USGS
science for a changing world

Water Resources Update

New Hampshire-Vermont District Newsletter

U.S. Department of Interior
U.S. Geological Survey
October 1998

INSIDE THIS ISSUE

Message from the District Chief

The new U.S. Geological Survey (USGS) visual identity (above) is part of an expanded program of outreach and information dissemination designed to increase public awareness of the USGS mission and how our products and services benefit the Nation every day. Here in the New Hampshire-Vermont District, program growth has made it more challenging to keep our colleagues informed of all our new water-resources activities. We hope this new annual newsletter will help.

The leading article highlights the water-quality activities of the District. In October 1998, the New England Coastal Basins study for the National Water Quality Assessment (NAWQA) Program will begin its 3-year high intensity phase, which is funded at more than $5 Million. We are looking forward to managing this major project from our District.

Other articles provide brief descriptions and updates for on-going projects, such as the statewide assessment of fractured-bedrock aquifers in New Hampshire, the investigation of the effectiveness of remediation activities at the Savage Well Superfund site in Milford, N.H., and the global change research at the Sleepers River Watershed in Danville, Vermont. Also included is an article on new borehole imaging technology that will be available through our District.

A new 5-year study to develop a Geographic Information System (GIS)-based flood-frequency estimating system for ungaged streams in Vermont is described on page 6. This project is being undertaken in cooperation with the Vermont Agency of Transportation. This Fall we will begin our first collaborative study with the University of New Hampshire, which is also described on page 6. This study, funded cooperatively by the USGS and the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), will investigate ground-water inflows and associated loadings of nutrients and contaminants to the Great Bay Estuary system.

Key statistics for the floods in New Hampshire and Vermont that topped the news in the spring and early summer of 1998 are provided on page 4. Here we also describe the District's real-time streamflow Web page that tracked the events as they occurred.

(Photo by Jennifer Hauck-Valley News)

Hydrologic technicians measuring streamflow from a cableway during early spring floods on the Connecticut River near Lebanon, N.H.

Finally, in this issue we would like to introduce our new 'visible gage' educational site on the Contoocook River near Elm Brook State Park in Hopkinton, New Hampshire. A description of the gage and directions to it are provided in the article on page 7.

We hope you enjoy browsing through this first issue of the newsletter and would appreciate your feedback on how we might improve future editions.

—Brian R. Mrazik

Water Quality: Increasing Focus of District Projects

In recent years, many agencies and organizations have recognized the need for better information about the quality of the Nation's waters. A combination of existing and new studies underway in the NH-VT District will help to define water quality at a local, regional, and statewide scale in our two States. The importance of water-quality related studies to overall District programs is expected to increase in the years ahead. Future studies assessing nonpoint sources of contamination and the effect of best management practices and determining long-term changes in water-quality conditions are under development. The District will also be participating in developing regional nutrient criteria.

The ***National Water-Quality Assessment Program*** is designed to assess the quality of the Nation's surface and ground waters and to determine the primary factors influencing water quality. The Program conducts regional-scale studies and has two study areas that include parts of New Hampshire and Vermont - *the Connecticut-Thames-Housatonic River Basins study area* and the *New England Coastal Basins study area.* The Connecticut-Thames-Housatonic River Basins study ended an intensive monitoring period in 1997, whereas the New England Coastal Basins study will begin intensive monitoring of surface and ground waters this Fall and continue for the next 3 years. The data and reports from both of these efforts are available to the public and can assist policy makers in understanding regional water-quality conditions.

New Hampshire

In New Hampshire, the ***Bedrock Aquifer Assessment Project*** is evaluating the quality of ground water in bedrock throughout the State. Regional variations in levels of iron, manganese, arsenic, radon, and other indicators of water quality will be described. A cooperative study between the State of New Hampshire Department of Environmental Services (NHDES) and USGS, the Bedrock Aquifer Assessment Project will also help assess future water supplies from the bedrock aquifer. Also in New Hampshire, the District is cooperating with NHDES and the U.S. Environmental Protection Agency (USEPA) on a ***ground-water flow and chemical transport modeling study*** to assist with remediation of the contaminated Savage Well Superfund Site in Milford, N.H. The studies at this site will help to determine the effectiveness of clean-up activities.

