for equation development are drainage area, mean watershed elevation, mean watershed slope, percentage of drainage area above 7,500 feet of elevation, mean annual precipitation, and 6-hour, 100-year precipitation. For each of five hydrologic regions in Colorado, peak-streamflow equations that are based on peak-streamflow data from selected stations are presented for the 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year instantaneous-peak streamflows. For four of the five hydrologic regions, equations based on daily-mean streamflow data from selected stations are presented for 7-day minimum 2-, 10-, and 50-year streamflows and for 7-day maximum 2-, 10-, and 50-year streamflows. Other equations presented for the same four hydrologic regions include those for estimation of annual- and monthly-mean streamflow and streamflow-duration statistics for exceedances of 10, 25, 50, 75, and 90 percent. All equations are reported along with salient diagnostic statistics, ranges of basin and climatic characteristics on which each equation is based, and commentary of potential bias, which is not otherwise removed by log-transformation of the variables of the equations from interpretation of residual plots. The predictor-variable ranges can be used to assess equation applicability for ungaged sites in Colorado. The report, USGS SIR 2009-5136, is available on-line at <http://pubs.usgs.gov/sir/2009/5136/>

Connecticut

- Investigating the effects of road salting on stream quality along a stretch of I-95 as part of an environmental impact study of a proposed plan to widen the highway.
- Field work will begin in the winter of 2009 on 4 streams with monitoring sites upstream and downstream of the highway. Monitoring includes continuous conductance, temperature, pH, and chloride at all 8 sites plus continuous streamflow monitoring at downstream sites.
- Discrete samples for chloride will be collected frequently and samples for major ions will be collected periodically. Data collection will continue through winter 2011 and data analysis and final report writing will happen in FY 2012.

Delaware

- No highway related projects at this time.

District of Columbia

- No highway related projects at this time.

Florida

- Updating flood frequencies for all gages and developing regional flood-frequency relations for streams in Florida for the 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-years. It has been more than 25 years since flood-frequency characteristics of streams were last evaluated and described. The length of the project is for 48 months.

Georgia

- Ongoing statewide flood and bridge-site studies at sites selected by GADOT. Flood report planned to document the 2009 flooding.
- Analysis and report of rural flood-frequency at gaging stations and regionalization and updated skew study completed have been published in Gotvald, A.J., Feaster, T.D., and Weaver, J.C., 2009, Magnitude and frequency of rural floods in the southeastern United States, 2006—Volume 1, Georgia: U.S. Geological Survey Scientific Investigations Report 2009–5043, 120 p. (<http://pubs.usgs.gov/sir/2009/5043/>)
- Project to Update Urban Flood Frequency Equations for Georgia is underway. Flood-frequency analyses completed. Expected report in late 2010.
- Maintain a statewide network of 50 crest-stage gages as part of an ongoing flood-frequency study.

Hawaii

- Operated a network of 70 crest-stage gages to monitor peak stages and discharges at or near highway crossings on the islands of Kauai, Oahu, Molokai, Maui, and Hawaii. The peak-flow data collected at these stations adds significantly to peak-flow data collected at continuous stations and improves regional coverage of peak-flow measurements in Hawaii. Thirty-seven of the 70 gages was funded by the Hawaii State Department of Transportation. Due to program cuts, only 38 crest-stage gages will be operated in Federal Fiscal Year 2010 (FY2010). Gages on Kauai, Molokai, and Maui will likely be discontinued.
- Monitored storm-water quality and quantity from a portion of the H-3 freeway near Aiea, and receiving water bodies. Water-quality samples are collected quarterly, during storms, at 5 stations, and streamflow is continuously monitored with telemetry at 3 of these stations. Two of the stream stations are now collecting suspended-sediment samples for daily sediment records. Two rain gages were also operated as part of this project. In FY2010, the storm-water quality at 5 sites and streamflow at one site will be discontinued.
- Monitored storm-water quality and quantity from a portion of the H-1 freeway near the University of Hawaii Manoa campus. A real-time storm-water monitoring station and raingage are now in operation. In FY2010, a water-quality auto sampler will be added to collect samples in the Ala Wai Canal concurrently with the storm-water samples.
- Currently updating flood-frequency estimating equations for ungaged streams in Hawaii. Results from this project will be incorporated into the Stream Stats package.

- **Recent Publications**

Presley, T. K. and Jamison, M. T.J., 2009, Rainfall, discharge, and water-quality data during stormwater monitoring, July 1, 2008, to June 30, 2009; Halawa Stream drainage basin and the H-1 storm drain, Oahu, Hawaii: U.S. Geological Survey Open-File Report 2009-1162, 48p. (<http://pubs.usgs.gov/of/2009/1162/>)

Idaho

- Several changes have been made to the Idaho StreamStats web site in 2009 that benefit the Idaho Transportation Department (ITD). The Idaho StreamStats web site has been updated to the "StreamStats Version 2" web application. In addition to everything the site did before, it now includes estimates of low flows, the probability of zero flows, and improved identification of perennial streams. Several additional tools have been added as well, including surface and stream profiles. The biggest change for Idaho, however, is the data behind StreamStats are now based on 10-meter DEMs. The basins delineations now are much better and more detailed than before. The improvements to Idaho StreamStats were accomplished in cooperation with the Idaho Department of Environmental Quality and the Bureau of Reclamation. ITD uses the Idaho StreamStats web site extensively in the design of their Idaho Bridge Watch program (an early-warning bridge scour monitoring program based on the Q25 and Q50) as well as for other transportation-related design projects. The Idaho StreamStats website is at <http://water.usgs.gov/osw/streamstats/idaho.html>

Illinois

- Field Verification of SRICOS-EFA for Illinois Streams—The Scour Rate In Cohesive Soils-Erosion Function Apparatus (SRICOS-EFA) Methodology outlined in the National Cooperative Highway Research Program Report 24-15, provides a potentially useful methodology for assessing scour in cohesive sediments, but field validation data for the method are limited. The overall objective of this study is to test the SRICOS-EFA method for estimating scour depth of cohesive soils in Illinois streams. The project is near completion with data collection, laboratory testing, and modeling finished. A report has been drafted and is currently in review.

Indiana

- INDOT cooperatively funds 22 continuous-record gaging stations.

Iowa

- Cooperatively funds 25 continuous-record gaging stations.
- Cooperatively funds 89 crest-stage gages.
- Cooperatively funds ongoing flood-profiles project to document water-surface profiles of significant flood events. The flood of June 2008 was very extensive across eastern and central Iowa which lead to an expanded flood-profiles project to document flood elevations at 86 bridge sites along 630 river miles of the Iowa, Cedar, and Upper Iowa Rivers. 2008 flood elevations have been compiled for 236 stream sites along these three rivers (includes high-water marks collected by other agencies at 150 stream sites). Two flood-profiles reports will be published in 2010 to document the 2008 flood (a report for the Upper Iowa River and a combined report for the Iowa and Cedar Rivers). Additional cooperative funding was provided to the project from July 2008 through September 2010 to produce these two reports.
- Iowa StreamStats—A 2006-2012 investigation to develop a comprehensive flood-estimation method for unregulated, rural streams in Iowa. Specific objectives are to: (1) Implement an interactive StreamStats Web site for Iowa that allows users to easily select stream sites and estimate flood-frequency discharges by automating the measurement of basin characteristics and calculation of regression estimates. (2) Develop two sets of regional regression equations, one set for basins with drainage areas less than 50-100 square miles and another set for basins with drainage areas greater than 10-50 square miles, to estimate flood-frequency discharges. (3) Define the same hydrologic regions for both sets of regional regression equations, unless, the definition of a separate set of hydrologic regions for each set of small- and large-basin regression equations provides a significant improvement in the overall predictive accuracy of both sets of regression equations. (4) Develop the smallest drainage-area range for a transition zone as possible for Iowa to prevent the possibility of small-basin regression estimates exceeding large-basin regression estimates. In 2009, the project

was extended with additional cooperative funding to update flood-frequency discharges through the 2008 water year. The 2008 flood-frequency updates will include EMA (expected moments algorithm) analyses and new regional skews developed by Cornell University using Bayesian GLS (generalized least-squares) regression analysis.

Kansas

- The Kansas Water Science Center streamflow statistics project has provided improved estimates versus the ungaged regression equations for 5427 stream segments for flood frequency and various duration flows.
- The Kansas StreamStats is on the web at <http://ks.water.usgs.gov/Kansas/studies/strmstats/>.
- Cooperatively funds 37 crest-stage gages.
- The Kansas Water Science Center continued to verify theoretical stage-discharge ratings using direct measurement of flow at Flood Alert streamgages operated by Johnson County. Once the ratings for all stations are verified, peak-flow information can be used to develop flood-frequency equations for urban sites.
- Currently, there are few active streamgages (<30) in Kansas with drainage areas less than 32 mi² used to compute flood frequency. National Weather Service radar precipitation estimates from significant storms were used to locate peak runoff events on streams in Eastern Kansas. The peak discharge at these selected sites was measured by indirect methods. The relation between discharge per unit area (Q/DA) was related to the probability of the precipitation event, and other basin characteristics. These relations were tested to determine if flood frequency equations developed using gaged data from streams less than 32 and less than 5.4 mi² using the Q/DA relations were valid. The precipitation/flood frequency determinations at 28 sites were compared to the traditional flood frequency equations, flood-frequency equations using Q/DA, and the rational method equations. The newly developed Q/DA equations were superior to the other methods in this comparison. The full report can be found at <http://pubs.usgs.gov/sir/2008/5112/>.
- The Kansas program with Kansas Department of Transportation was ended September 30, 2009 because of State budget problems. Five crest-stage gages will be retained for operation in exchange for office space in a KDOT facility.

