Colorado River Water Science Stakeholders' Roundtable

A Meeting for
USGS Cooperative Water Program Partners

February 8-9, 2012 **Radisson Hotel**

Salt Lake City , UT

ICWP
Interstate Council on Water Policy

western states water council

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COLORADO RIVER WATER SCIENCE STAKEHOLDERS' ROUNDTABLE FOR THE USGS COOPERATIVE WATER PROGRAM

It is a pleasure to welcome you to this meeting of stakeholders who contribute to and depend upon the USGS water data and science programs! These Roundtable conferences are designed to provide you an opportunity to meet the leaders of these programs and help shape their future development.

This meeting is the result of extensive efforts among many water users, scientists and policy leaders to make sure that one of the best sources of reliable water information will continue to meet all of our most important needs. We have been fortunate to have many strong and active partners in the development of this conference, starting with the Western States Water Council (WSWC), the Upper Colorado River Compact Commission and USGS leadership from headquarters and from each of the USGS Water Science Centers in the 7 Basin States. We also benefit from the assistance of many corporate leaders who make essential creative and technological contributions in the collection, management and application of good water data and science.

The value of accurate streamflow, groundwater and water quality data is something we struggle to compute or demonstrate clearly, but it increases exponentially as our population, economy and our diverse uses of water continue to expand. Making water resource management decisions for the benefit of our communities and the ecosystems around us is becoming more complex and more controversial. Making intelligent decisions requires that we sustain our monitoring, modeling and analytical science.

Agency budgets at every level are getting tighter, and our executive/legislative/budget process is a logjam. The USGS streamgaging networks have been dropping hundreds of stations each year for a decade. Both the Congress and the Interior Department have told us they "get it" and will "do the right thing" and our data networks and interpretive studies still struggle to maintain existing capacity.

The ICWP is proud to lead an annual campaign to showcase the stakeholders' support for the CWP, NSIP and USGS Water Census. This is the 5th year that coalitions of about 50 organizations have endorsed requests to the Secretary of the Interior and to Congressional leaders to provide USGS with the funding needed to fully implement the NSIP and to match Cooperator investments $ for $. Responding to popular demand, we are also collecting state agency endorsements on a similar letter to Interior. Building and demonstrating wide-spread support for these programs is a major element of the annual ICWP Washington Roundtable meetings (March 13-16, this year).

Fortunately, the contribution of more than 1,500 cost-share partners and other stakeholders nationwide includes funding, creative ideas and hard work directed toward stretching the USGS capabilities as far as possible within the available budgets.

Thanks for investing your time and sharing your ideas; these great science programs need you! We invite you to join is in the sustained effort to enhance and demonstrate the value –because that's what really sells!

Peter Evans

Colorado River Water Science Stakeholders' Roundtable

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Colorado River Water Science Stakeholders' Roundtable

for the

USGS Cooperative Water Program

Co-sponsored by the

Interstate Council on Water Policy,
Western States Water Council,
Upper Colorado River Compact Commission
&
U. S. Geological Survey

Wednesday, February 8, 2012 Radisson Hotel, Downtown Salt Lake City

Registration 12:30pm
Wasatch 2

Welcome, Program Overview and Introductions
Peter Evans, Executive Director, Interstate Council on Water Policy 1:00am
Anne Castle, Assistant Secretary for Water & Science, Dept. of the Interior 1:15pm

USGS Monitoring &Assessment Programs –Overview
Pixie Hamilton, National Coordinator, USGS Cooperative Water Program 2:00pm

Mike Norris, National Streamflow Information Program

Monitoring in the Upper Basin –Cory Angeroth 2:20pm
USGS Utah Water Science Center

Monitoring in the Lower Basin –Jim Leenhouts 2:40pm
USGS Arizona Water Science Center

Break 3:00pm

WaterSMART –National Assessment of Water Uses & Availability
& Focus Studies for the Colorado River Basin –
Overview of USGS Plans for WaterSMART and a National Water Census
Eric Evenson, National Coordinator, USGS Water SMART 3:30pm
Brett Bruce, Science Coordinator, USGS Rocky Mountain Region

Break 4:30pm

Stakeholder Perspectives –Panel Discussion
Moderator: Jerad Bales, Acting-Associate Director for Water, USGS 5:00pm
Tom Buschatzke, AZ Department of Water Resources
Steve Robbins, Coachella Valley Water District
Dave Kanzer, Colorado River Water Conservation District
Mike Foley, Navajo Nation (invited)
Jeff Johnson, Southern Nevada Water Authority
Kevin Flanigan, New Mexico Interstate Streams Commission
Steve Wolff, WY State Engineer's Office
Jim Prairie, Bureau of Reclamation

Discussion 6:00pm
Adjourn 6:30pm

Reception and Poster Session 6:30 - 8:00pm
Wasatch 3

Thursday, February 9 — Radisson Hotel, Downtown Salt Lake City

Recap from Day1–"Open Mic" — 8:00am
Wasatch 2

Pixie Hamilton, National Coordinator, Cooperative Water Program
Open discussion of new/significant information covered on Wednesday

Organization and charge to Break-Out Sessions — 8:45am
Peter Evans, Executive Director, Interstate Council on Water Policy

Facilitated Break-Out Discussions on Opportunities & Priorities — 9:00am
Proposed topics for participants:

- How can USGS activities supported by the Coop Program, NSIP and WaterSMART be leveraged to meet local, state, tribal, and federal responsibilities in the Basin?
- What current issues in the Basin deserve highest priority and increased attention by USGS within the next 3 years?
- What issues are on the horizon—not yet fully identified by the scientific community, water policy decision makers, or water managers?
- Which of the recommendations provided in previous Stakeholder Roundtables on the Coop Program remain highest in priority? (Note: a summary of recommendations and USGS actions is included in the meeting book.) Are other recommendations needed to improve the Program and activities that are jointly funded with Cooperators?

Luncheon — 11:30 am
Wasatch 3

Synthesis of Results and Next Steps - Highlights from the break-out groups — 12:15pm
Peter Evans, Executive Director, ICWP

Break-Out Group Leaders

Discussion

Closing Remarks — 1:00pm
Jerad Bales, Acting-Associate Director for Water, USGS
Tony Willardson, Executive Director, WSWC
Don Ostler, Executive Director, UCRCC
Peter Evans, Executive Director, ICWP

Adjourn — 1:30pm

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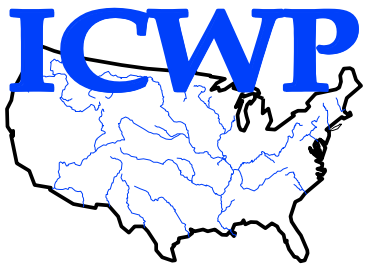


Interstate Council
on Water Policy

Colorado River Water Science Stakeholders' Roundtable

for the

USGS Cooperative Water Program

Biographical Sketches

for our

Speakers

Colorado River Science Stakeholders' Roundtable
for the
USGS Cooperative Water Program

Cory Angeroth
Data Chief
USGS Utah Water Science Center

Cory Angeroth is a hydrologist who has led the water data collection activities for the USGS in Utah since 2005. In this position he is responsible for the operation of over 150 streamgages distributed across the state. Prior to his current position, he was the Chief of the Yuma, AZ USGS Field Office which operated streamgages on the lower Colorado River from Davis Dam to the border with Mexico. He has worked extensively on a USGS Toxic Substances Hydrology site in Pinal Creek, AZ and has authored or co-authored reports on surface water flow, ground water flow, water quality, and lakes and reservoirs.

Cory received a degree in Hydrology and Water Resources from the University of Arizona.

Jerad Bales
Acting Associate Director for Water
US Geological Survey

Jerad is the USGS Chief Scientist for Water, and currently also is the Acting Associate Director for Water. He co-chairs the Subcommittee on Water Availability and Quality in the President's Office of Science & Technology Policy, and is co-leading preparation of the Water Sector Technical Input Document for the 2013 National Climate Assessment. He spent much of his USGS career in North Carolina, where he conducted national and international studies on water availability, flooding, and surface water transport processes has produced more than 120 publications on this work

Bret Bruce
Science Coordinator, Rocky Mountain Regional Executive's Office
US Geological Survey

Bret has over 30 years experience in the fields of geology, hydrology, and geochemistry. Various career paths have included energy and mineral exploration and environmental consulting. For the past 20 years Bret has been a hydrologist and project manager with the USGS, working mostly under the National Water-Quality Assessment (NAWQA) Program. He currently holds the position of Science Coordinator in the USGS Rocky Mountain Regional Executive's Office.

Tom Buschatzke
Assistant Director
Arizona Water Planning Division

Tom oversees the Division's five sections: Colorado River Management; Active Management Areas; Active Management Area Planning and Data Management; Assured and Adequate Water Supply and Recharge Permitting; and Statewide Planning and Tribal Liaison. These are the Department of Water Resources' primary planning and policy functions for the management of the State's water supplies.

From 2002 through July 2011, Tom served as the City of Phoenix' Water Resources Management Advisor and was responsible for policy development for management of the City's water resources and worked with City executive staff, the City Manager, the Mayor, and with members of City Council on a variety of water issues. He also served as the City's liaison with the Salt River Project, the Central Arizona Project and the Arizona Department of Water Resources.

Mr. Buschatzke has been on the Board of Director's of the Western Urban Water Coalition and served as Chair of their Endangered Species Act Committee. He was the Co-Chair of the Statewide Water Resources Development Commission and was on the Governor's Blue Ribbon Panel on Water Sustainability where he served as Co-Chair of the Regulatory and Permitting Group. He was a Commissioner on the Arizona Water Banking Authority and the Arizona Water Protection Fund. He was the City's representative on the Statewide Water Advisory Group and on the Governor's Colorado River Advisory Council. He served on the External Advisory Committees of the University of Arizona's Water Sustainability Program and Water Resources Research Center and the Decision Center for A Desert City at Arizona State University.

Mr. Buschatzke's career began with a Department of Water Resources internship in 1982 for the Phoenix AMA and he ultimately became a Program Manager in the Adjudications Division. He moved to the City of Phoenix in 1988 as a Hydrologist in the Law Department where he provided assistance to City management and attorneys on issues relating to the City's water rights, water use and water supply.

Anne Castle
Assistant Secretary for Water & Science
US Department of the Interior

Since June 2009, Anne Castle has served as the Assistant Secretary for Water and Science in the Interior Department, where she oversees water and science policy and has responsibility for the Bureau of Reclamation and the U.S. Geological Survey.