Vermont

In Vermont, the ***Sleepers River Water, Energy, and Biogeochemical Budget Study*** is part of a national research program to monitor geochemical processes in selected small watersheds across the country. The information generated from these studies can be used to help understand influences of global climatic changes on small headwater streams. Changes in hydraulic and hydrologic processes in such streams can often serve as early indicators of changes at larger scales. Finally, the District recently completed a study of ***phosphorus levels in the sediments of the Winooski River Basin*** in Vermont. This study was designed to assist in developing nutrient budget models for the Basin, which is the largest tributary to Lake Champlain. Managing phosphorus input to Lake Champlain is necessary to ensure the long-term health of the Lake.❑

Project Updates

National Water-Quality Assessment Program

Plans are near completion for 3-year field-data-collection efforts for the New England Coastal Basins study, which will be assessing ground- and surface-water quality and stream ecology in eastern New England. In September, samples of streambed sediment and fish tissue were collected at 10 sites in New Hampshire, Massachusetts, and Rhode Island to look at the occurrence of a variety of contaminants. In October and November, water-quality sampling will begin at about 10 stream sites in Maine, Massachusetts, and Rhode Island; monitoring of these streams/rivers will continue for the next 2 years. The purpose of this monitoring is to assess nutrient loadings to coastal waters from the major rivers in eastern New England and to determine the influence of gradients of urbanization on stream quality and ecology. In addition, shallow wells are being drilled at 30 locations in eastern Massachusetts and southern New Hampshire to evaluate the influence of new urbanization on the quality of water from stratified-drift aquifers.

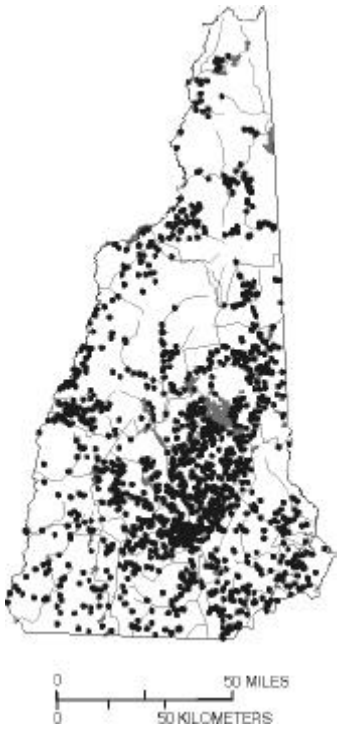
Over the past year, analysis of existing ground-water-quality data from 804 public-supply bedrock wells in eastern New England shows that the occurrence of arsenic in ground water varied significantly among the bedrock lithochemical groups found in the region. Data were collected from state laboratories in all the states in the study area. For example, water from nearly half of all wells drilled in calcareous metasedimentary bedrock contained detectable arsenic levels, whereas arsenic was detected in less than one-fourth of the wells drilled in other types of bedrock. A full report on this study is currently being prepared. ❑

Aquifer Assessments in New Hampshire

As of 1998, all mapping for New Hampshire's **sand and gravel (stratified-drift) aquifers** is complete and available to the public in a series of 13 reports. Aquifer boundaries, ground-water flow directions, transmissivity, saturated thickness, and water quality are shown on maps and described in an accompanying report for each watershed.

The **New Hampshire Bedrock Aquifer Assessment** project continues the effort by the State to identify water resources.