Kentucky

- No highway related projects at this time.

Louisiana

- A cooperative program with the Louisiana Department of Transportation and Development (LA DOTD) to operate 10 continuous real-time streamflow data collection stations, 13 real-time stage stations, 17 non-recording crest-stage gages, and 7 non-recording flood-profile gages.
- Cooperative program with LA DOTD to operate 12 real-time monitoring network gages specifically located on major hurricane evacuation routes. These gages monitor water-levels, precipitation, and wind speed. The gage can eventually be used to transmit traffic volume and average speed data for LA DOTD. Wind speed information could be used to make informed decisions on bridge overpass closure, and water-level information would be used to make informed decisions on closing evacuation routes due to flooding. This network is expected to expand to 22 sites in the future.
- **Sustainable Yield of Select Streams and Reservoirs in Louisiana**—Because of recent droughts, various government agencies, communities, and private groups are considering various streams, lakes, and reservoirs in Louisiana for alternate or emergency supplies of freshwater for municipal, industrial, or agricultural use. However, the amounts of available water required for local needs may be inadequate or unreliable from many of these sources, especially during drought conditions. In addition, excessive water withdrawals may result in adverse environmental, economic, or social impacts. The USGS in cooperation with the U.S. Department of Transportation (LDOT) is conducting a study to estimate the sustainable yield of selected streams, lakes, and reservoirs in Louisiana. Most of the Streams included are those that have adequate record lengths for computation of streamflow statistics. The reservoirs included are a subset of the Dams/Reservoirs that were constructed or are maintained by LDOT.

- **Watershed Response Monitoring on Bundicks Lake**—Bundick Lake was formed in 1961 when the dam was constructed on Bundick Creek. After construction, when the normal pool elevation was reached, private camps, piers, loading ramps, docks, and other structures were built along the perimeter of the Lake. The normal fluctuations in water level can interrupt the use of these features, and in some cases, result in damages to structures not designed to accommodate the changing water-levels. The users of these structures have generated interest in regulating the water level of the lake. Lake-side land owners are requesting that water levels in the lake be lowered prior to heavy rainfall events that increase lake levels. Monitoring of the Bundick Creek watershed is necessary to provide an estimate of potential increase in lake levels during rainfall events and trigger water releases to lower the lake level. This study is in cooperation with the U.S. Department of Transportation. Gages were installed at the lake to monitor the pool elevation , and upstream to monitor streamflow. The upstream site has become a forecast site by the National Weather Service, who is very interested in our rating development at the site.

Maine

- **The Effect of road-salt on bedrock wells**—USGS, in cooperation with MaineDOT, is studying possible long-term effects of road-salting practices on the quality of bedrock ground water. USGS is using geophysical data, water-quality analyses, and continuously recorded water level, water temperature, and specific conductance data from 4 wells to understand the roles of fractures on the persistence of chloride in bedrock.
- **Impact of historical peak-flow stationarity on bridge design**—The USGS, in cooperation with MaineDOT, is determining how design peak-flow estimates (such as the 100-year peak flow) vary when different periods are used for the computation of the estimates, for 28 regulated and unregulated streams in Maine that have at least 50 years of data. Design peak-flow estimates based on sub-periods of record are being compared to estimates (and confidence intervals) of those based on full periods of record. As part of the project, the magnitude of changes over time for maximum annual streamflows are being determined.
- **Impact of future peak-flow stationarity on bridge design**—The USGS, in cooperation with MaineDOT, will project future annual peak streamflows for 4 basins in coastal Maine, using the PRMS distributed-parameter watershed model, with input from multiple global climate models and future scenarios. Future design peak flows for selected recurrence intervals will be computed based on projected future flows and compared to design peak flows based on historical flows. As part of this project, historical peak flows and design peak flows will be modeled with PRMS and the accuracy of the models will be determined.
- **Small-watershed data collection**—Peak-flow data collection (crest-stage gages) continues on 12 streams, all with basins less than one square mile. Nine sites have 9 complete years of data collection, three sites have 8 complete years of data collection, and two have less than 5 years of data. In addition, 7 seasonal rain gages have been installed to prepare for a future time-of-concentration study. Five basins were selected for rain gages and two rain gages have been installed in each of two basins; one rain gage near the flow monitoring point and the other in the headwaters of the basin.
- **Continuous streamflow data collection**—Continuous data collection continues at 18 USGS streamflow gages and one tide gage.
- **Recent Publications**
 - Lombard, P.J., and Hodgkins, G.A., 2008, Comparison of observed and predicted abutment scour at selected bridges in Maine: U.S. Geological Survey Scientific Investigations Report 2008-5099, 23 p. <http://pubs.usgs.gov/sir/2008/5099/>

Maryland

- Thirteen stream gages were cooperatively funded by the Maryland State Highway Administration.

Massachusetts

- **The Quality of Stormwater Runoff Discharged from Massachusetts Highways**
Status: Monitoring Complete.
Report: USGS Scientific Investigations Report 2009-5269 (to be published in early 2010).

The purpose of the project is to document current concentrations of suspended sediment, particle size, selected dissolved ions, total nutrients, selected total-recoverable metals, and semivolatile compounds in highway runoff discharge from common highway-drainage conveyance structures in MA. Highway-monitoring stations were installed on 8 highways at 12 locations in MA. Automatic-monitoring techniques were used to collect composite samples of highway runoff and make continuous measurements of several physical characteristics. Flow-weighted samples of highway runoff were collected automatically during 140 rain and mixed rain, sleet, and snow storms from September 2005 and to September 2007. These samples were analyzed for physical characteristics and concentrations of 6 dissolved major ions, total nutrients, 8 total-recoverable metals, suspended sediment, and 85 semivolatile compounds (SVOCs). The study resulted in storm-event monitoring data from 1,523 storms with 14,563 EMC values. The final report also includes information about the quality and grain-size distribution of suspended sediment, soils at the edge of pavement, and soils near the highway.

- **The Quality of Stormwater Runoff Discharged from Massachusetts Highways in Ecoregion 84 (the Atlantic Coastal Pine Barrens)**

Status: Monitoring Complete. Final Report in Preparation

The data collected from the principal highways in MA indicated that the quality of runoff from a site in Ecoregion 84, where soil and vegetation is different from the rest of the State, was different from quality of runoff in other areas of MA, even for sites with similar traffic and land-use densities. Analysis of background soil samples collected during the study along the highways indicated that concentrations of trace metals in soils within Ecoregion 84 were considerably lower than in other ecoregions. This study was designed to collect more samples from the original test site, along Interstate 195 in Marion MA and a new test site along Route 6 near Harwich MA. EMCs for suspended sediment, major ions, nutrients, and trace elements were collected for 10-13 storms at the existing site on Interstate 195, and 15-18 storms at the near Harwich MA.

- **Effectiveness of catch basin hoods for retaining floatable debris, oil and grease, and total petroleum hydrocarbons in highway catch-basin sumps**

Status: Final Monitoring Complete. Final Report in Preparation

Catch-basin hoods are intended to enhance catch-basin performance by retaining floatable debris at the water surface within the sump of the catch basin. Evidence from recent highway-runoff quality studies in MA indicated that these hoods may not be highly effective. At the conclusion of the 14-month study targeting a hooded catch basin, the structure was virtually absent of floatable debris. Additional evidence indicating that catch-basin hoods were not effective in retaining floatable debris included the observation of large amounts of floatable debris found not only in the downstream water-quality inlet of the catch basin under study, but in four other water-quality inlets located along the Southeast Expressway that also received discharge from hooded catch basins. The purpose of the project is to document the effectiveness of cast-iron hoods in reducing the amount of floatable debris discharged from Southeast Expressway near Boston, Massachusetts. The results of this study will be useful for determining the physical and hydrologic circumstances that affect catch-basin hood performance. The amount of debris in catch basins at the beginning and end of the study are measured. Precipitation and runoff are monitored using automated methods. Samples of floatable debris were collected from six catch-basin outfalls. Water samples were collected and analyzed for oil and grease, and total petroleum hydrocarbons. Surveys are taken to assess the potential available mass of debris and to characterize the type of debris potentially available for washoff.

Michigan

- The Michigan Water Science Center operates 10 continuous record streamgages and 5 crest-stage gages for the Michigan Department of Transportation.
- Collected stream geomorphic data across Michigan and developed regional channel geometry curves for Southern Lower Michigan Ecoregion; data and curve analysis can be used in assessment of stable channel dimensions in the proximity of road crossings.