As a partner in the Denver, Colorado law offices of Holland &Hart LLP from 1981 to 2009, she had an extensive practice that included litigation and multi-party negotiations involving water issues, water related transactions, and advice on water policy and strategy. Her clients included a wide assortment of water users. While at the firm of Holland & Hart, she was elected to chair the firm's management committee and served in that position from 2001 to 2004. Castle has served on the South Platte River Basin Task Force; as chair and elected member of the Board of Directors, Genesee Water and Sanitation District; and as a member of the Colorado Ground Water Commission.

She has been listed in Best Lawyers in America for water law in 2007 and 2008. The Women's Vision Foundation selected her for its Woman of Vision award in 2008, recognizing positive, enlightened leadership and active promotion of the advancement of women within the law firm and in the community.

Peter Evans
Executive Director
Interstate Council on Water Policy

Peter Evans has been Director of the ICWP since May 2005. His priorities include supporting the national water data and science programs needed to support well-informed water resource management, enhancing the role that interstate organizations serve in connecting national water policy with state and local opportunities and authorities, providing opportunities for water agency officials to work together and learn from each other while contributing to the improvement of America's national water policy.

He started his career in 1976 conducting geochemical and geophysical measurements, lab analyses and computer simulations for NASA and the US Geological Survey in California. Attracted to natural resource management, he directed his scientific background to the reclamation of mining operations by the Colorado

Department of Natural Resources, especially in efforts to help small mining companies comply with new environmental requirements.

Peter practiced law in Colorado for 5 years, counseling municipal and corporate clients on natural resource development projects that required the environmental review and compliance with water allocation, water quality protection, wildlife management, hazardous waste disposal, mined land reclamation and public disclosure laws. Between 1990 and 2000, he served as Legal Counsel to the Executive Director of the Colorado Dept. of Natural Resources and as Director of the Colorado Water Conservation Board, leading its development of state water policy, promulgation of rules and oversight of water resource development, flood protection and environmental protection programs. He represented Colorado in federal and interstate commissions responsible for water resource management and endangered species conservation.

He earned a Bachelor's Degree in Geology from Pomona College (Claremont, CA, 1976) and his *Juris Doctorate* from the University of Denver (Denver, CO, 1985).

Eric J. Evenson

National Coordinator, WaterSMART Water Census
US Geological Survey

Eric Evenson has been the USGS Coordinator for the National Water Census since 2008. The USGS Water Census is one of the six major themes in the Survey's Science Plan, investigating the various aspects of water availability and use.

He started with USGS in 1992. While at USGS, he served ten years in the New Jersey District Office as the Associate District Chief and the District Chief and for six years as the Regional Program Officer of the USGS, Northeastern Region Water Programs, prior to his current position.

He worked for the New Jersey Department of Environmental Protection's (NJDEP) Division of Water Resources from 1979 to 1990. While working at for the NJDEP, he has served as an alternate commissioner representing the State of New Jersey on the Delaware River Basin Commission and as a member of the Management Committee of the Delaware Bay National Estuary Program. Eric also worked for the environmental consulting firm of Metcalf & Eddy, Inc from 1990 to 1992.

Eric is a native of Nebraska and a graduate of the University of Nebraska at Lincoln with a B.S. in Zoology (1976) and a M.S. in Ecology (1978).

Mike Foley
Hydrologist, Water Management Branch
Navajo Nation

Kevin Flanigan
Colorado Bureau Chief
New Mexico Interstate Stream Commission

Kevin has over 25 years of experience in hydrology and water resources engineering and administration and has been with the Interstate Stream Commission for thirteen years. His current responsibilities involve water resources management activities in the San Juan River Basin of New Mexico and protecting New Mexico's entitlements under the Colorado River Compact, the Upper Colorado River Basin Compact and the La Plata River Compact.

He has a B.S. in Civil Engineering from the University of Michigan, an M.S. in Hydrology from the New Mexico Institute of Mining and Technology and is a registered Professional Engineer with the State of New Mexico.

Pixie Hamilton
National Coordinator
US Geological Survey, Cooperative Water Program

Pixie Hamilton is the National Coordinator for the USGS Cooperative Water Program in Reston, Virginia, which involves cooperative agreements with about 1,600 individual State, local, tribal and interstate agencies; she has worked for the USGS since 1984.

As a hydrologist, she developed regional groundwater flow models in collaboration with the Virginia Department of Environmental Quality to help permit water use in southeastern Virginia, and worked with the USGS National Water-Quality Assessment Program to assess regional and national water-quality conditions in major river basins and aquifers across the Nation.

As a manager, she served as the Water Science Director in Virginia and provided managerial and technical oversight for a multitude of water-resource projects addressing water availability and quality issues throughout the State.

Between 1997 and April 2011, Pixie served as a Senior Hydrologist and Communications Coordinator for the USGS Office of Water Quality, with an emphasis on communicating scientific findings to government, research, and interest-group partners in order to help guide water-resource management and protection strategies and policies. Since 2008, she served as the USGS Co-Chair for the National Water-Quality Monitoring Council, which promotes collaboration and partnerships, and provides a national forum for coordination of consistent methods and strategies to improve water quality monitoring, assessment and reporting.

Pixie received a B.S. from the College of William and Mary in Environmental Sciences and a Masters in Civil and Environmental Engineering from the University of Virginia.

Jeff Johnson
Division Manager
Southern Nevada Water Authority

Jeff Johnson works in the Surface Water Resources Department of the SNWA, where he specializes in water resource investigations for groundwater development, surface water diversions, and Colorado River resources. He is a hydrogeologist with over 20 years of experience that includes optimization of production/artificial-recharge wells in the Las Vegas Valley, water resource acquisitions and water rights, Colorado River modeling, and regional groundwater develop studies for water conveyance to Clark County, Nevada. His current activities include water resource planning and water development strategies for Colorado River resources, the Muddy and Virgin Rivers, and Coyote Spring Valley.

Dave Kanzer
Senior Water Resources Engineer
Colorado River Water Conservation District

Although he's a non-native Coloradoan, having been raised in suburban Boston, Dave is acutely aware of the water resource issues facing western Colorado and the arid western US (including the invasion of pesky non-natives). Over the last 18 years, he has worked on the numerous water quality and quantity issues facing the Colorado River Basin for the District, which is headquartered in Glenwood Springs, Colorado.

As part of his diverse duties, Kanzer manages the River District's USGS Cooperative Program for both data and studies. This is the largest USGS cooperative program in the State of Colorado with a combined total investment of over $800,000 per year. Through these endeavors, Kanzer actively works with USDOI (USGS/USBR/USFWS/USNPS) representatives and District stakeholders and water users. In 2008, Kanzer

appeared in front of the House Natural Resource subcommittee on Water and Power at the US Capitol in support of the USGS Coop program. In addition, Kanzer is actively participating on the USBR Colorado River Basin Study Project Team and is getting involved in the Landscape Conservation Cooperative and related WaterSMART initiatives.

Dave earned his Bachelors and Masters Degrees in Geological Engineering at the Colorado School of Mines. He lives in Glenwood Springs and, as an avid skier, he anxiously awaits the snowfall every year not only to replenish our critical water resources.

Robert King
Interstate Streams Engineer
Utah Division of Water Resources

Robert King has served as a Senior Engineer with Utah Division of Water Resources working in the areas of River Basin Planning, Interstate Streams, the Salinity Control Forum, Colorado River Endangered Species Recovery Program, and the Water Conservation and Education programs. Robert currently is the technical advisor to the Governor's Interstate Streams Commissioner. As such Robert represents the State of Utah on issues dealing with the Colorado River Basin and serves as the Utah Interstate Streams Engineer. Prior experience includes work with a consulting firm in Oregon and as a field engineer with the USDA Soil Conservation Service in Washington State.

Robert is a Registered Professional Engineer in Utah, and is a native of Rupert, Idaho (where he was raised on a potato farm). He earned a Bachelors and a Masters degree in Civil Engineering from Brigham Young University.

James Leenhouts
Associate Director, Arizona Water Science Center
US Geological Survey

Jim currently oversees the operation of a variety of interpretive hydrologic projects ranging from surface-water statistics to groundwater geochemisty. Jim's educational background in hydrology focused on isotope hydrology and the specifics of boron geochemistry. His professional experience has focused on stream-aquifer interactions and examining the relation between groundwater development and sustainabilitiy of surface-water resources.

He earned an undergraduate degree in geology, Oberlin College in 1990, a M.S. in hydrology from the University of Arizona in 1994, and a Ph.D. in hydrology from the University of Arizona in 2000.

Mike Norris
National Coordinator
USGS National Streamflow Information Program

Mike Norris started with the US Geological Survey in Colorado in 1979 as a Hydrologic Field Assistant and was involved in data collection, analyses, computer programming and computer modeling. In 1982, Mike became a Hydrologist and spent the next 8 years in Colorado doing hydrologic studies including the effects of coal mining on water quality, computer modeling the effects on streamflow of oil-shale development, a study evaluating the comparability of water quality information collected by different agencies, and hazardous waste site evaluations at the U.S. Air Force Academy.

In 1990, Mike transferred to Massachusetts to become the Chief of the Hydrologic Investigations and Research Section. This position required program planning, development, review, and oversight. In addition,

Mike became the primary contact for state agencies involved with hydrologic data collection and hydrologic studies and investigations.

In 1998 Mike transferred to USGS headquarters to become the Assistant Chief of the Office of Surface Water, the office that provides national leadership and technical guidance to USGS's surface water programs. From 2001 to 2003, Mike served as the Acting Chief of the Office of Surface Water, during which time the National Streamflow Information Program was designed and developed.

Mike earned a BS in Watershed Science and an MS in Civil Engineering, Hydrology and Water Resources, both from Colorado State University. He has served as the Coordinator for the National Streamflow Information Program since 2003.

Don Ostler
Executive Director
Upper Colorado River Compact Commission

Don is the Executive Director and Secretary for the Upper Colorado River Commission which was created in 1948 and ratified by Federal Compact. The Commission is comprised by governor's representatives from the states of Colorado, New Mexico, Utah and Wyoming and one representative appointed by the President. The Commission is responsible to administer appropriate Federal laws respecting the uses and deliveries of the water of the Upper Basin of the Colorado River. Don has been heavily involved during this time in negotiations with the 7 Basin States of the Colorado River and the country of Mexico to develop a drought management plan including shortage management, improved efficiency of operations and augmentation of the water supply.