This assessment involves mapping potential locations of high-yielding zones in fractured bedrock through the use of remote-sensing images, field-level fracture analysis, and geophysical methods. The surface of the Earth is marked by straight-line patterns that are often the result of fractures in the underlying rock. Flows through these fractures could yield moderate to large quantities of ground water to wells drilled near them. Phase I of the study will produce a series of 14 maps that identify the location of these fracture patterns or lineaments. Currently, lineament data maps are published for five areas in the southern part of New Hampshire from the seacoast to Keene and north to Concord. Remaining lineament maps are scheduled to be published by the end of 1998. Well yields will be compared to lineament patterns, geologic data, and other site information to assess what information can help improve the location of high-yield bedrock wells.

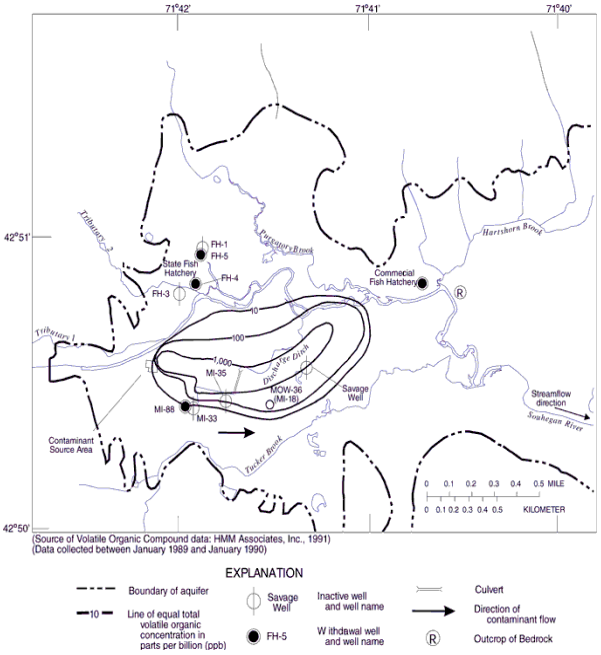


Map shows location of 1,353 bedrock wells matched with water-quality samples for the bedrock aquifer assessment project.

Phase II of the project includes creating a georeferenced water-quality data base from ground-water wells around New Hampshire by matching well sites with results of chemical analyses. With the assistance of the New Hampshire Department of Environmental Services, Water Management Section, water-quality samples have been matched with the location of wells constructed since 1982. More than 20,000 wells in New Hampshire have been geographically located and a total of 1,353 bedrock wells have been matched with 1,818 water-quality samples.

Relations between the mapped bedrock units, or major groupings of units, and various water-quality constituents are being identified. The New Hampshire Bedrock Aquifer Resource Assessment project is working with the New England Coastal Basins National Water-Quality Assessment Program to examine pH, hardness, fluoride, iron, manganese, arsenic, and radon in ground water. Additional arsenic and radon data, from public supplies in New Hampshire and adjacent states, are being included in the joint statistical analysis.

Reports on stratified-drift and bedrock aquifers are available through the New Hampshire/Vermont District's Publications and Outreach Coordinator. ❑



Map shows aquifer boundary, ground-water withdrawal locations, and extent of volatile organic plume, Milford, N.H.

Monitoring of Ground Water at a Former Hazardous-Waste Disposal Site

The USGS is cooperating with the NHDES and the USEPA in a study of the chemical transport of tetrachloroethylene (PCE)-contaminated ground waters in a glacial-drift river-valley aquifer in Milford, N.H. The aquifer is an important source of water for commercial and state fish hatcheries, supplying more than 2 million gallons of water per day (Mgal/d). Before the aquifer was contaminated, it also supplied more than 1 Mgal/d to two municipal water-supply wells. Through extensive field monitoring and numerical modeling of the contaminated area of the aquifer, called the Savage Well Superfund Site, the USGS is providing information to help improve the design and operation of a planned remedial system and the design of a long-term monitoring plan. ❑

Global Climatic Change Research

As part of the USGS Global Change Research Program, the Sleepers River Research Watershed in Danville Vermont is one of five USGS Water, Energy, and Biogeochemical Budgets (WEBB) sites across the nation. The purpose of WEBB is to (1) improve understanding of the processes controlling terrestrial water, energy, and biogeochemical fluxes, the interactions of these processes, and the relations of these processes to climatic variables; and (2) to improve the capability to predict continental water, energy, and biogeochemical budgets over a range of spatial and temporal scales.