- **Recent Publications**

- Rachol, C.M., and Boley-Morse, Kristine, 2009, Estimated bankfull discharge for selected Michigan rivers and regional hydraulic geometry curves for estimating bankfull characteristics in southern Michigan rivers: U.S. Geological Survey Scientific Investigations Report 2009--5133, 300 p. (<http://pubs.usgs.gov/sir/2009/5133/>)

Minnesota

- Operating a network of 77 crest-stage gages for flood frequency analysis. Updated data are being analyzed for an approved Flood Frequency Report on Small Streams for Minnesota. This report is in review planned for publication in FY 10.
- Minnesota has implemented StreamStats in FY 09 and is undergoing quality assurance.
- Provide hydraulic investigation support as requested, including bridge scour.
- Publishing the approved report that summarizes baseline water-quality conditions for a multi-year cooperative investigation of the effects of a proposed four-lane divided highway on the water quality and hydrology of relatively pristine streams and wetlands that drain to a large lake important for fisheries and tourism. The highway expansion has been delayed due to funding cuts, so an interpretive report will summarize only pre-construction conditions.
- Update StreamStats with new hydrologically enhanced Digital Elevation Models using the latest watershed boundaries from the Basin Characteristics project/Minnesota Department of Natural Resources Lakeshed Project (http://www.dnr.state.mn.us/watersheds/lakeshed_project.html).
- All basin characteristics data is available on-line at the Minnesota Watershed Information Project <http://gisdmnsp.cr.usgs.gov/watershed/index.htm>. This web page allows users to get basin characteristics and watershed areas for over 10,000 level 4-7 watersheds in and around Minnesota.

Mississippi

- Continue to provide streamflow records, hydrologic analyses of basins, and hydraulic analyses of the flooding potential at selected stream crossings, known as bridge-site studies. Scour analyses are also conducted at selected sites.
- Continue to operate and maintain 88 crest-stage gages and 2 flood hydrograph gages.
- Continue to operate a near real-time scour monitoring gage at a coastal bridge. Streambed soundings are obtained at this and other selected bridges to document scour.
- Continue to prepare an updated version of the 1991 flood-frequency reports to include the use of GIS determined basin characteristics for development of regional flood-frequency equations and the implementation of StreamStats. Plan to finish the flood frequency update for StreamStats in FY 2010. The following watershed boundary map has been printed and awaits the open-file report being made available on the web before public distribution.
- Streamflow statistics that were compiled from published annual data, low-flow, and flood-frequency reports are now available on the National StreamStatsDB web page at: <http://streamstats.usgs.gov/gages/viewer.htm>
- Continue to maintain web access for selected historical flood reports at the USGS Mississippi Water Science Center (MSWSC) page at: <http://ms.water.usgs.gov>. Along the left side of the current MSWSC page, see: **Surface-Water Data and Maps, Historical Publications, Hurricane Camille Atlas, and Bridge Backwater Atlases**. The MSWSC page is being updated.
- **Recent Publications**
 - Wilson, K.V., Jr., Clair, M.G., II, Turnipseed, D.P., and Rebich, R.A., 2009, Watershed boundary dataset for Mississippi: U.S. Geological Survey Scientific Investigations Map 3020: Scale 1:500,000
 - Wilson, K.V., Jr., Clair, M.G., II, Turnipseed, D.P., and Rebich, R.A., 2009, Development of a watershed boundary dataset for Mississippi: U.S. Geological Survey Open-File Report 2008-1198, xx p.

Missouri

- Operated a network of 38 crest-stage gages to be used with future flood frequency study.

- Operation and maintenance of 7 stream-gaging stations as part of the state-wide stream-gaging network.
- Operated two near-real-time scour monitors at gaged sites: Chariton River near Novinger, Missouri, and Mississippi River at Mehlville, Missouri. These are both scour-critical sites and the monitoring is part of MoDOT's action plan for remediation. Mississippi River site was supplemented with three bathymetric surveys of pier with sensor and other nearby, unmonitored piers using multibeam echosounder this year. Current findings documented in report by Rydlund, P.H., Jr., (in press), Real-Time River Channel-Bed Monitoring at the Chariton and Mississippi Rivers in Missouri, 2007-09: U.S. Geological Survey Scientific Investigations Report 2009-XXXX.
- Bathymetric survey using multibeam echosounder at structure A-1700 over the Mississippi River on I-155 near Caruthersville, MO, for Tennessee DOT.
- Bathymetric survey and habitat assessment at site of proposed I-70 bridge over the Mississippi River at St. Louis, MO, to be documented in report by Huizinga, R.J., Elliott, C.M., and Jacobson, R.B., (in review), Bathymetric and velocimetric survey and assessment of habitat on the Mississippi River in the vicinity of the proposed Interstate 70 Bridge at St. Louis, Missouri, U.S. Geological Survey Scientific Investigations Report 2010-XXXX.
- First in a series of bathymetric surveys at site of new bridge for U.S. 59 over the Missouri River at Atchison, KS for Kansas DOT to monitor the main channel pier of old U.S. 59 bridge for additional scour effects from coffer dam of new pier.

Montana

- Bridge-scour data collection and analysis program ongoing since 1991. As part of this program, near real-time scour monitoring is being conducted at four sites.
- Small-stream peak-discharge data collection program ongoing since 1955. Currently operating 96 crest-stage gages and 3 flood-hydrograph continuous-record streamflow gages.
- Ongoing cooperative project to investigate the hydrology of selected wetland areas affected by proposed highway projects.
- Monitor scour and related hydraulic conditions at the I-90 bridge near the mouth of the Blackfoot River following the 2008 removal of Milltown Dam, which was located just downstream on the Clark Fork.

Nebraska

- No highway related projects at this time, but in contact with the Nebraska Department of Roads in developing StreamStats application for the state.

Nevada

- Maintain a Statewide network of 24 crest-stage gages.
- USGS and Nevada Department of Transportation entered into an agreement in FY06 to compute sediment loads in the Clear Creek Drainage. This study will assess the impact of runoff from a U.S. Highway. The study is event driven where the sample collection intensifies during snowmelt and summer thunderstorms. The report will be published in FY09. A proposal to continue monitoring sediment and selected water quality constituents in the Clear Creek drainage was submitted to the Nevada Department of Transportation in the summer of 2009 and a signed agreement was received in October, 2009 for this three year study.
- A web based flood chronology of the Carson River Basin in cooperation with the State of Nevada and FEMA is available at <http://nevada.usgs.gov/crflid/index.htm>. The web site shows frequency plots, lists of flood discharge with Return Periods or Recurrence Intervals, and digital photographs of floods in the Carson River Basin.
- **Recent Publications**

Crompton, E.J., 2008, Traveltime data for the Truckee River between Tahoe City, California, and Vista, Nevada, 2006 and 2007: U.S. Geological Survey Open-File Report 2008-1084, 12 p. (<http://pubs.usgs.gov/of/2008/1084/>)

Seiler, Ralph L.; Wood, James L., 2009, Sediment Loads and Yield, and Selected Water-Quality Parameters in Clear Creek, Carson City and Douglas County, Nevada, Water Years 2004-07: U.S. Geological Survey Scientific Information Report 2009-5005, 45 p.
(<http://pubs.er.usgs.gov/usgspubs/sir/sir20095005>)

New Hampshire

- A 2-year study was completed in FY09 that began in FY07 in cooperation with New Hampshire DOT to update regression equations for estimating flood-flow frequency on unregulated, rural streams and to implement StreamStats for the state of New Hampshire.
- New Hampshire Department of Transportation (NHDOT) funds approximately one-third of New Hampshire's stream-gaging network

New Jersey

- Operate and maintain 40 crest-stage gages on small drainage basins of less than 2 square miles, and 15 older crest-stage gages under 9 square miles in drainage area. After 10-years of record have been recorded, a study to compare the gaged results with the various flood magnitude and frequency estimation methods will be initiated.
- A bridge scour data collection project was started in April 2008. The general objectives of this program are to monitor and validate the effects of scour at NJDOT bridge structures designated as scour critical and to obtain updated flow and velocity data. This will be a long-term project with additional monitoring locations added each year. The monitoring work started in FY2008 includes:
 - Operate and maintain continuous-record discharge gaging stations at 5 locations to provide discharge data to improve models to calculate scour. Gage height and discharge data available in near real-time from <http://nj.usgs.gov>.
 - Continuous monitoring of streambed elevations at selected locations near bridge piers and abutments at 3 sites. The effects of scour at these bridge sites will be evaluated by NJDOT by monitoring streambed elevations over time at selected locations. Streambed elevation is available in near real-time from http://waterdata.usgs.gov/nj/nwis/current/?type=bridge&group_key=basin_cd
 - Survey channel cross-sections at multiple locations upstream and downstream of the bridge at the gages and the bridge at an additional 10 sites to monitor changes in channel geometry over time.
 - A crest-stage gage is operated and maintained at 1 bridge to record peak stage and discharge.
 - An acoustic doppler current profiler is operated and maintained to record a continuous-record of velocity at one gaging station.
- A new joint funding agreement with NJDOT proposes the expansion of the bridge scour data collection project to include the addition of new monitoring locations in fiscal year 2010. The agreement includes the installation of 7 new continuous-record monitoring stations and surveying of channel cross sections at an additional 13 locations. Continuous-record discharge gaging stations will be installed at 6 locations. Gage height and discharge data available in near real-time from <http://nj.usgs.gov>. Cross sections will be surveyed quarterly. Continuous monitoring of streambed elevations will be done at two location; one discharge gaging station and one stream-bed elevation only, both in near realtime. An ADCP on a boat will be used to survey the channel cross-section biannually at one site. The channel cross section will be surveyed at 12 other locations.

New Mexico

- **Flood Analysis**
 - Operate and maintain the New Mexico crest-stage gage network of 86 gages. Fifty-two of the crest-stage gages operated in ephemeral streams around the State are currently equipped with automated pressure transducers. Seventeen additional pressure transducers will be installed in existing gages this year.
 - Updated estimates of peak discharge magnitude for gaging stations in the region and regional equations for estimation of peak discharge and frequency at ungaged sites. Results are

published in Waltemeyer, S.D., 2008, " Analysis of the Magnitude and Frequency of Peak Discharge and Maximum Observed Peak Discharge in New Mexico and Surrounding Areas: USGS Scientific Investigations Report 2008-5119 (<http://pubs.usgs.gov/sir/2008/5119/>).