Don served previously in a politically appointed position as the Director of the Utah Division of Water Quality and Executive Secretary to the Utah Water Quality Board. In this capacity he was responsible for protection of the quality of all surface water and ground water within the state of Utah. He was involved with the legislative branch of government in passing needed water legislation. Under his leadership the first programs to protect ground water quality in Utah were developed. Don worked to improve coordination of water quality and quantity issues on a watershed basis. Don has been involved in many policy issues with many opposing stakeholders where collaboration was the only mechanism to progress. He has been President of the Association of State Water Quality Directors in Washington D.C. and chaired the WSWC Water Quality Committee.

Don holds a B.S. and a Masters Degree in Civil Engineering from the University of Utah, and he is a licensed professional engineer in the state of Utah.

James Prairie
Hydraulic Engineer
US Bureau of Reclamation

Jim works with the Bureau's Upper Colorado Region, and has been working with the agency for more than 10 years. He is the Reclamation lead for the Basin Study's Demand Scenario development. In addition to his contributions to Reclamation's Basin Study team, he leads the Colorado River Hydrology Workgroup that facilitates Reclamation's leadership role in water management and planning, including integration of climate variability and change into operational planning on the Colorado River. In addition, Jim analyzes the river's salinity, oversees the historic and projected natural flow and salinity database, and analyzes the Upper Basin consumptive uses on the Colorado River system. He also works on development of operational and planning models of the Colorado River system.

Jim holds a Ph.D. and M.S. in Civil Engineering from the University of Colorado, and a B.S. in Environmental Resources Engineering from the State University of New York College of Environmental Science and Forestry.

Steve Robbins
General Manager-Chief Engineer
Coachella Valley Water District

Since 2002, Steve has served as the Coachella Valley Water District's General Manager-Chief Engineer, reporting directly to the Board of Directors. He is responsible for planning and supervising daily operations of a multi-faceted water district with nearly 500 employees. The graduate of UCLA joined CVWD as a domestic water engineer in 1978, was in the private sector for about nine years and returned to CVWD in 1994 as assistant director of engineering.

In addition to representing the board and district in interaction with elected officials, government agencies, community groups and specialized organizations, he is responsible for the implementation of short- and long term water management programs, policies and procedures; such as a 35-year blueprint to ensure affordable and reliable water sources for future generations. Steve serves on the boards of the State Water Contractors, Delta Specific Project Committee and the State and Federal Contractors Water Agency, as well as being active in numerous other water-related organization.

Tony Willardson
Executive Director
Western States Water Council

Tony was recently appointed as the Executive Director of the WSWC, which is affiliated with the Western Governors' Association. Formerly the Deputy Director, he has been with the Council for over 30 years. He is the editor of a weekly newsletter, *Western States Water* and author of numerous articles and reports covering a wide range of water resource issues, including water project financing and cost sharing, ground water management and recharge, water conservation, drought, and interregional water transfers. He is also one of the principal author's of the WGA's 2006 Report, *Water Needs and Strategies for a Sustainable Future* and its' 2008 *Next Steps* Report.

He holds a Bachelor of Arts degree in Political Science from Brigham Young University, and a Masters in Public Administration from the University of Utah.

Steve Wolff
Colorado River Coordinator
Wyoming State Engineers' Office

Steve Wolff is Program Manager for Wyoming's Colorado River Compact Administration Program, located in the Interstate Streams Division of the Wyoming State Engineer's Office. The program was initiated in 2006, and has been responsible for the development, implementation and operation of the consumptive use accounting for Wyoming's Colorado River basin depletions. The program is needed to address requirements outlined in the basin compacts.

USGS Cooperative Water Program

Cooperative Water Program

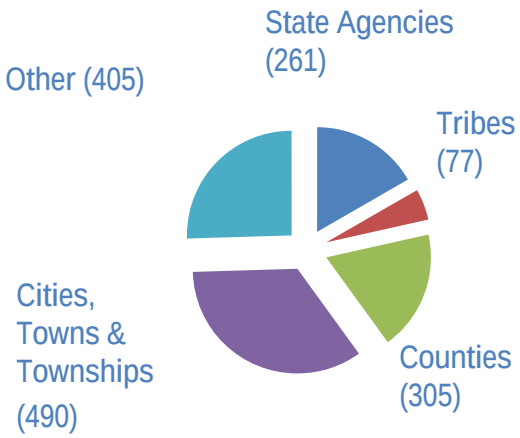
Background

The Cooperative Water Program is the Water Mission Area's "bottom-up, on-the-ground" program working in every State, protectorate, and territory of the U.S in partnership with nearly 1,550 local, State, and Tribal agencies.

Jointly planned monitoring and science efforts bring local, State, and Tribal water needs and decision-making together with USGS capabilities, including nationally consistent methods and quality assurance; innovative monitoring technology, models, and analysis tools; and robust data management and delivery systems.

Findings are thereby comparable across local, State, Tribal, and regional boundaries because data and analyses adhere to strict national protocols; water issues in a specific watershed, municipality, or State can be compared to those in other geographic regions and through time. In addition, large-scale syntheses and problem-solving in different regions and across the Nation are possible.

Stakeholders - The total number of Cooperators across the U.S. totaled nearly 1,550 in FY11. (Note: "Other" includes organizations associated with local, State, and Tribal agencies, such as regional commissions, State Universities and conservation, irrigation, and natural resource districts.)



Program Strengths

- Shared costs, shared benefits
- Impartial information, universally available and accepted by all parties
- Built-in local, State, and Tribal relevance through Cooperator interaction, directly applicable to regulatory decisions, management, policy, and jurisdictional disputes (see pages 2 and 3)
- Foundation for USGS hydrologic national monitoring networks and data delivery systems (see page 4)
- Scientific response to "on-the-ground" emerging water issues, with raised visibility at regional and national scales
- Innovative tools, models, and technology transfer across the Nation
- Regional and national assessment of priority water issues

Funding

- FY11 Federal appropriation: $ 63.5M
- FY11 Reimbursable funding from localities, States, and Tribes: $ 160.3M
- FY11 Total program funds: $ 223.8M
- FY12 Federal appropriation: $ 64.1M

Contact: Pixie Hamilton
pahamilt@usgs.gov
(703) 648-5061
http://water.usgs.gov/coop/

Assessments and Research - The Cooperative Water Program (CWP) conducts more than 700 interpretative studies annually, producing more than 300 information products each year and resulting in a myriad of stakeholder decisions related to water availability, ecosystem health, water quality and drinking water, hazards, energy, and climate.

Selected Stakeholder Highlights in 2011

Water availability

Washington State Department of Ecology uses USGS models to quantify the effects of groundwater pumping on streams and to define "groundwater reserve" areas for accommodating new permit-exempt wells in basins that are closed to additional surface-water rights.

Rio Grande, Pecos, and Costilla Compacts use CWP streamflow information to account for water passing to and from New Mexico.

Wake County managers in North Carolina use USGS groundwater information in managing water conflicts.

Colorado State Engineer's Office uses real-time streamflow information in the administration of water rights.

State of Mississippi uses CWP irrigation conservation models for decisions on irrigation use and conservation management in the Mississippi Delta.

Tribal communities throughout the State of Wisconsin use CWP groundwater models to optimize water-supplies.

Pumping was believed to be the largest contributor to hundreds of feet of groundwater level decline near Mosier, Oregon, but a cooperative project with the Mosier Watershed Council and the Wasco Soil and Water Conservation District identified leakage between aquifers through well boreholes as the likely dominant cause of large declines over the past 35 years.

Ecosystems

The Utah Department of Environmental Quality issues fish consumption warnings and employ methods to reduce methyl mercury in reservoirs based on CWP research in Great Salt Lake and surrounding wetlands.

State of Hawaii Water Commission set minimum in-stream flow standards for 27 streams in Maui to protect fish and other aquatic life.

The Montana Department of Fish, Wildlife, and Parks uses CWP real-time temperature and streamflow data to optimize the duration and timing of open season for recreational fishing.

Beginning with a CWP project in Austin, Texas, continued USGS assessments led to new regulations by the State of Washington on the use of coal-tar sealcoat on parking lots, driveways, and other pavement—a major source of toxic PAHs to aquatic life.

Selected Stakeholder Highlights in 2011, continued

Water quality and drinking water

The Water and Electric Board in Eugene, Oregon adopted high-tech USGS optical sensors and analyses to manage drinking-water supplies.

The Spartanburg, South Carolina Regional Water System uses CWP research to minimize harmful algal blooms in their public supplies.

Miami-Dade County, Florida is re-evaluating injection of treated wastewater into the Floridan Aquifer System, in response to CWP investigations.

The Iowa Environmental Management Agency adopted CWP real-time nitrate sensors to manage sources and nitrate treatment in municipal supplies.

The City of Wichita, Kansas uses real-time surrogate estimates of water quality and other USGS research to manage drinking-water supplies from Cheney Reservoir and to manage artificial recharge in the Equus beds aquifer.

Hazards

The Alaska Department of Transportation closed Copper River Highway based on CWP long-term streambed scour assessments.

State of New Jersey uses CWP groundwater monitoring, ongoing for more than a decade, for drought monitoring and water restrictions.

State of Alabama issues drought declarations based on CWP monitoring.

Town of Fort Kent and Maine's Emergency Management Agency used CWP real-time streamflow information and USGS inundation mapping in their 2011 flood response.

CWP-supported and other USGS streamgages informed local and State emergency decision making related to evacuations, floodways, navigation, and levee systems during the unprecedented flooding in the Mississippi River Basin in 2011.

Energy

The Louisiana Department of Natural Resources used CWP groundwater data to declare and protect "areas of groundwater concern," including in several parishes where groundwater and streams are used for shale fracturing for natural gas production.

In response to Marcellus Shale fracturing, the CWP is collaborating with the West Virginia Department of Environmental Protection on developing a public web-based tool to access stream information and assist in water-withdrawal decisions.

Climate – The City of Newport News in Virginia reassessed "safe yields" from Chickahominy River water-supply intakes based on CWP findings on changing salinity due to sea level rise.

Data Networks — The Cooperative Water Program (CWP) supports national hydrologic data networks, real-time capabilities, and data delivery across the Nation.