(cont. on page 5)

Significant Events

Spring Floods

Three highwater events since January 1998 have caused major flooding and extensive property damage in parts of New Hampshire and Vermont. The flooding began with an early spring snowmelt runoff at the end of March. Three days of 80+ degree temperatures triggered major snowmelt (greater than 6 inches of water equivalent), and this coupled with an inch or more of precipitation in the northern parts of New Hampshire and Vermont, caused flooding in the Androscoggin, Connecticut, and Missisquoi River Basins from March 31 to April 2. The highest flows in 83 years on the Androscoggin River and in 59 years on the Connecticut River were recorded.

Early summer arrived with more than 7 inches of rainfall during June 13–17 in eastern and southern New Hampshire. Many rivers and streams were flooded, primarily in the Saco and Piscataqua River Basins in New Hampshire.

Vermont did not escape unscathed when 10 days later, on June 27, parts of northern Vermont and New Hampshire received heavy rainfall ranging from 2 to 5 inches. The heaviest amounts of rain fell on saturated soil and swollen rivers in central Vermont from about Bristol on the western side of the Green Mountains to Bradford to the east. As a result, flash flooding occurred primarily along rivers in the St. Lawrence and Connecticut River Basins of central Vermont. Property damage was extensive and a state of emergency was declared by the Governor. More details of these events can be accessed through the District home page at

http://bowdnhbow.er.usgs.gov

(photo by B. Mrazik, USGS)

Flood waters rush through the dam on Ossipee River in eastern New Hampshire after June 13-17, 1998.

Other features on the page include streamflow data (historical and current) and monthly summaries of ground- and surface-water conditions. Parts of the annual report, Water Resources Data, New Hampshire and Vermont, Water Year 1997, are posted on the home page and available for downloading. ❑

Table 1. Provisional flood data for selected stream-gaging sites in New Hampshire and Vermont for spring floods, 1998

[ft^3/s, cubic feet per second; ~, approximately; gt, greater than; Stage, water level in feet above gage zero; --, no data; modified from the NH-VT District home page]

Station	Drainage area, in square miles	Station number	Peak stage	Peak discharge (ft^3/s)	Approximate recurrence interval (years)	Date	Time
Provisional data for floods of March 31- April 1, 1998							
Diamond River near Wentworth Location, N.H.	152	1052500	12.11	13,700	100	3/31/98	1900
Androscoggin River near Gorham, N.H.	1,361	1054000	10.15	20,200	~50	4/01/98	1100
Conn. R below Indian Stream, nr Pittsburg, N.H.	254	1129200	7.6	4,760	50 to 100	3/31/98	1515
Connecticut River at North Stratford, N.H.	799	1129500	15.63	28,600	50 to 100	3/31/98	1745
Missisquoi River near North Troy, Vt.	131	4293000	12.68	7,710	~50	3/31/98	0200
Missisquoi River near East Berkshire, Vt.	479	4293500	17.09	20,400	~50	3/31/98	0415
Provisional data for floods of June 14-15, 1998							
Saco River near Conway, N.H.	385	1064500	14.66	36,400	20-25	6/14/98	2145
Bear Camp River near South Tamworth, N.H.	67.6	1064801	9.61	6,000	gt 25	6/14/98	0245
Ossipee River at Effingham Falls, N.H.	330	1065000	10.38	7,500	25-50	6/14/98	--
Oyster River near Durham, N.H.	12.1	1073000	5.26	586	10	6/14/98	1300
Lamprey River near Newmarket, N.H.	183	1073500	11.50	4,440	10	6/15/98	2330
Provisional data for floods in Vermont, June 27, 1998							
East Orange Branch at East Orange, Vt.	8.9	1139800	5.09	513	10-25	6/27/98	0545
Ayers Brook at Randolph, Vt.	30.5	1142500	11.93	4,200	gt 100	6/27/98	0800
White River at West Hartford, Vt.,	690	1144000	17.38	34,500	10-25	6/27/98	1545
New Haven River at Brooksville near Middlebury, Vt.	115	4282525	14.08	21,200	gt 100	6/27/98	0715