- Continued documentation of notable floods through collection of flood information such as peak stages and discharges by indirect measurements at miscellaneous flooded sites.
- **Streamstats**
 - The USGS Web application for stream information for New Mexico has been partially funded by the USGS in cooperation with the New Mexico Department of Transportation for FY 2010. Total reduction in funding from FY 2009 is 75 percent. Information about StreamStats can be found at <http://water.usgs.gov/osw/streamstats/>
 - The The StreamStats project submitted a "pilot area" to the National StreamStats Team for their web-site completion in order to have a functioning web-site example of the StreamStats program. The pilot area is being tested and will be available for public access in 2010.
 - GIS creation efforts on NHD and basin characteristics continue for the rest of the state.

New York

- Documentation of notable floods through collection of flood information such as peak stages and discharges at discontinued gages, flood profiles along flooded streams, and indirect flood discharge measurements at miscellaneous flooded sites.
- The interaction of two storm systems over western New York produced heavy rains and severe flash flooding in parts of Cattaraugus, Chautauqua, and Erie Counties during the early morning of August 10, 2009. Extensive flooding was reported in the villages of Gowanda and Silver Creek, New York. Both communities experienced floodwater elevations that exceeded the 500-year profiles published in the current FEMA flood-insurance studies. The USGS has already provided FEMA with post flood documentation of high-water marks and is proposing a project to prepare a flood report to document the flooding in these two villages and surrounding areas.
- Maintain a statewide network of 48 crest-stage gages.
- USGS continues to support GIS software included on a DVD in the report of updated flood-frequency relations for New York (Lumia, 2006) to provide an automated method of calculating flood frequency discharges until STREAMSTATS is fully operational in New York.
- The use of GIS techniques to automate the computation of estimated flood frequency discharges at any unregulated stream location in New York using STREAMSTATS is in progress. StreamStats in New York is operational and currently being tested.
- An effort to update a report showing the maximum known stages and discharges at nearly 1500 gaging stations in New York is in progress. Recurrence intervals will be assigned to each peak discharge, where feasible. The scope of this report was revised to include peaks from the 2006 water year due to significant flooding in 2006.
- USGS assisted the NYSDOT in the developing an RFP to use natural brine for use in highway de-icing in the Syracuse, NY area .USGS NY WSC is a member of the Technical Advisory Group for this project and the start of the brine-application project is planned for the 2009-2010 snow season.
- USGS NY WSC worked with the State Emergency Management Office, NYSDOT, NYSGS, and others to develop a statewide landslide susceptibility mapping project that is currently unfunded. Landslide monitoring continues in and around the Tully Valley, New York area, and two reports were prepared on the landslides in Tully Valley, NY.
- **Recent Publications**
 - Mulvihill, C.I., Baldigo, B.P., Miller, S.J., DeKoskie, Douglas, and DuBois, Joel, 2009, Bankfull discharge and channel characteristics of streams in New York State: U.S. Geological Survey Scientific Investigations Report 2009-5144, 51 p. (<http://pubs.usgs.gov/sir/2009/5144/>)
 - Mulvihill, C.I., Filipowicz, A., Coleman, A. and B.P. Baldigo, 2007, Regionalized Equations for Bankfull Discharge and Channel Characteristics of Streams in New York State— Hydrologic Regions 1 and 2 in the Adirondack Region of Northern New York: U.S.

- Geological Survey Scientific Investigations Report 2007-5189, 18 p., online only.
<http://pubs.usgs.gov/sir/2007/5189/pdf/SIR2007-5189.pdf>
- Mulvihill, C.I. and Baldigo, B.P., 2007, Regionalized equations for bankfull-discharge and channel characteristics of streams in New York State--Hydrologic region 3 east of the Hudson River U.S. Geological Survey Scientific Investigations Report 2007-5227, 15 p., online only. (<http://pubs.usgs.gov/sir/2007/5227/pdf/pdf/SIR2007-5227.pdf>)
- Suro, T.P., Firda, G.D. and Szabo, C.O., 2009, Flood of June 26-29, 2006, Mohawk, Delaware and Susquehanna River Basins, New York: U.S. Geological Survey Open-File Report 2009-1063, 354p. (<http://pubs.usgs.gov/of/2009/1063/>)
- Suro, T.P. and Firda, G.D., 2007, Flood of April 2-3, 2005, in the Esopus River Basin, New York: U.S. Geological Survey Open-File Report 2007-1036, 90 p. (<http://pubs.usgs.gov/of/2007/1036/>)
- Tamulonis, K.L., Kappel, W.M., and Shaw, S.B., 2009, Causes and movement of landslides at Rainbow Creek and Rattlesnake Gulf in the Tully Valley, Onondaga County, New York: U.S. Geological Survey Scientific Investigations Report 2009-5114, 18 p. (<http://pubs.usgs.gov/sir/2009/5114/>)
- Tamulonis, Kathryn, and Kappel, W.M., 2009, Dendrogeomorphic assessment of the Rattlesnake Gulf landslide in the Tully Valley, Onondaga County, New York: U.S. Geological Survey Scientific Investigations Report 2009-5134, 14 p. (<http://pubs.usgs.gov/sir/2009/5134/>)

North Carolina

- The USGS in cooperation with the North Carolina Department of Transportation (NCDOT) completed a pilot project to develop and implement the StreamStats application for the Upper French Broad River basin in western North Carolina. The pilot project utilizes the local resolution NHD product, 20-foot DEMs (derived from LIDAR data), and the most current regional streamflow regression equations, and datasets of landscape characteristics. Basin characteristics developed for the streamflow regression application, including National Oceanic and Atmospheric Association (NOAA) rainfall intensity data, topographic variables (for example slope and drainage area) and best available land cover classifications, were incorporated into StreamStats. A Factsheet (<http://pubs.usgs.gov/fs/2009/3088/>) was published to document the StreamStats application.

As an extension of the StreamStats project, work will be undertaken during the 2010FY to expand the processing of data layers that will be part of the eventual statewide StreamStats application

- On July 1, 2008, the North Carolina General Assembly passed House Bill 2436, Session Law 2008-107, Stormwater Runoff from Bridges Section 25.18.(a,b,c). This bill requires the North Carolina Department of Transportation (NCDOT) to study 50 bridges to (1) quantify the constituents in stormwater runoff from bridges across the state, (2) evaluate the treatment practices that can be used to reduce constituent loadings to surface waters from bridges, and (3) determine the effectiveness of the evaluated treatment practices.

Working collaboratively, NCDOT and USGS identified study objectives which could provide information valuable in helping understand the effects of bridge deck runoff on receiving water quality and in managing stormwater runoff from bridges. In order to better understand the effects of stormwater runoff from bridges on receiving waters the following tasks are being performed: (a) characterize stormwater runoff quality and quantity from selected representative bridges in North Carolina; (b) determine if the chemistry of bed sediments upstream and downstream from selected bridges differs substantially; (c) measure stream water quality upstream from selected bridges in order to compare bridge deck stormwater concentrations and loads to stream constituent concentrations and loads; and (d) estimate the length of the mixing zone at the bridge deck study sites under a range of flow conditions, where the mixing zone is defined here as the stream reach required for a point source of stormwater entering the stream from the bank to become fully mixed across the stream.

This investigation is measuring bridge deck runoff from 15 bridges across NC. Bridges represent a range of physiographic and climatic conditions, a range of average daily traffic (ADT), and a range in

size. Runoff from both concrete deck and asphalt deck bridges are being sampled. The goal is to sample 12 runoff events at each bridge during the study. Samples are being analyzed for a wide range of constituents, including nutrients, major ions and trace metals, oil and grease, and semivolatile organic compounds.

- Continued to operate a continuous water-quality streamflow gaging station on Goose Creek at Fairview, NC (02124692) just outside of Charlotte in cooperation with the NCDOT. The gaging station has been in operation since 1999 to monitor the water-quality effects of an interstate bypass that runs through the Goose Creek watershed where the presence of the Federally Endangered Carolina Healsplitter mussel has been documented. The site is also being used to develop a continuous rating of sediment load by directly measuring a sediment surrogate (specific conductance).
- The multi-state project to update rural flood-frequency relations for North Carolina in conjunction with the USGS WSC offices in South Carolina and Georgia was completed with the publication of three flood-frequency reports (one for each state). The updated relations are based on regionalization derived from watershed boundaries that cross state lines. The flood-frequency report for North Carolina is available online at <http://pubs.usgs.gov/sir/2009/5158/>. Flood-frequency estimates and basin characteristics for 828 gaged stations across the three states were combined to form the final database that was used in the regional regression analysis. Regional regression analysis, using generalized least-squares regression, was used to develop a set of predictive equations that can be used for estimating the 50-, 20-, 10-, 4-, 2-, 1-, 0.5-, and 0.2-percent chance exceedance flows for rural ungaged, basins in North Carolina, South Carolina, and Georgia. The final predictive equations are all functions of drainage area and the percentage of drainage basin within each of the five hydrologic regions. Contact Curtis Weaver (jcweaver@usgs.gov) concerning this project.
- **Recent Publications**
 - Wagner, C.R., Tighe, K.C., and Terziotti, Silvia, 2009, Use of StreamStats in the upper French Broad River basin, North Carolina—A pilot water-resources Web application: U.S. Geological Survey Fact Sheet 2009–3088, 4 p. (<http://pubs.usgs.gov/fs/2009/3088/>)
 - Weaver, J.C., Feaster, T.D., and Gotvald, A.J., 2009, Magnitude and frequency of rural floods in the Southeastern United States, through 2006—Volume 2, North Carolina: U.S. Geological Survey Scientific Investigations Report 2009–5158, 111 p. (<http://pubs.usgs.gov/sir/2009/5158/>)