Groundwater

CWP supported groundwater measurements at more than 8,000 sites in FY11. About 1,400 are in real time. Real-time groundwater levels, such as measured at this platform in North Carolina, are critical for managers during times of drought.

Streamgages

CWP and 850 cooperators helped to support more than 75 percent of streamgages across the Nation in FY11. About 95 percent are in real time, critical during flooding and to support emergency decisions to protect life and property. Other common uses include infrastructure design (roads, bridges), recreation, and water permitting.

Water Quality

CWP supported water-quality monitoring at nearly 4,000 stream sites and wells in FY11. Real-time water-quality sensors measure pH, water temperature, dissolved oxygen, specific conductance, and turbidity which can change quickly, particularly before, during, and after storms. Data are critical in day-to-day operations of reservoirs, and management of drinking-water intakes and beach health.

USGS Cooperative Water Program— High Priority Issues Addressed by Data Collection and Interpretative Science – FY12

The CWP values data collection activities *and* scientific investigations. The Program strives to maintain a balance in support of national USGS hydrologic networks and scientific investigations that inform local, State, Tribal, regional and national water issues.

Overall, CWP supports nearly 700 hydrologic investigations of the quality and quantity of the Nation's water resources, resulting in more than 325 publications in FY11. Key topics relate to water quantity and quality of surface water and groundwater to meet the Nation's myriad of water uses; environmental flows in streams needed to maintain ecosystem health; effects of changing land use on water availability; flood inundation and analysis of risks; sediment; and emerging contaminants in drinking water.

Data-collection activities support USGS national hydrologic-data networks, which constitute the foundation for all USGS mission areas, as well as watershed and aquifer management decisions by stakeholders across the Nation. The comprehensive, uniform, and accurate data on surface-water, groundwater, water-quality, sediment, and water-use are required for sustaining water that is available and safe for all drinking, ecosystems, industry, agriculture, energy, and navigation, and for water-rights determination by State and Federal agencies, as well as for simulating and forecasting hydrologic conditions and events. In addition, the long-term record of water quantity and quality developed by USGS is invaluable as a baseline for detection of change and to assess human influence over time.

The CWP partially or fully supports 77 percent of the USGS stream gages throughout the Nation, 95 percent of which provide information in real-time. In addition, the CWP supports more than 8,000 groundwater observation wells, many of which provide real-time information that is critical for drought analysis and tracking, as well as about 4,000 water-quality monitoring sites (many of which are real-time).

High priority data-collection activities associated with the CWP in FY12 include:

(1) enhancement of the hydrologic-data networks;
(2) improved accessibility and delivery of data; and
(3) increased availability of real-time data for surface water and groundwater.

Because of the widespread importance of USGS data, Science Centers are strongly encouraged to continue to allocate CWP funding to support data collection and USGS hydrologic data networks at similar levels in FY11. The National Program will continue to track and strive for a balance between data collection and interpretative studies (assessments and research), which is currently, on average, about 60 percent data collection and 40 percent interpretative studies within Centers.

Data and Interpretative Studies Support USGS Priorities

Data collection (i.e. networks) and interpretative studies support the USGS Science Strategy, and specifically six Water Mission and USGS priorities, including (1) water availability, (2) hydrologic hazards, (3) ecosystems, (4) environmental health, (5) energy, and (6) climate and land-use change.

Specific topics addressed by CWP activities are listed below that provide the foundation for water resource decision making at local, State, Tribal, regional, and national scales. Note: Many of the topics are those identified by stakeholders who participated in national stakeholder meetings and (or) in one of nine regional stakeholder roundtables held across the Nation.

While all topics listed under the six USGS priorities are important at local, State, Tribal, regional, and national scales, selected topics are noted in the guidance with italicized font that currently are of high national priority to the Water Mission Area. Science priorities will continue to evolve as we await the completion of work by Science Strategy Planning Teams (SSPT) and

as priorities are established by the Water Mission Program Council (consisting of Water Program Coordinators) and Policy Team (consisting of Water Technical Office Chiefs).

Water Availability

- *Water use (including conjunctive use; i.e. integrated groundwater/surface water management)*
- *Groundwater recharge and storage assessments, including the associated hydrogeologic framework of groundwater supplies, and groundwater/surface water modeling and analysis*
- *Assessments of in-stream flow requirements and water availability for environmental and wildlife needs*
- *National compilation, regionalization, estimation and distribution of streamflow (such as to ungaged sites)*
- Water budgets and systems analysis of hydrologic components – including precipitation, evapotranspiration, groundwater recharge, storage (including snowpack), and surface water flow
- Low flow, peak flow, and recreational flow assessments
- Geochemical constraints on water availability

Expected outcomes include critical information on the quantity, quality, and use of available surface water and groundwater needed for improved management of waters that serve as important local and regional sources of water supply and for the management and support of watershed ecosystems. The information will help in critical decisions on the timing of flow releases and allocation or reallocation of water resources to meet multiple needs, and decisions related to Federal reserved water rights and interstate compacts and water rights settlements.

CWP data collection and interpretative studies on water availability support the USGS initiative for a Water Census that results in improved information on water uses (including thermoelectric and irrigation, the two largest users), as well as watershed budgets and an improved understanding of water use and effects on the hydrologic components, including groundwater/surface water relations, evapotranspiration, surface water flows (such as needed to for ecosystem sustainability).

Hydrologic Hazards

- *Flood response, flood-frequency and inundation analysis and risks, improved depiction and communication tools to minimize impacts on life and property*
- *Drought risks, trends, and forecasting*
- Catastrophic movement of sediment and debris, such as associated with post-fire runoff
- Subsidence

Expected outcomes include (1) increased protection of lives and property and prevention of economic losses from floods, storm surge, debris flows, and droughts (which can amount to millions of dollars annually); and (2) improved forecasting of the probability of occurrence based on increased understanding of trends and processes driving hydrologic events.

Ecosystems

- *Environmental flow requirements and effects on aquatic communities*
- *Impacts of land-use change and practices on stream ecosystems (including best management practices, such as storm water management and combined sewer overflows in urban areas and controls of non-point contamination in all land uses)*
- *Sources (point and non-point), transport, and fate of chemicals and algal toxins* (related to point and non-point sources) entering streams, estuaries, lakes, and reservoirs
- Effects of streamflow alterations on ecosystems
- Sediment transport and storage in streams, lakes, and reservoirs
- Assessing ecosystem services

Expected outcomes are improved information for (1) strategies to protect and restore streams; (2) regulations of point sources, mining permits, and Total Maximum Daily Load (TMDL) requirements of the Clean Water Act; (3) management of excessive nutrients and sediment originating upstream from estuaries and other receiving waters; and (4) strategies to control sources and transport of non-point contaminants (associated with urban, agricultural, and mining areas) to streams.

Environmental Health

- *Occurrence of emerging contaminants such as antibiotics, hormones, pharmaceuticals, and pesticides in source water used for drinking and their effects on ecosystem health*
- *Effects of naturally occurring contaminants (such as radiochemicals, mercury, arsenic, uranium, selenium, and perchlorate) and man-made activities on the quality of groundwater used for drinking*
- Effects of salt water intrusion on groundwater used for drinking
- Man-made contaminants in wastewater entering source water used for drinking
- Harmful organic compounds and algae in groundwater, streams, and reservoirs
- Contamination in recreational waters (such as microbial)

Expected outcomes are (1) clean and safe drinking water to citizens and early indication of possible water-quality problems required in long-term management and protection of groundwater resources that serve as a water supply for more than half of all Americans, and (2) improved warning and tracking of contamination affecting beach health and other recreational waters.

Energy

- *Impacts of energy development, including hydrofracking and coal bed methane extraction, on surface water and groundwater quantity and quality*
- Impacts of abandoned and active mining on water quality

Expected outcome is improved information for strategies to minimize impacts of energy and mineral development on the quality and quantity in streams and groundwater resources.

Climate and Land-Use Change

- *Analysis and tracking of groundwater levels*
- *Changes in streamflow patterns and trends (seasonal and over the long term)*
- Assessments on the timing, form, distribution, and intensity of precipitation events and impacts on water availability
- Impacts of sea-level rise
- Impacts of climate and land-use change on water supplies and demand
- Carbon sequestration

Expected outcome is long-term hydrologic data and hydrologic systems models that are capable of forecasting the consequences of climatic variability and land-use change, critical to local, State, regional and national water managers.

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

In Reply Refer To:
Mail Stop 409

January 19, 2012

WATER MISSION AREA MEMORANDUM NO. 12.01

Subject: Avoiding Competition with the Private Sector

This memorandum reiterates the longstanding Water Mission Area (WMA)(formerly Water Resources Discipline) policy on avoiding competition with the private sector and provides references for additional guidance in areas where competition may be an issue.

The need to review the role of the WMA in performing work on a reimbursable basis with a variety of partners continues to be relevant in light of the changing technical and political environment and evolving expertise and capabilities of the water-resources consulting community. The U.S. Geological Survey (USGS) mission continues to provide clear and compelling justifications for a Federal role in water-resources data collection, assessments, and research. It is our intention to adhere to that role. The existence of even a few projects (out of the many hundreds undertaken) for which the justification is weak can undermine our ability to continue to provide the services to the Nation that is our proper mission. Thus, for every study we undertake, we must be able to demonstrate that the work is consistent with our Federal role.

The essential role for the WMA is to be the principal Federal provider of water-resources data, assessments, research, and new technology for the Nation. As such, the WMA intends to maintain its competence through hydrologic research and methods development; distributed data-collection and resource-assessment programs; and continuous stakeholder input. The continued vitality and relevance of our programs depend on our close involvement and responsiveness to stakeholder agencies. Internally, strong competence in field techniques and assessments; familiarity with the full range of hydrologic systems; and a robust and relevant research program will be maintained. The data and hydrologic system information gathered from the individual local and regional activities are used in turn by the WMA to synthesize regional- and national-scale water-resources perspectives and are vital to our overall mission. Without these elements, the WMA would soon lose its scientific leadership and relevance to emerging water-resource issues.