(cont. from page 3)

The research is primarily conducted in a headwater forested catchment where hydrologic flow paths are studied at scales ranging from a small hillslope to the 43-square mile Sleepers River Watershed.

One focus of the study is to examine how streamflow-generation mechanisms change as basin size increases and land cover shifts from forest to agriculture. Research is also addressing the process of biogeochemical cycling in low-order drainage basins or catchments. Isotopic, chemical, and hydrometric techniques are providing complementary information on water source and flow paths. Currently, the USGS has focused on near-stream or riparian processes as the potential key to how streams respond to rain and snowmelt.

Future data collection at Sleepers River will address the effects of agriculture on runoff and water quality through measurements of streamflow, precipitation, temperature, relative humidity, seasonal snow depth and water equivalent, and seasonal ground frost depth. ❑

Sediment Transport in Vermont Rivers

On July 14-16, 1997, flooding in northern Vermont caused severe localized damage and resulted in a disaster declaration. Erosion and deposition was significant at numerous locations in the disaster area. Many local officials and the public believe that removal of sand, gravel, and cobbles from channels is a

(cont.on page 6)

New Technology

Borehole Imaging

The USGS is assessing new capabilities for collecting high-resolution digital images of rocks and fractures below the surface. A digital borehole camera, called Borehole Image Processing System (BIPS), can obtain video images of the inside of a well above and below the water surface. The camera permits the direct inspection of the borehole wall and records a digital image. The images provide quantitative and qualitative data that can be used to describe the lithology and fractures observed in the boreholes, potentially identify onsite contamination, aid in the planning and interpretation of other geophysical logs, and provide insight for conceptual models of fractures, ground-water flow, and contaminant transport.

The digital borehole camera collects a continuous, magnetically oriented and digitized 360° color image of the borehole wall. Complete radial coverage is obtained by collecting an image from a narrow scan by a conical-shaped mirror. The resolution of the scan can be as high as 720 pixels for each 0.25 millimeter depth of the well. The digital camera can collect images in boreholes ranging from 66 to 200 millimeters in diameter and record magnetic declination and inclination with depth. In addition, the instrument collects three-dimensional (3-D) location data as it goes down the well, which provides the information needed for mapping how far the well has deviated from vertical and the azimuthal direction (0-360°).

Each video image from the digital imaging tool can be viewed as an unrolled, flat image that shows the depth along the vertical axis and magnetic direction along the horizontal axis (fig. 1). The horizontal axis represents a 360° scan of the borehole wall from south (on the left side of the plot), through west, north, east, and south again (on the right side of the plot). Depth, in meters, is shown along the vertical axis. The sinusoidal lines in the two-dimensional image actually represent a 3-D plane that intersects the borehole. Planes, such as fractures, foliation, and lithologic contacts, can be identified directly on the images and strike and dip can be determined. With the use of post-processing software, the image can be wrapped into a cylinder and viewed as a "virtual core" (fig. 2) from wells where no core was taken. The BIPS has been tested in boreholes at the USGS fractured rock research site near Mirror Lake in Thornton, New Hampshire. ❑