North Dakota

- A network of 28 crest stage gages was operated in cooperation with the North Dakota Department of Transportation. The purpose of the network is to provide annual discharge peaks on small basins with less than 100 square miles. These data can then be used to improve our knowledge about flood frequencies on small basins and refine predictive regression equations.
- Operated two continuous record lake stage gage and one continuous-record discharge gage.
- A two-dimensional unsteady flow model for Devils Lake, North Dakota, is being developed in cooperation with the North Dakota Department of Transportation and the North Dakota State Water Commission. The objectives are to develop and apply a circulation model of Devils Lake. The model is being calibrated using data collected in 2006. The model will provide information on water movement patterns, lake level variations, and transport of dissolved materials throughout the lake under variety of weather, inflow, and lake-level conditions. The unsteady flow model will be calibrated and ready for simulations in November 2009.
- The StreamStats application is being developing for North Dakota. This work began in July 2008 and will be completed by December 2011.

Ohio

- A network of 18 crest-stage gages was operated in cooperation with the Ohio DOT and the Ohio Department of Natural Resources. The crest-stage gage data will be used to augment existing flood-frequency information available for Ohio.
- A brochure describing surface water in Ohio has been published. The brochure also describes research in support of highway projects. Morris, J.R. 2008, Surface water: U.S. Geological Survey, 4 p. (http://www.pdfdownload.org/pdf2html/pdf2html.php?url=http%3A%2F%2Foh.water.usgs.gov%2Freports%2Fowsc_2008_brochures%2FSurface_water_2008_OH_Web.pdf&images=yes)

Oklahoma

- Updating peak flows, flood-frequency estimates, and peak-streamflow frequency regression equations for Oklahoma utilizing 13 more years of recent data, updating the skew map, and using a consistent set of basin characteristic predictor variables.
- These regression equations and datasets will be implemented into the Oklahoma StreamStat. The StreamStats Program was created to make estimation of these characteristics easier, faster, and more consistent than previously used manual techniques. It is a map-based Internet application that allows users to easily and quickly obtain flood frequency statistics, basin characteristics, and other information.

Oregon

- Completed data analysis for estimating streamflow characteristics using regression equations, including flow duration and low-flow at ungaged sites for the entire state of Oregon. These coverages and equations will be implemented into Oregon StreamStats. A report describing this work has been published:

Risley, John, Stonewall, Adam, and Haluska, Tana, 2008, Estimating flow-duration and low-flow frequency statistics for unregulated streams in Oregon: U.S. Geological Survey Scientific Investigations Report 2008-5126 (<http://pubs.usgs.gov/sir/2008/5126/>).

Pennsylvania

- **StreamStats**—The current application of StreamStats for Pennsylvania is at: <http://water.usgs.gov/osw/streamstats/pennsylvania.html>. StreamStats for Pennsylvania can be used to estimate the following flow statistics:
 - Low-flows: 7-day, 10-year; 7-day, 2-year; 30-day, 10-year; 30-day, 2-year; 90-day, 10-year
 - Base-flows: 10-year, 25-year, and 50-year recurrence intervals
 - Mean flows: including the harmonic mean and mean annual flow
 - Flood-flows: 2- year, 5- year, 10- year, 50- year, 100- year, and 500-year recurrence intervals.
 - The application also can be used to determine selected basin characteristics at ungaged sites throughout the state.
- **Alternative streamflow measurement methods**—Continuous radar is being used to collect water-surface velocities at the Susquehanna River at Bloomsburg, Pa. (01538700) gaging station. A method of streamflow determination using a single-point surface-velocity method is being tested. The use of this instrument and the method is ideal especially during unsteady flow events such as those created by debris and ice jams and will help to provide real-time streamflow estimates throughout the year without the need for a series of flow measurements. Additional velocity data are being collected in open-water and ice-cover conditions at other sites that are a high-priority for the National Weather Service. The additional data will be corroborated with recently acquired acoustic velocity meters and an enhanced radar antenna.
- **Flood inundation mapping**—Development of flood inundation maps for selected water-surface elevations at National Weather Service (NWS) flood forecast points in the Susquehanna River basin. The initial study is located on the West Branch Susquehanna River at Jersey Shore, Pa. The final inundation map will be displayed on the NWS Advanced Hydrologic Prediction Service web site. Paper versions of the flood-inundation plates will be made available upon request to county and local emergency management agencies. The project is to be completed by December 2010.
- **Aquatic habitat**—Investigation and modeling of velocity and streambed configuration in relation to mussel habitat and bridge-pier design in the Allegheny River at Foxburg, Pa. A journal article describing the results of the study was completed:

Fulton, J.W., Wagner, C.R., Rogers, M.E., Zimmerman, G.F., 2010. Hydraulic modeling of mussel habitat at a bridge-replacement site, Allegheny River, Pennsylvania, USA. *Ecol. Model.* 221, 540-554 p.
- **Stream restoration**—Erosion and sedimentation, hydrologic alterations, channel/streambank modification, and the associated effects on aquatic habitat have been identified as threats in the French Creek basin in Crawford County, and are especially problematic in Wymans Run, a tributary to French Creek. Streambank erosion and sedimentation are evident throughout the watershed and contribute to flooding upstream of PA 285 bridge. Hydrologic alterations within the floodplain near the

bridge, and channel modifications through the reach upstream of the bridge also factor into the flooding problems. Changes to hydrologic and sediment-transport dynamics may have adversely affected the conveyance within the channel, and its ability to transport sediment. The hydraulic impact of various stream restoration and flood control measures along the main stem of Wymans Run for a range of streamflows will be evaluated with a one-dimensional model. Results will be delivered in a USGS report that is currently being prepared.

- **Wetland monitoring**—The Valley Creek Highway Encroachment project involves monitoring of a constructed wetland, stabilized stream reach in Valley Forge National Historical Park, and a planted riparian buffer began in 2000 and concluded in 2006. The project was done in cooperation with PennDOT District 6. Report:
Chaplin, J.J., White, K.E., and Olson, L.E., 2009, Physical and vegetative characteristics of a newly constructed wetland and modified stream reach, Tredyffrin Township, Chester County, Pennsylvania, 2000–2006: U.S. Geological Survey Scientific Investigations Report 2009-5020, 64 p. (<http://pubs.usgs.gov/sir/2009/5020/>)
- **Gages**—A network of crest-stage and continuous-record streamgages are operated statewide to provide real-time and historical stage and streamflow data to support real-time flood-warning and forecasting efforts. The network will also be used in the development of statistics to describe and predict low-flow and peak-flow conditions.

Puerto Rico

- Conducting weekly point sampling to determine the turbidity levels at the Laguna del Condado in San Juan, as part of the construction of a new bridge at the site highway.

Rhode Island

- No highway related projects at this time.

South Carolina

- Operates 6 continuous-record gaging stations and 49 partial-record crest-stage stations. (Number of gaging stations fluctuates slightly from year to year.)
- **Live-bed pier and contraction scour envelope curves**

In August 2004, the U.S. Geological Survey (USGS) and South Carolina Department of Transportation (SCDOT) began a cooperative program to investigate live-bed pier and contraction scour in the Piedmont and Coastal Plain of South Carolina. The purpose and objectives of this project included (1) the documentation of historic occurrences of live-bed pier scour and contraction scour at approximately 80 bridges in the Piedmont and Coastal Plain of South Carolina using ground penetrating radar; focus was given to old bridges and bridges that have had large floods; (2) a comparison of observed scour with predicted scour in order to assess the scour-prediction methods of HEC-18; (3) the investigation of various physical relations that may help explain live-bed scour processes in South Carolina; and (4) the development of envelope curves for evaluating the potential for live-bed pier and contraction scour in South Carolina. This project was completed in March 2009 and the published report can be found at the following link:

Benedict, S.T., and Caldwell, A.W., 2009, Development and evaluation of live-bed pier- and contraction-scour envelope curves in the Coastal Plain and Piedmont Provinces of South Carolina: U.S. Geological Survey Scientific Investigations Report 2009–5099, 108 p. (<http://pubs.usgs.gov/sir/2009/5099/>)

- **Evaluation of the Maryland abutment-scour equations using field data**

The USGS, in cooperation with the Maryland State Highway Administration, used field measurements of scour to evaluate the sensitivity of the Maryland abutment-scour equation to the critical- (or threshold-) velocity variable. This evaluation was accomplished by applying four selected methods for estimating threshold velocity to the Maryland abutment-scour equation and comparing the predicted scour to the field measurements. Results indicated that performance of the Maryland abutment-scour equation was sensitive to the threshold velocity with some threshold-velocity methods producing better estimates of predicted scour than others. Additionally, results indicated that regional stream characteristics can affect the performance of the Maryland abutment-scour

equation with moderate-gradient streams performing differently than low-gradient streams. Based on the findings of the investigation, guidance for selecting threshold-velocity methods for application to the Maryland abutment-scour equation are provided and limitations noted. This project was completed in the fall of 2008 and the journal article documenting the findings is currently in review with the Journal for the Transportation Research Board.