Paramount in our relationships and programs with other agencies, however, is the need to maintain the longstanding WMA policy not to compete with the private sector. This means that the WMA must be responsive to the requests and interests of potential partners, but at the same time, set limits on the type of work undertaken on their behalf. As such, projects undertaken with funding partners must meet several basic standards. Our projects must provide an enhancement of

knowledge or an enhancement of hydrologic methodology that is useful beyond the immediate needs of the cooperator. In general, if the project provides services readily available from the private sector and or driven solely by an operational need of the cooperator to meet an agency-specific requirement, (such as a design or permit application) we should not undertake the work. However, if services are not readily available from the private sector or the partner's operational need can be satisfied along with one or more of the following broader WMA goals, then the work may be considered appropriate. These broader goals include:

- advancing knowledge of the regional hydrologic system;
- advancing field or analytical methodology;
- advancing understanding of hydrologic processes;
- providing data or results useful to multiple parties in potentially contentious inter-jurisdictional conflicts over water resources;
- furnishing hydrologic data required for interstate and international compacts, Federal law, court decrees, and congressionally mandated studies;
- furnishing hydrologic data or information that contribute to protection of life and property; and,
- providing standardized, quality-assured data to national data bases available to the public that can be used to advance the understanding of regional and temporal variations in hydrologic conditions.

A critical aspect of each of these goals is that all WMA programs (whether funded by appropriations or by funding partners) actively share the results through widely-accessible data bases and published reports. Further guidelines on our appropriate role are given in WRD Memorandum No. 84.21; this memorandum specifically addresses criteria to be used to decide which hydrologic activities are not appropriately included in the Cooperative Water Program.

The USGS uses private sector contractors to carry out specific tasks in projects where it is appropriate and efficient to do so. Agreements for such arrangements should contain clear expectations as to how the USGS and the private sector firms will collaborate.

An External Task Force Review of the Cooperative Program completed in 1999 provided two important recommendations related to competition (USGS Circular 1192, p. 19) as follows:

**Convene ad hoc committees by project type, composed of private sector, other agencies, and Cooperators, to resolve emerging competition issues, and to help determine what types of projects are appropriate for the USGS to undertake.*

To address this recommendation, USGS convened 'listening sessions' at major national conferences involving topical areas where competition could be a potential issue. To date, these listening

sessions have resulted in two guidance memorandums on floodplain mapping (August 22, 2002; April 19, 2002). A third guidance memorandum (WRD Policy 03.06) on the subject of bridge scour is based on numerous interactions with cooperators and the private sector on this topic. Other topics will be covered as they arise and as appropriate venues for addressing them are identified.

**Create and convene biennially, a review panel to update WRD Memorandum No. 95.44, as necessary.*

Because guidance memorandums on specific topical areas are being used to update information about competition issues, we have agreed to review and revise, as needed, our policy memorandum on competition at least every 5 years.

The WMA remains committed to stay relevant to the needs of its funding partners while maintaining significant technical leadership, innovation, and hydrologic expertise of benefit to stakeholders across the Nation.

William H. Werkheiser
Associate Director for Water

DISTRIBUTION: A, B, WSCs

This memorandum supersedes WRD Memorandum No. 04.01, which superseded WRD Memorandum No. 95.044 and WRD Memorandum No. 85.059

Results from Previous Cooperator Roundtable Meetings (in chronological order)

National Roundtables

March 2005

January 2006

Regional Roundtables

Georgia & the Carolinas - March 2007

California - May 2007

Texas - September 2007

Upper Mississippi River States - November 2007

Upper Missouri River States - August 2008

Ohio River Basin States - September 2008

Florida - November 2008

Mid-Atlantic States - February 2009

Pacific Northwest States - September 2009

New England - March 2010

National Roundtable

March 2010

USGS Response – April 2010

First National Roundtable Discussion
on the
USGS Cooperative Water Program

March 9, 2005 **Washington, DC**

On March 9, 2005 twenty-six representatives of USGS water cooperators joined fourteen managers from the U.S. Geological Survey for the first national meeting of stakeholders in the Cooperative Water Program (see attached roster). The cooperators represented a cross section of the nearly 1,400 government entities at the State, local, and tribal government level who participate with the USGS in jointly funded water data collection and studies. The meeting was jointly sponsored by the USGS and the Interstate Council on Water Policy (ICWP). Marci DuPraw of Resolve served as the Facilitator.

The objectives of the meeting were to provide an opportunity for the cooperators to hear about the status and recent achievements of the Program, to learn about the nearly-completed external review of the Program, to give feedback to the USGS about the Coop Program, and to share common ideas with each other (see attached agenda). To summarize the Cooperator panel discussion:

Strengths of the Program:

- Innovative; ability to synthesize disparate approaches to data collection
- Full agency support and resources
- Gaging Network itself and its longevity
- Quality, reliability and availability of data
- "cost-effective" way to provide high quality data; consistent data over time
- Dedicated staff, bring a lot of expertise
- Way of leveraging cooperative resources
- Separation between 'information' and 'regulation' (science-based objectivity)

Challenges that USGS could Improve On:

- Need clarity about scale of new initiatives – has resource implications
- How baseline/background water quality is taken into consideration re WQ standards…USGS should stay in objective science mode; technical/regional-peer benchmarks OK, being careful not to adopt 'stds' that might not be supported….
- Help reconcile directional pulls on District Chiefs – e.g., agency mission/national public good vs. district/state/local needs
- Pressure from USDOI on USGS to turn inward vs. toward cooperator needs
- Training cooperators to help with streamgaging activities
- Improve coordination with state, Federal and tribal entities seeking funds for streamgaging
- Increase Federal match
- Get out of 'crisis' mentality (toward long term planning) – note: thought this applied esp. to state strategic planning (not USGS – they do national long-term strategic planning)

Possible Cooperator Actions:

- Document benefits of data collection (and also Interpretive studies) to states

- States being transparent w/USGS re Strategic Planning (and doing such planning at state level) to coordinate deployment of people, resources, etc.
- Ongoing support for streamgaging network and USGS role in it
- Take more ownership of Coop Studies (offer in-kind services, esp. in terms of state staff involvement; co-author reports…)
- Improve coordination with state, fed, tribal entities seeking funds for streamgaging
- Get out of crisis mentality – take more long-term view, do strategic planning
- Coordinated effort across cooperators (nationwide) to seek additional Federal funds for Coop Water Program (esp. for NSIP stream gages of National interest) – e.g., expand role of statewide group(s) like ICWP, WSWC, ASIWPCA…

At the conclusion of the meeting, the facilitator led a discussion to amplify the list of strengths, challenges, and actions that could be taken for the Cooperative Water Program. The results:

Strengths:
- Sound, unbiased science (science independent from policy)
- Credibility
- Ability to draw on entire agency resources
- Direction of the work is both locally-led to a large extent, but because of soundness and consistency, easily rolled up for National picture. Tricky balance to maintain and explain, but a real strength of program.
- USGS is now delivering better data products and delivery, real time, less lost data
- Quality, longevity, access to data key strengths

Areas where the <u>USGS</u> could improve:
- Timeliness of Products
- Highlighting existing "cooperative" effort
- Document program benefits
- Lack of state and Federal budget increases to cover cost of inflation
- USGS produce targeted Fact Sheets and communications to also assist in the funding process
- USGS needs to listen to cooperators and Strike appropriate balance between data and projects
- Expanding Coop program to include other disciplines, importance of streamgaging program, bring in extra dollars and more participation to project work
- Use of USGS equipment (by states) for relaying traffic information (example), bring in more support for program.
- Increase public and political awareness of the availability of equipment for various uses.

Actions <u>Cooperators</u> could take:
- Proactive outreach, get the message out

- Grass roots up at local level – local/county/state--talk about streamgaging, flood protection, QW, WQ issues, talk about value of programs and real life impacts. Nice to get ahead and articulate values, as opposed to crisis reaction and management to be more strategic.
- Helping USGS brand itself that it is a science agency – USGS State of the Union.
- Water is a big issue, all people should be able to relate to it.
- Cooperators can help set vision for multi-year program planning.
- Cooperators can collaborate with USGS on data collection and interpretive studies.
- Need for cooperators to get together and form a commonality, consistent story, that cooperators can take to congress to request additional support for program, ICWP, WSWC, TWDB for state-specific funds; more effective National letter jointly from Cooperators to take to each of local state reps for overall support at Federal level for NSIP program.
- Incorporate working with USGS and Admin and Congress to bring National perspectives into planning/budget process
- Coordinated efforts, more effective and more powerful – and not compete for individual piecemeal resources.
- Involvement of Cooperator throughout all stages of products, planning, implementation, and delivery.

The **final discussion** was a session just among the Cooperators. Among the comments emanating from this session:

- Cooperators cannot continue indefinitely to absorb more than their fare share of cost increases. USGS needs to pick up some of the increased costs.
- Both the Cooperative Water Program and the National Streamflow Information Program (NSIP) are in need of additional Congressional funding.
- Cooperators would like to be partners, not just payers.
- Cooperators, working at times with each other and at times with the USGS, can help with public relations, political strategy, and strategic planning. They should discuss these issues with their association members and encourage them to make their feelings known to influential groups.
- Four associations emerged as potential leaders in consolidating cooperator actions: Interstate Council on Water Policy, Western States Water Council, Association of State Floodplain Managers, and National Association of Flood and Stormwater Management Agencies. ICWP will put the notes from this meeting on their website.
- Cooperators can be a part of the work, including data collection and projects.
- USGS should protect data first before interpretive studies.
- A follow-up meeting similar to this one might be helpful.

2ND NATIONAL COOPERATORS' ROUNDTABLE
FOR THE
USGS COOPERATIVE WATER PROGRAM

January 31-February 1, 2006 **Washington, DC**

There was a very good turnout for the reception Monday evening and for the Roundtable meeting Tuesday, January 31, 2006, including approximately 70 people representing Cooperators from 20 states and 45 people from USGS Headquarters and Water Science Centers in 18 states.

Following a challenging and informative series of presentations regarding current capabilities of the CWP, its relation to the NSIP and the management of both programs, we broke into 5 smaller groups to explore and evaluate options for improving the CWP. Each group included a random mix of Cooperator and USGS representatives in a discussion and refinement of suggestions. However, USGS representatives did not participate in the prioritization of these ideas, since they are especially interested in the Cooperators' viewpoint. As a first cut, the following outline summarizes the ideas of greatest interest to the participating Cooperators:

WHAT CAN USGS DO TO IMPROVE THE CWP?