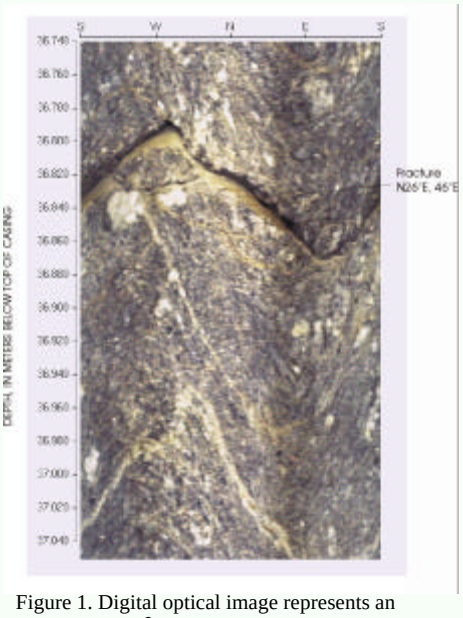


Figure 1. Digital optical image represents an "unrolled" 360° scan of the borehole well.

Figure 2. The two dimensional image can be rolled into a "virtual core," and the core can be rotated using post-processing software.

(cont. from page 5)

key to preventing future flooding. Currently, Vermont streambed management policies restrict such activities.

In response to this problem, the USGS, in cooperation with the Vermont Agency of Natural Resources and the Federal Emergency Management Agency, began a study of sediment transport by rivers during floods. The rivers selected for the study are the Trout River in Montgomery, the Wild Branch in Wolcott, and the Lamoille River in Cambridge. The investigation includes resurveying channel cross sections at the same locations surveyed for flood insurance studies more than 10-years ago and documenting changes in channel shape. A hydraulic-flow model will be developed from the post-flood cross sections to evaluate changes in the 10- and 100-year water-surface profiles. A sediment-transport computer model will also be applied to simulate deposition and erosion of the channel.

The sediment-transport model will be used to simulate the effect of various streambed management practices on the movement of channel bed materials and the 10- and 100-year water-surface profiles. Practices such as no removal of bed materials, removal of bars or other areas of channel deposition, and dredging of the entire section of the river will be simulated to assist the State in evaluating its current policies and formulating any future changes. The study is scheduled to be completed in July 1999. ❑

New Projects

Flow Frequency in Vermont Streams

The USGS, in cooperation with the Vermont Agency of Transportation, is embarking on a project to evaluate the flow-frequency characteristics of Vermont streams. Estimates of the magnitude and frequency of floods are primarily used in the design of bridges, culvert openings, roadbed elevations, embankments, dams, or other structures near streams. This information is also used for floodplain management, identification of flood hazard areas, and establishing flood insurance rates. These estimates are generally required at ungaged sites where no observed flood data are available for frequency analysis.

For this study, the flow statistics at each of the Vermont gages will be recomputed and statistical relations will be developed between various basin characteristics and flood flows. This will allow flood discharges at an ungaged site to be estimated from measured basin characterisitics such as drainage area. Estimates of flood flow for small, high-elevation watersheds is of major concern in the mountainous areas of the State where gage data are sparse. In these areas, basin rainfall-runoff models will be used to simulate streamflow records.

Because the measurement of basin characteristics can be a time consuming task, the final product submitted to the Vermont Agency of Transportation will include software and a data base developed to provide a user-friendly interface with Geographic Information Systems (GIS). With this new software, a user will be able to zoom in on a map of Vermont, visually select a point on a stream, and obtain basin characteristics and flow frequency statistics for that area of the stream. ❑

Inflow and Chemical Loadings from Ground Water to the Great Bay Estuary, New Hampshire

Great Bay, in southeastern New Hampshire, is part of the National Estuarine Research Reserve. The health of this estuary, similar to many of the Nation's estuaries, is threatened by point and non-point-source pollution. The quantity and rates of ground-water discharge, and associated chemical and nutrient load to the Bay, are unknown. Ground-water discharge to the Great Bay Estuary most likely follows preferred hydraulic pathways through overlying sediments and through bedrock fracture zones. Water-use and land-use practices influence the amount and quality of ground and surface water discharged to the Bay. Whereas surface-water inflows and associated chemical and nutrient loads have been studied, the quantity of ground water flowing into the Bay remains to be investigated in order to determine the locations and effects of these influences on marine environments and ecosystems.