- **Evaluation of recently developed NCHRP abutment-scour equations**

The USGS in cooperation with the National Cooperative Highway Research Program (NCHRP) will evaluate the performance of recently developed abutment-scour equations using 324 field measurements of abutment scour collected in South Carolina (Benedict, 2003), Maine (Lombard and Hodgkins, 2008), and the USGS National Bridge Scour Database (NBSD; <http://water.usgs.gov/osw/techniques/bs/BSDMS/index.html>; Wagner and others, 2006). Results from the analysis will identify performance characteristics for each scour-prediction method and will help formulate application guidance. This project is scheduled to start in FY2010.

- **Bridge-scour envelope curve guidance manual**

The The USGS, in cooperation with the SCDOT conducted a series of three field investigations (Benedict, 2003; Benedict and Caldwell, 2006; Benedict and Caldwell, 2009) with the goal of collecting historic scour measurements in order to better understand regional trends of scour within South Carolina. The studies collected historic scour data at approximately 200 riverine bridges including measurements of clear-water abutment, contraction, and pier scour, as well as live-bed contraction and pier scour. These investigations have provided valuable insights for regional scour trends and have yielded bridge-scour envelope curves for assessing all components of scour at riverine bridges in South Carolina. The application and limitations of these envelope curves are documented in 3 reports. Each report addresses different components of bridge scour and there is a need to develop an integrated procedure for applying the envelope curves to help assess scour potential at riverine bridges in South Carolina. This project will integrate the 3 previous investigations and provide a guidance manual for application of the integrated procedure. This project is anticipated to start in FY2010.

- **Application of South Carolina envelope curves to selected bridges in South Carolina**

The Federal Highway Administration (FHWA) has begun an initiative to encourage states to determine the characteristics of bridge foundations over waterways that are currently classified as having unknown foundations. The South Carolina Department of Transportation (SCDOT) has initiated an investigation to estimate foundations at approximately 600 bridges with unknown foundations. Once the foundation characteristics have been defined, the SCDOT will need to evaluate the bridges for scour vulnerability. The U.S. Geological Survey (USGS) has developed regional bridge-scour envelope curves for each component of scour based on three field investigations of historic scour in South Carolina. The bridge-scour envelope curves can be used to help assess the potential for scour at selected bridges without the need for a detailed hydraulic model. The purpose and objective of this investigation is to develop a protocol and template for applying the South Carolina bridge-scour envelope curves, and then assess the scour vulnerability using the envelope curves at the bridges provided by the SCDOT. The project is anticipated to start in FY2010.

- **Rural flood frequency investigation**

A multistate approach was used to update methods for estimating the magnitude and frequency of floods in rural, ungaged basins in South Carolina, Georgia, and North Carolina that are not substantially affected by regulation, tidal fluctuations, or urban development. Annual peak-flow data through September 2006 were analyzed for 943 streamgaging stations having 10 or more years of data on rural streams in South Carolina, Georgia, North Carolina, and adjacent parts of Alabama, Florida, Tennessee, and Virginia. Flood-frequency estimates were computed for the 943 stations by fitting the logarithms of annual peak flows for each station to a Pearson Type III distribution. As part of the computation of flood-frequency estimates for the stations, a new value for the generalized skew coefficient was developed using a Bayesian generalized least-squares regression model.

Additionally, basin characteristics for these stations were computed by using a geographical information system and automated computer algorithms.

Regional regression analysis, using generalized least squares regression, was used to develop a set of predictive equations that can be used to estimate the 50-, 20-, 10-, 4-, 2-, 1-, 0.5-, and 0.2-percent chance exceedance flows for rural, ungaged basins in South Carolina, Georgia, and North Carolina. Flood-frequency estimates and basin characteristics for 828 streamgaging stations were combined to form the final database used in the regional regression analysis. The final predictive equations are all functions of drainage area and percentage of the drainage basin within each hydrologic region.

As a result of this investigation, three USGS Scientific Investigation Reports and one USGS Fact Sheet were published as follows:

Gotvald, A.J., Feaster, T.D., and Weaver, J.C., 2009, Magnitude and frequency of rural floods in the southeastern United States, 2006—Volume 1, Georgia: U.S. Geological Survey Scientific Investigations Report 2009–5043, 120 p. (<http://pubs.usgs.gov/sir/2009/5043/>)

Feaster, T.D., Gotvald, A.J., and Weaver, J.C., 2009, Magnitude and frequency of rural floods in the Southeastern United States, 2006—Volume 3, South Carolina: U.S. Geological Survey Scientific Investigations Report 2009–5156, 226 p. (<http://pubs.usgs.gov/sir/2009/5156/>)

Weaver, J.C., Feaster, T.D., and Gotvald, A.J., 2009, Magnitude and frequency of rural floods in the Southeastern United States, through 2006—Volume 2, North Carolina: U.S. Geological Survey Scientific Investigations Report 2009–5158, 111 p. (<http://pubs.usgs.gov/sir/2009/5158/>)

Feaster, T.D., Gotvald, A.J., and Weaver, J.C., 2009, Methods for estimating magnitude and frequency of rural floods in the Southeastern United States: South Carolina: U.S. Geological Survey Fact Sheet 2009–3085, 2 p. (<http://pubs.usgs.gov/fs/2009/3085/>)

- **Urban flood frequency investigation**

Urbanization can produce significant changes in the flood-frequency characteristics of streams; consequently, rural basin flood-frequency relations are typically not applicable to urban streams. Updates and improvements of South Carolina's highway infrastructure at stream crossings require an ongoing understanding of flood characteristics especially for urban watersheds. In addition, urban planners and engineers need current information for establishing flood-insurance rates and other water-resource management decisions. One of the tools necessary for such management are techniques that allow for the estimation of the magnitude and frequency of floods at sites on urban streams where gaged data are not available.

Using a similar approach as was used for updating regional flood-frequency equations for rural basins in the Southeastern United States, the USGS has proposed a similar approach for an urban flood-frequency investigation. The USGS South Carolina Water-Science Center would seek to work with the North Carolina and Georgia Water-Science Centers to update the urban flood-frequency equations using a multi-state regional approach.

The specific objectives of the investigation would be to (1) update the magnitude and frequencies of peak-flows at urban stations, (2) update basin characteristics for the urban stations using consistent geographical information system methods, and (3) update the regional urban-flood-frequency equations for the 50-, 20-, 10-, 4-, 2-, 1-, 0.5-, and 0.2-percent chance exceedance flows. The project is anticipated to start in FY2010.

- **Characterization of storm runoff from selected South Carolina Department of Transportation (SCDOT) Maintenance Yards**

The SCDOT operates maintenance yards throughout the State. At this time, the SCDOT has no data to define the quality of stormwater leaving these sites. To provide these data, the USGS will conduct an investigation to identify and quantify constituents that are transported in stormwater runoff from two maintenance yards and a section shed. The two maintenance yards, located in North Charleston and Conway, S.C., represent facilities where equipment and road maintenance materials are stored and that conduct complete equipment repair operations. The section shed, located in Ballentine,

S.C., (about 15 miles west of Columbia, S.C.) is a facility that stores equipment and road maintenance material. Water-quality samples and flow measurements of stormwater runoff will be collected at these sites. In addition to identifying and quantifying constituents that are transported in stormwater runoff from SCDOT maintenance facilities, the information collected in this investigation also may be used by the SCDOT in the development of stormwater management plans and to address future, potential National Pollutant Discharge Elimination System (NPDES) permit requirements to characterize and mitigate stormwater quality at these sites. This 4-year investigation began on October 5, 2009.

The objective of this investigation is to collect sufficient stormwater water-quality and flow data to document the type, concentration, and load of selected constituents transported from SCDOT maintenance yards by stormwater runoff. Water-quality samples will be taken from 1 to 2 locations at each site. A total of 5 sites will be sampled. The total sample locations at each facility are Ballentine (1), North Charleston (2), and Conway (2). Over a two-year period, one sample per season (winter, spring, summer, and fall) will be collected at each site as a flow-weighted composite or a grab sample, as appropriate. A total of eight samples will be collected at each location. These samples will be analyzed for selected constituents including suspended sediment, total suspended solids, turbidity, total organic carbon, biochemical oxygen demand, selected metals, nutrients, oil and grease, and polyaromatic hydrocarbons. Flow measurements will be made at the time of sampling in order to composite the samples and compute constituent load leaving the yards. Rainfall data also will be collected at each site. The results of the investigation will be published during the final year of the project.