Communication:

- Hold future Cooperator meetings at state or regional level
- Broaden the "customer base" for gaging (e.g., identify underpaying beneficiaries)
- Give Cooperators more input on the use of cost-sharing funds; include opportunity to consider environmental justice, data/study balance, *etc*
- Communicate with broader community of interested stakeholders regarding any threatened gages (not just the Cooperators directly involved in funding those specific gages)

Setting Program Priorities

- Give first priority to monitoring (*vs* investigations) when funds are limited
- Have more stakeholder input into setting the priorities of the CWP
- Implement national policy for state-by-state prioritization scheme (Cooperator's match rate could be based on importance of issues)

Funding Issues

- Re-establish 50-50 match in the CWP
- Continue to seek to full fund NSIP as a way to bring CWP closer to a 50-50 split

Cost Containment

- Control costs—examine 3 biggest costs for gaging and look for ways to save; include Cooperators and equipment suppliers in evaluation
- Be more creative in finding ways to reduce costs; USGS could provide QA and disseminate data collected by Cooperators
- Consider greater use of in-kind (especially if Cooperators provide certified operators, data)
- More coordination up front on how funds are being spent could help with cost efficiency (e.g., cooperator handle low-flow gaging)

Technical

- Give cooperators access to unit-value data
- Make internet access to data more user-friendly

- Improve QA for estimated peak flows

What can Stakeholders do to Improve the CWP?

Communication

- Ask the Administration and Congress for additional support; organize our leaders for a "Water Day" in DC to inform their representatives and agency officials
- Become more organized and active as a Cooperator community; get more Cooperators involved
- Enhance public awareness of USGS water data programs.
- Use USGS data in user-friendly ways to increase recognition of CWP data.

Funding Issues between Cooperators and USGS

- Identify non-traditional Cooperators in private sector to fund gages (e.g., power companies)
- States (or other large Cooperators) might be able to reduce number of cost share agreements (and associated overhead expense) by consolidating groups of interested stakeholders; maybe by establishing a general fund to allowing any entity to contribute (e.g., recreation and environmental groups)
- Increase effort to coordinate contributions from multiple funding partners
- Increase Cooperator involvement in deciding which NSIP gages to support

Cost Containment

- Make greater use of in-kind services
- Cooperators could be involved in the USGS cost comparison exercise
- States could take over data collection and provide the data to USGS ("furnished records")

Technical

- Stay current with the state of the art (e.g., in data transmission technology)

Southeastern Coastal States CWP Cooperators' Roundtable 2007

Held March 28-29, 2007

Summary: In conjunction with the 2007 meeting of the Georgia Water Resources Conference, the Interstate Council on Water Policy (ICWP) and the US Geological Survey (USGS) held the first regional Cooperative Water Program (CWP) Cooperator's Roundtable on the University of Georgia campus in Athens, GA on March 29. This was the first in a series of regional stakeholder meetings designed to present an overview of the USGS streamgaging and water science programs and to create a constructive opportunity for stakeholders to help guide those programs. The meeting included presentations by USGS staff on the purposes, history and capabilities of the CWP and some of the current challenges facing it; presentation materials are accessible on the internet. Several Cooperator representatives described the scientific contribution that the CWP data collection and interpretive investigations and the benefits they bring to local water management. The meeting concluded with a discussion of ideas for strengthening the CWP and addressing the emerging water management issues.

Facilitated Break-Out Group Discussion of Opportunities & Priorities: Peter Evans divided the participants into two groups for a facilitated exploration of opportunities that both the USGS and the Cooperators might choose to improve the CWP. The two groups met for about half an hour, one lead by Peter and the other by Sue Lowry (ICWP's Chair and Administrator of the Interstate Streams Division in the Wyoming State Engineers' Office) to respond to two questions and then prioritize the results.

Recommendations for USGS consideration were:

- Improve outreach to local government, enhance USGS awareness of local issues and become a recognized participant in problem solving;
- Projects should be designed with more frequent "results" (e.g., reports, other deliverables), especially for long-term projects;
- Optimize the entire gaging network. Provide to local cooperators the background information so that they understand the decisions made by USGS when locating NSIP gages. Better coordination between the two programs as the local level is desirable. But having both programs is good so that some trade-offs can be made between the programs on specific gages.
- Enhance fact sheets describing investigation results in understandable terms, focus on informing the public;
- Anticipate next-steps and implications (e.g., for information needs, permitting, budget and other decisions) earlier in the project for future program and budget planning (e.g., design-build contracting);
- Promote this regional approach in having discussions with the cooperators.

Recommendations for CWP Cooperators' consideration were:

- Cooperators can do more to promote education/funding with Congress and the Administration. Also, look beyond the present set of supporters (e.g., to the National Association of County Officials, since in the southeast, water issues are very important and many county commissioners are very knowledgeable and would be willing to work on water issues when they are in DC or talking with their congressional contacts.
- Develop a better understanding of the CWP role, managers, decision cycles, resources, etc and the scope of USGS capabilities.
- Cooperators and the USGS need to work together to be more creative in financing streamgaging. New opportunities for in-kind services should be explored.
- Remember to invite USGS to more of the meetings where water issues are explored so they have better awareness and can contribute to the consideration of information needs and potential solutions. Cooperators can be of help in the information transfer working with USGS. Many cooperators participate in organizations beyond those with which USGS might typically participate. Cooperators should keep in mind opportunities to reach difference audiences with outreach on water resources research results.

California CWP Cooperator's Roundtable Summary

Monday, May 7, 2007 **Hyatt Regency Sacramento**

Summary: In conjunction with the spring meeting of the Association of California Water Agencies, the Interstate Council on Water Policy and the US Geological Survey (USGS) held the first California Cooperative Water Program (CWP) Cooperator's Roundtable in Sacramento on May 7. This roundtable was the second in a series of regional stakeholder meetings, the purpose of which is to extend information about the USGS streamgaging and water science programs and create an opportunity for stakeholders to help guide those programs. The meeting program included presentations by USGS staff on the purposes,

history and capabilities of the CWP and some of the current challenges facing it. Several Cooperator representatives described the scientific contribution that the CWP data collection and interpretive investigations have made in California and the benefits they bring to local water management. The meeting concluded with an open discussion of ideas for strengthening the CWP and addressing the emerging water management issues in California.

Facilitated Break-Out Group Discussion of Opportunities & Priorities: Peter Evans divided the participants into two groups for a facilitated exploration of opportunities that both the USGS and the Cooperators might choose to improve the CWP. The two groups met for about an hour, one lead by Dennis Bostad (Sweetwater Authority) and the other by Eric Senter and Greg Smith (both with California DWR) to respond to two questions and then prioritize the results.

Sue Lowry, who chairs the ICWP Board of Directors and administers the Interstate Streams Program in the Wyoming State Engineer's Office, facilitated a brief summary and discussion of the highest-ranked suggestions from the two break-out groups.

The highlights for USGS consideration were:

- Restore 50/50 financial match (or reduce program cost, using newer hardware, software technologies, *etc*) so that Cooperators can afford more data and science;
- Further meetings between the USGS and groups of the CWP Cooperators to discuss agency and program management opportunities and challenges would be very helpful; embrace Cooperators more fully as partners, sharing more of budget, staffing, other key management challenges before significant decisions need to be made; provide annual summary of projects, programs to Cooperators.
- Provide more frequent reports on the subject and progress of interpretive studies; reduce the time required for internal review and deliver data quicker;
- Update the statewide flood frequency statistics at gaging stations in California (last updated about 30 years ago); also update streamflow and watershed characterizations;
- Provide additional technical assistance (e.g., facilitating access to the GOES, providing streamgage training more frequently, providing guidance and training in statistical and time series analytical methods, clarifying USGS QA/AC procedures, providing assistance to integrate data within a stream segment and reduce discrepancies, facilitating access to other published water resources data) and information (e.g., cross sections in downloadable form, data for unimpaired flows in mountain areas with tools to integrate/associate data from adjacent stations) to Cooperators; a watershed discussion among stakeholders would help promote awareness of emerging issues, shared concerns and the relevant science;
- Add older data to online databases, provide statistical tools for analysis and interpretation;

Highlights for CWP Cooperators' consideration were:

- Our legislative and congressional leaders need a better understanding of the value that the CWP and NSIP have in our ability to make intelligent decisions for our communities and in our relation with other states; also the financial burden it places on our agencies if federal funding for these programs is insufficient;
- Organize public/media events around water issues in which USGS experts can present their science as a means to increase public awareness of water issues and the USGS contribution to understanding and solving water problems;
- Develop a model or standard agreement for use between California state agencies and the USGS to streamline internal review (especially with the AG's Office)

- Take more initiative to learn CWP managers, opportunities and difficulties;
- Co-locate staff to enhance communication and understanding between USGS and Cooperators;

Texas Cooperators' Roundtable
for the
USGS Cooperative Water Program

September 6, 2007 **Austin, TX**

What can <u>USGS</u> do to improve their service?

- Better communication of current and ongoing CWP projects
- Local/Regional meetings to discuss USGS ongoing projects in local area…Cooperators possibly host such a meeting?
- USGS & cooperators could partner to organize meetings to share ideas, technical needs and challenges facing region (communication awareness)
- USGS need(s) help developing 5-year plan, science directions of cooperators for the next 5 years
- Need local forums to help educate stakeholders on USGS capabilities
- Better use of Webcasts to provide project information, expertise, capabilities
- Better "marketing" of capabilities, Cooperators don't know what you can do
- Better referencing of reports (accessibility)
- FAQ on process for acquiring USGS services
- Better info on who is funding gages/studies
    - List cooperators who pay for gage on gage website (and add logo's)
- Make web site and project material more appealing to public, revise and update website, to hard to find information
- Need "redneck press here" button (Laurie's suggestion)
- Graphic-based web site for getting water data
- Publicize/Communicate happenings throughout the USGS
- What are future focuses of USGS, what new Science Directions and Capabilities
- What experience does the USGS have in Watershed Protection Planning?

Emerging issues

- "Certification" for water data collection training program for cooperators staffs
- Tarrant Regional Water District has a network of streamgages and staff to collect data, to expensive, will have USGS more involved in the future after staff retirements
- Need 3rd party to look at feasibility of involving cooperators in data collection activities to reduce costs.
- What work can cooperators perform to cut gage costs?
- How can USGS lower costs by using local help?