To assess inflow and loadings of contaminants to the Great Bay Estuary, the USGS is cooperating with the University of New Hampshire, Department of Civil Engineering, in a three-phase investigation. The first phase will use remote-sensing (thermal infrared imagery) and geophysical methods to identify the areas in the Great Bay Estuary that receive significant ground-water discharge. The second phase of the project will involve estimating the quantity of ground water flowing into the Great Bay Estuary. This phase will build on the results of the first phase and will involve well installation, hydraulic testing, and measurement of hydraulic gradients. The third phase of the project will assess ground-water quality. Ground-water samples will be collected and analyzed from selected locations determined in the earlier phases of the project. Data from these samples will be used to estimate chemical and nutrient loads and will be incorporated into an existing computer model of the Great Bay Estuary system. Additionally, the project results will be directly applicable to the development of the Estuarine Contaminant Status and Forecast System. ❑

Outreach

Visible Stream-Gaging Station and Educational Center

Efforts are underway to create a "visible stream gage" educational center on the Contoocook River near the Elm Brook State Park and Hopkinton Dam in Hopkinton, New Hampshire. This self-directed educational center is being built in cooperation with the U.S. Army Corp of Engineers and the property owner, Papertech Corporation. A new gage house has been constructed on the site and will be equipped with state-of-the-art streamflow, hydrometerological, and water-quality measuring equipment and a satellite hookup to relay instantaneous data to the District's website.

The gage house has a glass door through which visitors can view the equipment in action. The site also has a cableway that is used to make streamflow measurements during floods. A display sign will be erected to explain why and how streamflow is monitored and to identify the equipment used and its purpose. This information will give the public a better understanding of why and how the USGS keeps track of the amount of water flowing in streams and rivers in New Hampshire and Vermont. This self-directed educational site will be a resource for teachers from local schools and to the general public passing by or visiting Elm Brook State Park. A grand opening in the Spring is planned.

The station can be reached by taking Exit 6 off I-89, State Route 127 South. Proceed 2.0 miles south on Route 127. The gage is on the right just downstream of Covered Bridge No. 9. ❑

(photos by M. Coakley, USGS)

District and cooperator staff are shown constructing the Contoocook River visible stream gaging station and educational center in Hopkinton, N.H.

District Contacts

District Chief: Brian Mrazik (603) 226-7807 bmrazik@usgs.gov

Water-Quality Program: Keith Robinson (603) 226-7809 kwrobins@usgs.gov

Surface-Water Investigations and Monitoring:

Kenneth Toppin (603) 226-7808 ktoppin@usgs.gov

Ground-Water Investigations: Thomas Mack (603) 226-7805 tjmack@usgs.gov

Water Use: Laura Medalie (802) 828-4512 lmedalie@usgs.gov

Publications and Outreach Requests, Editor of Newsletter: Debra Foster (603) 226-7837

Recent Publications of the New Hampshire/Vermont District

October 1, 1997-September 30, 1998

Clark, S.F., Jr., Ferguson, E.W., Picard, M.Z., and Moore, R.B., 1998, Lineament map of area 4 of the New Hampshire bedrock aquifer assessment, southeast-central New Hampshire: U.S. Geological Survey, Open-File Report 97-763, 1 sheet, scale 1:48,000.

Coakley, M.F., Olimpio, J.R., Kiah, R.G., and Ward, S.L., 1998, Water resources data, New Hampshire and Vermont Water Year 1997: U.S. Geological Survey Water-Data Report NH-VT-97-1, 180 p.