South Dakota

- Operate a network of about 50 crest-stage gages for the purpose of peak-flow analysis.
- A statewide update of peak-flow frequency estimates for gaged streams in the state was completed in July, 2008. Results are provided in Scientific Investigations Report 2008-5104, which was published as an online-only report. The citation is: SIR 2008-5104: Peak-flow Frequency Estimates Based Data through Water Year 2001 for Selected Streamflow-Gaging Stations in South Dakota, 2003–07 (<http://pubs.usgs.gov/sir/2008/5104/>)
- Work has been completed on a multi-year study initiated in 2003 to evaluate scour potential at bridges on primary highways using a combination of Level 1.5 and Level 2 analyses. Results are provided in Scientific Investigations Report 2008-5161, which was published as an online-only report. The citation is: SIR 2008-5161: Estimation of Potential Bridge Scour at Bridges on State Routes in South Dakota, 2003–07 (<http://pubs.usgs.gov/sir/2008/5161/>)
- Implementation of StreamStats in South Dakota was initiated in 2005 and was recently extended to continue through 2009 to allow incorporation of high-resolution topographic data that now have been completed. A separate project (with different cooperators) to develop a 6th level Hydrologic Unit Map for South Dakota also has been completed and will serve as another cornerstone for StreamStats digital base layers.
- A recent reconnaissance-level study demonstrated the utility of using paleoflood hydrology techniques to improve peak-flow frequency estimates for the Black Hills area of South Dakota. A subsequent study phase that involves three other cooperating agencies (besides SDDOT and USGS) has now been implemented within four major stream basins in the area. The primary approach involves extrapolation of peak-flow records through stratigraphic analysis and age dating of flood slackwater deposits that provide chronologies of very large flood events that may date back as much as several millennia. Results of the reconnaissance-level study are provided through an online-only report that is available via the SDDOT Office of Research web site at: http://www.state.sd.us/Applications/HR19ResearchProjects/oneproject_search.asp?projectnbr=SD2005-12
- SDDOT and USGS implemented two new project starts during 2009. One project involves analysis of potential bridge scour for sites along local government roads. An important component of this work will be to develop regression equations specific to South Dakota for bridge velocity and head loss, which should substantially improve the scour predictions. The other project involves updating of statewide regression equations for estimating peak-flow magnitudes and frequencies for ungaged

streams, which will improve estimates of peak-flow magnitudes for the numerous ungaged locations associated with the local government bridge sites.

Tennessee

- Providing hydraulic interpretative support and miscellaneous flood-measurement support to Tennessee Department of Transportation (TDOT) as needed.
- Operating an ongoing network of 60 crest-stage gages at or near highway crossings and operating another 12 stage-discharge gages across the state for the purpose of flood-frequency analysis and general resource evaluation.
- Routinely updating basin characteristics files and statewide flood-frequency equations for ungaged streams in Tennessee. Our most recent update was based on the region-of-influence statistical model and was completed in FY 2003.
- Continuously monitoring turbidity and relating turbidity to sediment concentrations on a stream in West Tennessee. This was initiated in FY2004.
- Large-scale study of the effects of highway construction on stream ecology throughout Tennessee—looking specifically at sediment export from disturbed areas, the efficiency of sediment control structures (EPSCs) at construction sites, sediment transport processes, the effects of sediment on downstream habitat and biotic communities, and improved methods for monitoring sediment-related effects. This work began in FY2004 and will continue through FY2014.
- Refining GIS coverages and enhancing tools and analytical protocols for the Tennessee Streamstats page (<http://water.usgs.gov/osw/streamstats/tennessee.html>). This page was completed and released in 2007.
- Developing and applying GIS techniques to identify karst features on a regional scale and producing a GIS karst dataset for Tennessee. The dataset of karst features will span the eastern 2/3 of Tennessee classified as karst and will include closed depressions and their watersheds. The GIS techniques will be applied to the highest-resolution and most accurate digital elevation datasets available for Tennessee. This work began in FY2009 and should continue through FY2011

Texas

- **Bed Mobility in Edwards Plateau, Central Texas (FY05-08): Completed**

The SW research group with the Texas Water Science Center has completed a peer-to-peer research consortium with Texas Tech University, Lamar University, and University of Houston in a project funded by the Texas Department of Transportation to investigate gravel transport phenomena within the Plateau. Gravel transport within high gradient streams is contributing to recurring infrastructure damage in the study area. The Department hopes that the research will contribute to enhanced design guidance on bridges and low-water crossings. The primary USGS focus will be on spatial documentation of gravel transport through imagery and field investigations. Contact Frank T. Heitmuller (ftheitmu@usgs.gov) for further information.

Heitmuller, F.T., and Asquith, W.H., 2008, Potential for bed-material entrainment in selected streams of the Edwards Plateau---Edwards, Kimble, and Real Counties, Texas, and vicinity: U.S. Geological Survey Scientific Investigations Report 2008-5017, 76 p. (<http://pubs.usgs.gov/sir/2008/5017/>)

Heitmuller, F.T., and Asquith, W.H., 2008, Bed-material entrainment and associated transportation infrastructure problems in streams of the Edwards Plateau, Central Texas: U.S. Geological Survey Fact Sheet 2008-3047, 4 p. (<http://pubs.usgs.gov/fs/2008/3047/>)

- **Rational Method Assessment (FY08--10): ON-GOING**

The SW research group with the Texas Water Science Center has been engaged in a peer-to-peer research consortium with Lamar University and University of Houston in a project funded by the Texas Department of Transportation to investigate the rational method for small to moderately sized rural and urban watersheds in Texas. Over 20,000 storms from about 200 watersheds around Texas and the United States have been "parsed" through the algebra of the rational method. No research results yet to report.

- **Refinement of Flood-Frequency Relations (FY07--09): ON-GOING**

The SW research group with the Texas Water Science Center has been engaged in a peer-to-peer research consortium with Texas Tech University in a project funded by the Texas Department of Transportation to develop statewide regional regression equations to estimate peak-streamflow frequency for ungaged locations (focused on undeveloped watersheds) in Texas using L-moment-based analysis of at-site annual peak streamflow values. The scope of the project includes about 638 streamflow-gaging stations and various methods (technologies) for estimation of watershed characteristics. This project is intended to produce one or more additional equation ensembles from those developed in the mid 1990s. The core report is SIR2009--5087, but an ancillary report SIR2008-5084 also was published. One of several results of interest is that through site-specific L-moment of approximately 638 streamflow-gaging stations, we have independently created a regional ensemble of quantile-based regression equations that are ****extremely**** similar to those derived a decade ago using "wide latitude of interpretation" of Bulletin 17B guidelines. As of this writing, it appears that the Texas Department of Transportation will be incorporating the L-moment-based equations along with a residual adjusted parameters known as OmegaEM.

Asquith, W.H., and Roussel, M.C., 2009, Regression equations for estimation of annual peak-streamflow frequency for undeveloped watersheds in Texas using an L-moment-based, PRESS-minimized, residual-adjusted approach: U.S. Geological Survey Scientific Investigations Report 2009--5087, 48p. (<http://pubs.usgs.gov/sir/2009/5087/>)

Asquith, W.H., and Thompson, D.B., 2008, Alternative regression equations for estimation of annual peak-streamflow frequency for undeveloped watersheds in Texas using PRESS minimization: U.S. Geological Survey Scientific Investigations Report 2008--5084, 40p. (<http://pubs.usgs.gov/sir/2008/5084/>)

Asquith, W.H., 2007, L-moments of the generalized lambda distribution: Computational Statistics and Data Analysis, vol. 51, p. 4,484–4,496.

- **Assessment of Watershed Subdivision on Hydrologic Modeling (FY08--10): ON-GOING**

The SW research group with the Texas Water Science Center has been engaged in a peer-to-peer research consortium with Texas Tech University, Lamar University, and University of Houston in a project funded by the Texas Department of Transportation to investigate the effects of watershed subdivision on hydrologic models and to provide guidance (if possible) as to how or why subdivision should be done.

Thompson, D.B., and Cleveland, T.G., 2009, Subdivision of Texas watersheds for hydrologic modeling: Lubbock, Texas, Texas Tech University, TechMRT, Texas Department of Transportation Research Report FHWA/TX-0-5822-01-2, 97p. (<http://drdbthompson.net/writings/0-5822-fpr.pdf>)

- **Staggered-Barrel Culvert Research: (FY10-12)**

The SW research group with the Texas Water Science Center has been engaged in a peer-to-peer research consortium with Texas Tech University and University of Houston in a project funded by the Texas Department of Transportation to investigate whether staggered or culvert barrel inlets, inlets with overlapping crowns and inverts, can be arranged to maintain gravel and similar bed-material transport through the system by frequent storm events. The project will largely be executed by physical modeling at the Texas Tech University Hydraulics lab. As of this writing, special provisions to the capR software described in the following section have been made. Further, a cohort of students at Texas Tech University under direction of Dr. Cleveland and Dr. Asquith have digitally recovered about 7,000 records of flume data from the literature that include conventional measures such as discharge, sediment charge, Froude number, and grain size.

- **Small Watershed Gaging Program: (FY06-10, and three more 5-year increments)**

The Texas Department of Transportation and the USGS have returned in earnest to small watershed data collection. A program of about 50 crest-stage gages for flood-peak recording on small watersheds in western Texas. About ten of these gages will have autonomous stage recording and rainfall for production of rainfall and runoff data sets to drive the TxDOT research program in future decades. About three of the gages will also be operated as continuous real-time (conventional gages). An emergent contribution to hydraulic computations from this project is the development of a R-based implementation "capR" of the FORTRAN-based USGS-Culvert Analysis Program (CAP). We have a functional tool that can readily process time series of contemporaneous headwater and tailwater conditions.