Upper Mississippi River Basin States CWP Cooperator's Roundtable

November 1-2, 2007 **Five Flags Holiday Inn, Dubuque, IA**

Summary: In cooperation with the Upper Mississippi River Basin Association, the Interstate Council on Water Policy and the US Geological Survey organized the first Cooperative Water Program (CWP) Cooperator's Roundtable for the five Upper Mississippi River Basin States in Dubuque, IA. This roundtable was the fourth in a series of regional stakeholder meetings, the purpose of which is to extend information about the USGS streamgaging and cooperative water science programs and create an opportunity for stakeholders to help strengthen those programs.

The program included presentations by USGS staff on the purposes, history and capabilities of the CWP and some of the challenges facing it. Several Cooperator representatives presented excellent descriptions of the scientific contribution that the CWP data collection and interpretive investigations have made and the benefits they bring to state and local water management. The reception and exploration of the National Mississippi River Museum and Aquarium were very enjoyable and the meeting concluded with a discussion (and ranking) of ideas for building a stronger Cooperative Water Program with USGS.

Break-Out Group Discussion of Opportunities & Priorities: The participants divided into two groups to explore opportunities for both the USGS and the Cooperators to improve the CWP. The two groups met for about an hour, one lead by Kent Lokkesmoe (Minnesota DNR) and the other by Greg Good (Illinois EPA) to respond to two questions and prioritize the results. The highest ranking recommendations were:

For USGS consideration:

- Get back to 50% match and increase USGS funding for new work;
- Reduce HQ overhead cost;
- Enhance interagency coordination of data collection;
- Improve sediment monitoring and analysis program;
- Better recognize synergy of USGS and state monitoring programs;
- Simplify and reduce cost of reports and consider a new methods for producing reports quickly, especially for small studies;
- Stay on cutting edge, advancing the available technology, and continue technology transfer to Cooperators,
- Continue pushing for more timely release of data and information on web, final and provisional;
- Hold regular, statewide meetings with Cooperator community to review needs, opportunities, priorities;

For CWP Cooperators' consideration:

- Advocate full NSIP implementation and continuing increases for the CWP;
- Cooperators can/need to be more vocal with policy makers /influential people;
- Promote base funding for USGS to separate overhead from CWP cost share agreements;
- Improve accessibility of data for electronic transfer of information;
- Discuss streamgage issues and priorities with more organizations and data users more often;

- Identify and promote awareness of more sources of water data; deal with funding implication;
- Help USGS avoid CWP agreements that are too small to be cost-effective;

Upper Missouri River Basin States CWP Cooperator's Roundtable

August 26-27, 2008 The Historic Plains Hotel, Cheyenne, WY

Summary: In cooperation with the Missouri River Association of States & Tribes, the Interstate Council on Water Policy and the US Geological Survey organized the first Cooperative Water Program (CWP) Cooperator's Roundtable for the five Upper Missouri River Basin States in Cheyenne, WY. This roundtable was the fourth in a series of regional stakeholder meetings, the purpose of which is to extend information about the USGS streamgaging and cooperative water science programs and create an opportunity for stakeholders to help strengthen those programs.

The program included presentations by USGS staff on the purposes, history and capabilities of the CWP and some of the challenges facing it. Several Cooperator representatives presented excellent descriptions of the scientific contribution that the CWP data collection and interpretive investigations have made and the benefits they bring to state and local water management.

Break-Out Group Discussion of Opportunities & Priorities: The participants divided into two groups to explore opportunities for both the USGS and the Cooperators to improve the CWP. The two groups met for about an hour, one lead by Tracy Streeter (Kansas Water Office) and the other by Garland Erbele (South Dakota Department of Environment & Natural Resources) to respond to two questions and prioritize the results. Those questions and the combined results are available, but and the highest ranking recommendations were:

What can the USGS do to improve the CWP?

- "Market" the USGS products and the value of data collection to Congress, demonstrating the importance of CWP funding needs and request more federal funding for both the CWP and NSIP; expand awareness beyond the water managers
- Offer more expert availability to Cooperators in program and issue exploration to improve the anticipation of data needs and increase probability that baseline will be available in early stages of decision making
- Expand and utilize CWP flexibility to lower cost and collect more data related to specific Cooperator's needs; examine (in an open discussion with the Cooperators) the viability of "different data qualities" and allowing non-USGS staff to collect data and maintain gages in accord with USGS standards so that ht e data can be published the same as USGS data –also water quality analyses
- Establish competitive grant program to help Cooperators extend data collection and meet USGS standards, (similar to the Cooperative Mapping Program; offer 50:50 cost share)
- Better delivery of data and study results (from provisional to final) on schedule
- Maintain/expand research role
- Continue adding to and improving the NWIS –web capabilities & products
- Provide better explanation of the study and data collection cost and progress
- Keep flexibility & decisions at Water Science Center level for studies/data mix

What action should the Cooperators consider to improve the CWP?

- Advocate for CWP & NSIP funding increases Bring USGS staff/message to the news media Get congressional hearings set on basic data collection; be more strategic in our efforts
- Stay more actively involved in the interpretive studies as they progress
- Engage USGS more often, even informally, to explore issues & options – enhance the interpretation of USGS data in context of management decisions, improve the anticipation of issues & data needs, whether it leads to interpretive studies or not
- Be more aware of USGS data collection and processing protocols to increase consistency); need USGS guidance on extent- of-compliance
- Organize regular statewide Cooperator forums to bring current and new funding partners to the table, increase shared understanding of capabilities, needs and opportunities and to identify and explore opportunities to improve CWP efficiency

What should USGS & Cooperators do to enhance data compatibility across networks?

- Establish a water data portal –to help identify other useful sources of data

Ohio River Basin States CWP Cooperator's Roundtable

September 11-12, 2008 **Cincinnati, OH**

Overview: In cooperation with the Ohio River Basin Commission (ORBC), the Ohio River Valley Water Sanitation Commission (ORSANCO), the Interstate Council on Water Policy (ICWP) and the US Geological Survey (USGS) organized the first Cooperative Water Program (CWP) Cooperator's Roundtable for the five of the Ohio River Basin States in Cincinnati, OH. This roundtable was the sixth in a series of regional stakeholder meetings around the US, the purpose of which is to extend information about the USGS streamgaging and cooperative water science programs and create an opportunity for stakeholders to help strengthen those programs.

Break-Out Group Discussion of Opportunities & Priorities: The participants divided into two groups to explore opportunities for both the USGS and the Cooperators to improve the CWP. The two groups met for about an hour, one lead by Larry Feazell (Ohio River Basin Commission) and the other by John Stark (The Nature Conservancy) to respond to three questions and prioritize the results. Those questions and the combined results are available, but and the highest ranking recommendations were:

What can the USGS do to improve the CWP?

- Organize more state monitoring councils to strengthen support for funding, identify opportunities to share costs, identify needs and agree on priorities; make sure Cooperators are aware of USGS Science Strategy
- Explain the value of the CWP data collection and interpretive studies more clearly and make the results more accessible; newsletters, presentations to community groups, briefings for local agencies and officials, attendance in watershed group meetings were suggested;
- Look for opportunities to share cost of interpretive studies among WSCs, especially where transfer value is stronger, e.g., interstate waters; also, streamline/standardize design for interpretive studies to increase administrative efficiency

What can the Cooperators do to improve the CWP?

- Do better in explaining value & importance of CWP to our congressional delegation and to state and local policy makers; work with USGS to "get the word out" to public and local policy makers; press releases, outreach events
- Build stronger awareness among Cooperators and with OFAs of their respective needs and expand collaboration among Cooperators in designing CWP studies and the development of interpretive tools; look for opportunities to share interpretive tools
- Highlight USGS involvement when using CWP data & study results in program and project decisions

What should USGS & Cooperators do to enhance data compatibility across networks?

- Expand awareness of National Water Quality Monitoring Council and National Atmospheric Deposition Program (NADP) –and other efforts to establish and use common standards
- Work with USGS and others to engage all the stakeholders in basinwide coordination groups; consider developing & supporting statewide Monitoring Councils

Cooperative Water Monitoring and Assessment in Florida

November 12-13, 2008 **Orlando, FL**

Overview: In cooperation with the US Geological Survey (USGS), the Interstate Council on Water Policy (ICWP) organized this Cooperative Water Program (CWP) Roundtable for stakeholders in Florida. This roundtable was the seventh in a series of regional stakeholder meetings designed to provide information about the USGS water data and science programs and create an opportunity for stakeholders to help strengthen those programs.

The program included presentations by USGS staff about the purpose, history and capabilities of the CWP and some of the challenges facing it. Cooperator representatives presented excellent descriptions of the scientific contribution that the CWP data collection and interpretive investigations have made in the fulfillment of local water resource responsibilities.

Break-Out Group Discussion of Opportunities & Priorities: The participants divided into two groups of about 25 each to explore opportunities for both the USGS and the Cooperators to improve the CWP. The groups worked independently for about 90 minutes, one lead by Elizabeth Thomas (SJRWMD) and the other by Adam Munson (SWFWMD) to respond to three questions and prioritize the results. Those questions and the combined results are available, and the highest ranking recommendations were as follows**:**

What actions should the USGS consider to improve the CWP?

- Implement NAVD '88
- Shorten turnaround for data delivery and study reporting;
- Increase regular communication with Cooperators (improve accounting transparency), show how they're getting their money's worth; request Cooperator comments on draft FISC Science Communication Strategy; schedule regular meetings in WMD offices for information exchange;
- Improve "marketing/outreach" of monitoring and science capabilities for Cooperators' managers and governing boards; hold regional meetings annually with all stakeholders, including all who use the data and science; help policy makers be more aware when USGS is (or could be) contributing to

decision making abilities; make study results easier for the public to find and to understand/apply; sponsor public meetings to present monitoring and interpretive study results;

- Increase availability of USGS training to Cooperators, formalize programs and promotion of training schedules
- Increase CWP finding to match Cooperators' investments 50:50
- Fund data collection, not studies

What action should the <u>Cooperators</u> consider to improve the CWP?

- Invite USGS-FISC leadership for periodic meetings, information exchange and introduction to Cooperator leadership; involve USGS more directly and in planning and designing projects, studies, etc;
- Help leaders within Cooperator organizations to recognize and appreciate the value of USGS contributions to their projects, studies, operational decisions, etc; acknowledge USGS as source of data and science when presenting issues/decisions to the public, policy makers, etc;
- Become more active for support of funding; energize statewide organizations, develop grassroots effort
- Encourage blog writers to highlight recent USGS studies and projects

How can we coordinate monitoring efforts to increase the value of all the data for use in interpretive studies and program decisions?