Ferguson, E.W., Clark, S.F., Jr., Picard, M.Z., and Moore, R.B., 1998, Lineament map of area 3 of the New Hampshire bedrock aquifer assessment, eastern New Hampshire: U.S. Geological Survey Open-File Report 97-762, 1 sheet, scale 1:48,000

_____ 1998, Lineament map of area 5 of the New Hampshire bedrock aquifer assessment, southwestern New Hampshire: U.S. Geological Survey Open-File Report 97-761, 1 sheet, scale 1:48,000

Harte, P.T., Flynn, R.J., Kiah, R.G., Severance, Timothy, and Coakley, M.F., 1997, Information on hydrologic and physical properties of water to assess transient hydrology of the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire: U.S. Geological Survey Open-File Report 97-414, 96 p.

Harte, P.T., and Willey, R.E., 1997, Effects of historical withdrawals on advective transport of contaminated ground waters in a glacial-drift aquifer, Milford, New Hampshire: U.S. Geological Survey Fact Sheet FS-162-97, 6 p.

Johnston, C.M. and Harte, P.T., 1998, Documentation and application of a method to compute maximum slope and aspect of hydraulic gradients: U.S. Geological Survey Water-Resources Investigations Report 98-4021, 25 p.

Olimpio, J.R., and Mullaney, J.R., 1997, Geohydrology and water quality of stratified-drift aquifers in the Upper Connecticut and Androscoggin River Basins, northern New Hampshire: U.S. Geological Survey Water-Resources Investigations Report 96-4318, 172 p., 8 pls.

Mack, T.J., Johnson, C.D., and Lane, J.W., Jr., 1998, Geophysical characterization of a high-yield, fractured-bedrock well, Seabrook, New Hampshire: U.S. Geological Survey Open-File Report 98-176, 28 p.

Medalie, Laura, 1997, Estimated water withdrawals and use in New Hampshire, 1995: U.S. Geological Survey Water-Resources Investigations Report 97-4177, 18 p.

_____ 1997, Estimated water withdrawals and use in Vermont, 1995: U.S. Geological Survey Water-Resources Investigations Report 97-4178, 18 p.

Robinson, K.W. and Horn, M.A., 1998, Availability and suitability of data from public water-supplier sources for use in water-quality assessments: U.S. Geological Survey Open-File Report 97-825, 18 p.

Abstracts

Ayotte, J.D., 1998, Relation of arsenic concentrations in ground water to bedrock lithology in eastern New England: Geological Society of America abstracts with programs, Annual Meeting, October 26-29, 1998, Toronto, Canada.

Chalmers, A.T., 1998, Distribution of phosphorus in bed sediments of the Winooski River Watershed, Vermont: poster for Lake Champlain Research Consortium.

Harte, P.T., and Willey, R.E., 1998, An examination of the anatomy of a chlorinated solvent plume: A superfund site case study: Geological Society of America abstracts with programs, Annual meeting, October 1997, Salt Lake City, Utah.

_____ 1998, Is it necessary to incorporate transient-flow processes in model simulations?: An example from a river-valley aquifer: American Geophysical Union abstracts with programs, Annual Meeting, May 1998, Boston, Mass.

Mack, T.J., and Harte, P.T., 1998, Use of test models to assess discretization in the design of a complex ground-water-flow model: American Geophysical Union abstracts with programs, Annual Meeting, May 1998, Boston, Mass. ❑

The USGS provides the Nation with reliable, impartial information about the Earth to minimize the loss of lives and property from natural disasters, to manage biological, water, mineral, and energy resources, to enhance and protect the quality of life, and to contribute to wise economic and physical development.

USGS
science for a changing world

U.S. Department of Interior
U.S. Geological Survey
New Hampshire/Vermont District
361 Commerce Way
Pembroke, NH 03275

Address Correction Requested

Visit the USGS website at http://www.usgs.gov