Utah

- Completed an update of the peak-flow regression equations for the state of Utah in 2008, a cooperative investigation with the Utah Department of Transportation. The USGS StreamStats program is undergoing implementation for Utah and will include the new peak-flow equations.
- **Recent Publications**
 - Kenney, T.A., Wilkowske, C.D., and Wright, S.J., 2007, Methods for estimating magnitude and frequency of peak flows for natural streams in Utah: U.S. Geological Survey Scientific Investigations Report 2007-5158. (<http://pubs.usgs.gov/sir/2007/5158/>)

Vermont

- Vermont Agency of Transportation (VTrans) is currently funding a network of 29 crest-stage gages located in small headwater watersheds throughout the state.
- VTrans is funding one streamgaging station (Allen Brook in Williston, VT) for continuing research of storm water management on small urban streams.
- A cooperative investigation between VTrans and the USGS began in Fiscal Year 2005 to investigate the effects of road salting on stream quality. During Fiscal Years 2006 to 2008, monitoring of stream water-quality (continuous conductance and discrete samples for chloride, sodium and calcium) and discharge were performed at 3 streams at locations upstream and downstream of state highways and data were analyzed. In Fiscal Year 2009, a USGS interpretative report was prepared summarizing the results of the study to be published in 2010.

Virginia

- Continuation of Annual Flood Peaks of Streams in Virginia—The objectives of the study are to update annual flood-peak data in preparation for a flood frequency analysis study.
- Maintain and operate a network of 45 crest-stage gages to determine annual peak flows, document extreme flow events, and improve flood frequency estimates.
- Collection of stream geomorphic data in the Piedmont physiographic province at USGS streamflow-gaging stations to be used in the development of regional channel geometry curves.
- **Recent Publications**
 - Austin, S.H., and Wiegand, U., 2009, Annual maximum stages and discharges of selected streams in Virginia through 2007: U.S. Geological Survey Open-File Report 2009-1007, 733 p. (<http://pubs.water.usgs.gov/ofr2009-1007>)
 - Lotspeich, R.R., 2009, Regional curves of bankfull channel geometry for non-urban streams in the Piedmont Physiographic Province, Virginia: U.S. Geological Survey Scientific Investigations Report 2009-5206, 51 p. (<http://pubs.usgs.gov/sir/2009/5206/>)

Washington

- The Washington Water Science Center (WAWSC) recently reviewed the Washington State Department of Transportation's (WSDOT) stormwater monitoring program. WSDOT requested the review to help them plan and revise their monitoring program because Washington State is renewing stormwater permits and in the process is revising the monitoring requirements. USGS compared WSDOT procedures and protocols to past and future requirements, as well as other existing stormwater monitoring programs. The results of the review were published in the following report:

Sheibley, R.W., Kelly, V.J., and Wagner, R.J., 2009, Scientific framework for stormwater monitoring by the Washington State Department of Transportation: U.S. Geological Survey Open-File Report 2009-1236, 22 p. (<http://pubs.usgs.gov/of/2009/1236/>)

- The WAWSC sits on a multiagency Stormwater Workgroup, which includes the Washington State Department of Transportation. This workgroup is developing a strategy for designing a coordinated stormwater monitoring program in the Puget Sound area. Federal, State, and local agencies, Native American Tribes, business, and environmental groups are represented on the workgroup.

West Virginia

- A network of crest-stage gages will continue to be operated in cooperation with WVDOT to provide on-going peak-flow data for flood-frequency information and analysis.
- WVDOT provides funding in support of operating and maintaining the streamflow-gaging stations.
- Cooperated with WVDOT on an investigation of stream geomorphology in the Appalachian Plateaus physiographic province.
- WVDOT provided funding for a flood-frequency investigation that follows the WRC guidelines and including development of a State skew map.
- Recent Publications:
 - Atkins, J.T., Jr., Wiley, J.B., and Paybins, K.S., 2009, Generalized skew coefficients of annual peak flows for rural, unregulated streams in West Virginia: U.S. Geological Survey Open-File Report 2008-1304, 13 p. (<http://pubs.usgs.gov/of/2008/1304/>)

Wisconsin

- **Flood Frequency**
 - A network of 89 crest-stage gages will continue to be operated in cooperation with WisDOT to provide on-going peak-flow data for flood-frequency information and analysis.
 - Updated frequency estimates for 32 gages with large floods in June of 2008.
 - Continued working on updating the regression equations using GIS-based basin characteristics. Decided to include the 2008 peaks in the Log Pearson analyses and updated regression analyses based on widespread and extreme flooding in June 2008. Further, decided to produce an intermediate report with Frequency Analyses and regional skewness analysis. The Frequency Analysis report will include a historical analysis of 9 2008 peaks identified as outliers, and an analysis of regional skewness to replace the outdated national map used in Bulletin 17B. The regression analysis and report will be completed as soon as the Frequency Analysis report is finished. The two reports are expected to be finished in FY2010.
 - Continued working with StreamStats personnel to compile information necessary to implement StreamStats for the State. The first phase, checking the hydro layer, has been completed. The implementation of StreamStats cannot be completed until the regional regression equations have been developed and a report describing the study and equations has been published. Expect implementation of StreamStats during FY2010.
- **Evaluation of Storm Water Treatment Technologies for Highway Runoff**

Comparing Structural BMPs at Milwaukee's Historic Third Ward River Walk and I-794 Freeway Test Site -The Wisconsin Department of Transportation (WisDOT) is required to improve the quality of runoff from roadways under their control as part of the National Pollution Discharge Elimination System (NPDES) and an agreement with the Wisconsin Department of Natural Resources (WDNR). In addition, future state and federal regulations will prescribe new performance standards for non-point runoff management and calculation requirements for total maximum daily loads (TMDLs) of contaminants discharging in watershed basins.

One way to improve the quality of roadway runoff, particularly in urban areas, is to use structural Best Management Practices (BMPs). There are several commercially available BMPs that could be used, but these new technologies lack field performance testing and validation, especially in Wisconsin type climates. So it is essential to field test these devices to determine their contaminant removal efficiency and practical application for WisDOT.

This study is funded by the National Cooperative Highway Research Program and is being conducted by the WisDOT in cooperation with the U.S. Geological Survey. The objective of this study will evaluate two structural BMPs to determine their removal efficiency. Data collection and analysis is complete and several reports will soon be available.

Published Reports

Horwathich, J.A., Bannerman, R.T., and Pearson, R., 2008, Effectiveness of a Hydrodynamic Settling Device and a Stormwater Filtration Device in Milwaukee: Wisconsin Department of Transportation Research, Development & Technology Transfer, Final Report No. 0092-00-03. September 2008, p 120. (<http://on.dot.wi.gov/wisdotresearch/database/reports/00-03hydrodynamicdevice-f.pdf>)

- **Pollutant Loadings to Storm Water Run-Off from Highways**

The Impact of a Highway Sweeping Program-Phase II - This study is in cooperation with the National Cooperative Highway Research Program and is being conducted by the WisDOT in cooperation with the U.S. Geological Survey. The study site is located on USH 151 near IH 90/94/39, in Madison WI. The objective of this study is a continuation of a previous highway sweeping study that will evaluate the effectiveness of a highway-sweeping program as a best management practice (BMP) for reducing pollutant levels. Phase II would address the data collection and analysis issues that occurred during the Phase I study by using new technology for monitoring and calibrating flow, eliminating freeway median area, improved sample processing and change in laboratory procedures for particle size distribution.

Published Report

Judy A. Horwathich, J.A., and Bannerman, R.T., 2009, Pollutant Loading to Stormwater Runoff from Highways: Impact of a Highway Sweeping Program—Phase II: Wisconsin Department of Transportation Research, Development & Technology Transfer, Final Report No. 0092-04-04, p. 126. (<http://on.dot.wi.gov/wisdotresearch/database/reports/04-04sweeperstudy-f.pdf>)

- **Evaluation of Storm Water Treatment Technologies for Parking-lot Runoff**

The Wisconsin Department of Transportation (WisDOT) has a Cooperative Agreement with the Wisconsin Department of Natural Resources (WDNR) (November 2002), Trans401 (December 2002), and NR 216 (September 2002), that require the Department to establish a Storm water Management program to reduce Total Suspended Solid (TSS) loading from highway surfaces. The regulations require the Department evaluate and assess best management practices (BMPs). This study is made possible by a partnership with the Madison Gas and Electric Company (MG&E), United States Geological Survey (USGS), Stormwater Management Inc., and the Wisconsin Department of Natural Resources (WDNR). The site is a parking lot located in downtown Madison, WI at the MG&E facilities plant and the BMP to be evaluated is gravity filtration.

This study would complement research just completed on a filtration BMP called the StormFilter (Evaluation of Storm Water Treatment Technologies for Highway Runoff, under the direction of Wendy Braun, WDOT). The StormFilter was evaluated using runoff from Highway 794 in Milwaukee. A 45 percent reduction in TSS loads was observed for the 30 storms used for the evaluation. Before these results are applied to other highways or DOT facilities, such as park and rides, maintenance yards and rest areas, it must be determined if the findings are unique to the characteristics of the runoff from elevated freeways.

Published Reports

Horwathich, J.A., Bannerman, R.T., 2008, Use of a Stormwater Filtration Device for Reducing Contaminants in Runoff from a Parking Lot in Madison, Wisconsin, 2005-07: Wisconsin Department of Transportation Research, Development & Technology Transfer, Final Report No. 0092-05-17, p. 77. (<http://on.dot.wi.gov/wisdotresearch/database/reports/05-17stormwaterfiltration-f.pdf>)

Horwath, J.A., Bannerman, R.T., 2009, Parking Lot Runoff Quality and Treatment Efficiency of a Stormwater Filtration Device, Madison, Wisconsin, 2005-07: U.S. Geological Survey Scientific Investigations Report 2009-5196

Wyoming

- No highway related projects at this time.