- Support existing efforts, e.g., FL Water Resource Monitoring Council, where stakeholders could agree on minimum standards, metadata –before integration; meet periodically to review/refine and promote plans, progress & needs (e.g., the Oceans Council "GAMES," ACF bi-weekly teleconference);
- Invite Cooperators to USGS coordination meetings to share and review data collection plans
- Establish data portal where all data can be accessed (e.g. "FREAC"); establish a data warehouse (e.g., Storet, Sofia, DBHydro);need to get funding to support reasonable level of quality and consistency; identify and promote a single agency (state or federal?) to gather and distribute data and study results; super site – multi-parameter, prioritization
- Require data "contribution" from local projects in exchange for funding;
- Establish an electronic bulletin board for new monitoring projects, studies, etc;

Mid-Atlantic Region Cooperators' Roundtable for the USGS Cooperative Water Program

Thursday, February 5, 2009 **Philadelphia Historic Dist**

<u>Overview</u>: In cooperation with the US Geological Survey (USGS), the Interstate Council on Water Policy (ICWP) organized this Cooperative Water Program (CWP) Roundtable for stakeholders in Delaware, the District of Columbia, Maryland, New Jersey, New York, Pennsylvania, Virginia and West Virginia. This roundtable was the eighth in a series of regional stakeholder meetings designed to provide information about the USGS water data and science programs and create an opportunity for stakeholders to help strengthen those programs.

The program included presentations by USGS staff about the purpose, history and capabilities of the CWP and some of the challenges facing it. Cooperator representatives provided excellent descriptions of the scientific contribution that the CWP data collection and interpretive investigations have made in the fulfillment of local and regional water planning and management responsibilities.

Break-Out Group Discussion of Opportunities & Priorities: The participants divided into three groups of about 25 each to explore opportunities for both the USGS and the Cooperators to improve the CWP. The groups worked independently to respond to three questions and prioritize the results. Those questions and the specific results are available in the full meeting summary, but the highest ranking recommendations were as follows:

What actions should the USGS consider to improve the CWP?

- Provide reviews of interpretive studies faster, produce more informal products prior to formal report delivery; make data more easily accessible
- Promote broader recognition and use of transferable tools (e.g., StreamStats); more rapid transfer of new technologies; continue development of new technologies in the interest of cost savings
- Fully fund NSIP and return the CWP to 50:50 match
- Expand Cooperator base, identify and encourage smaller Cooperators and other users of information
- Increase effort to include Cooperators input into NSIP design and prioritization for the funding of gages
- Assign a person as liaison, single point of contact, for key regions and for science themes; develop regional inventories of skills, equipment, ability to support other Water Science Centers, e.g., Regional Workforce Study
- Stop putting headquarters' overhead onto CWP cost (e.g., reduce "business style" accounting for projects); identify data management as an element of O&M
- Give Cooperators credit for in-kind services in CWP requirements

What action should the Cooperators consider to improve the CWP?

- Improve decision maker (Congress, state legislatures and local) awareness of USGS monitoring and interpretive science, their importance to water management and society; coordinate the message and delivery timing by as many groups as possible; make the USGS role and contributions to Cooperator decisions more visible to the public, legislators and congressional representatives; highlight the large number of (multiple) uses of the same data and studies that support different Cooperators and communities; make opportunity with incoming Administration officials to improve interagency communication and coordination
- Highlight the importance of monitoring and interpretive studies funding in our state and local agency budgets; develop streamgage-specific line items; enhance message delivery to state legislatures; specify conditions in permits and dockets, set up trust fund to accumulate fines and judgments to support long-term operation of streamgages (e.g., Marston shale);
- Use regional Cooperator meetings to share assessment of needs, opportunities, etc; Collaborate in defining tools and products needed from USGS, and in sharing cost; actively prioritize Cooperators needs, like WV Monitoring Council; communicate more regularly among Cooperators, involve new Cooperator groups (e.g. private sector) in Cooperator base; states should identify a "point person"

How can we coordinate monitoring efforts within the region to increase the value of all the collected data for use in interpretive studies and program decisions?

- agencies should conduct a gaps analysis and communicate what is available, from who & where; coordinate the design of monitoring network among agencies at a regional scale and develop (agree

on) standards for metadata and data collection to support data clearinghouse, data portal; apply consistent methods and protocols to yield comparable results; develop techniques for evaluating data and comparability to normalize data collected by different sources;

- Invest in new technologies (e.g., remote sensing, acoustic Doppler, etc);
- Identify key management systems, key objectives and related monitoring needs and data gaps; and
- Collect water use data the same way we do water availability and water quality data, for national and regional comparability.

Pacific Northwest Cooperators' Roundtable for the USGS Cooperative Water Program

September 2-3, 2009 **Tacoma, WA**

Overview: In cooperation with the US Geological Survey (USGS), the Interstate Council on Water Policy (ICWP) organized this Cooperative Water Program (CWP) Roundtable for stakeholders in Idaho, Oregon and Washington with advisory support from the Washington State Water Resources Association, The River Network, the Oregon Water Resources Congress, the Northwest Indian Fisheries Commission and the Idaho Water Users Association. This roundtable was the ninth in a series of regional stakeholder meetings designed to provide information about the USGS water data and science programs and create an opportunity for stakeholders to help strengthen those programs.

The program included presentations by USGS staff about the purpose, history and capabilities of the CWP and some of the challenges facing it. Cooperator representatives presented excellent descriptions of the scientific contribution that the CWP data collection and interpretive investigations have made in the fulfillment of water resource planning and management responsibilities in the region.

RESULTS FROM THE DISCUSSION OF OPPORTUNITIES & PRIORITIES

Following a series of panel presentations, we discussed budget pressures that have limited the USGS ability to share the cost of data collection and interpretive studies on the traditional 50:50 basis and the mounting pressure on state and local agency budgets. We also discussed the USGS sensitivity to conducting interpretive studies in competition with experts in the private sector. Several factors identified previously (e.g., their competence in such a wide range of geotechnical sciences and research capabilities, their independence and reputation for impartiality as a federal agency and the cost-share) were repeated, but we also discussed the time frame available for decision making and the distinction between issues that require an advance in the basic science and those that involve application of reasonably well-established analytical skills.

The participants divided into three groups of 20-25 each to explore opportunities for both the USGS and the Cooperators to improve the CWP. The three groups worked independently for about 90 minutes to respond to three questions and prioritize the results. Those questions and the combined results are available on the internet, but the highest ranking recommendations were as follows:

What actions should the USGS consider doing to improve the CWP?

- USGS should convene regular advisory committees (and less formal meetings) to share science, enhance understanding and relations with Cooperators on a on topical/regional basis, to seek opportunities that are mutually beneficial and get partners more engaged in the planning and management decisions; this would also help USGS maintain awareness of emerging needs;

- Place greater priority in budget requests to restore 50:50 cost-share capability in CWP and full funding for the NSIP;
- Collect more data available from other agencies and make available through the NWIS or a portal;
- Make better use of informal data collection methods (e.g., volunteers, web cams, etc.); and
- Provide more timely access to interim and final results from both data collection and interpretive studies.

What action should the <u>Cooperators</u> consider doing to improve the CWP?

- Remind your congressional and state legislative delegations of the CWP and NSIP benefits and needs so that appropriate support (from federal, state and other sources) can be secured; and
- Help with the formation of state monitoring councils and make sure USGS clearly understands Cooperator needs; invite USGS into Cooperator meetings to help WSC leadership identify and understand issues early.

How can we coordinate monitoring efforts within the region to increase the value of all the data for use in interpretive studies and program decisions?

- The USGS, Cooperators and other stakeholders should collaborate in the organization and support for statewide or watershed monitoring councils that could inventory water monitoring programs and promote a set of useful standards, protocols, meta-data, etc. to reduce discrepancies among the data sets developed by different agencies, etc.;
- A portal should be established, funded and maintained to provide efficient access to water data from a wide variety of sources; and
- If the monitoring councils become focused on specific tasks (or operate at a very technical level), the USGS and Cooperators should organize less formal meetings on a regular basis to bring various agencies and organizations that collect and/or need water data to facilitate the coordination of their needs, plans and investments.

New England Cooperators' Roundtable
for the
USGS Cooperative Water Program

Tuesday, November 9-10, 2010 **Chelmsford, MA**

Overview: In cooperation with the New England Interstate Pollution Control Commission (NEIWPCC) and the US Geological Survey (USGS), the Interstate Council on Water Policy (ICWP) organized this Cooperative Water Program (CWP) Roundtable for stakeholders in Connecticut, Maine, Massachusetts, New Hampshire, and Vermont. This conference was the ninth in a series of regional stakeholder meetings designed to provide information about the USGS water data and science programs and create an opportunity for stakeholders to help strengthen those programs.

The program included presentations by USGS program leaders and scientists about the purpose, history and capabilities of the CWP and some of the challenges facing it. The capacity for data collection and interpretive studies is limited and adapted to regional needs.

Approximately fifty conferees (about ½ of them were cost-share partners in the CWP) worked together for a total of about 6 hours. The Cooperator representatives provided examples of their reliance on CWP data and investigations in meeting local and regional water planning and management responsibilities.

Break-Out Group Discussion of Opportunities & Priorities: Following the briefings and discussion, the participants divided into two groups of about 25 each to explore opportunities for both the USGS and the Cooperators to improve the CWP. The two groups worked independently to respond to three questions and prioritize the results. Those questions and the specific results are available in the full meeting summary, but **the highest ranking recommendations** were as follows**:**

What can the USGS do to improve the CWP?

- Increase funding to NSIP & WSCs (25 Votes)
- Regional approach to climate change and other studies, spokesman for all regional offices (22 Votes)
- Maintain excellence –science & service, enhance interpretive presentation (18 Votes)
- Market USGS more effectively –strategic look at communication products & strategies for CWP & NSIP, design for use by a wide variety of audiences (17 Votes)
- Coordination with other USGS programs (e.g., NAWQA), EPA & other federal agencies –funds to support different issues (13 Votes)
- Acknowledge Cooperators & enhance information sharing –list serves, regional contact databases, webinars (12 Votes)

What can the Cooperators do to improve the CWP?

- Need to communicate end results & collaboration with USGS more effectively, so that congressional, OMB and state legislative contacts understand value to the region (35 Votes)
- Annual "summit" with federal agencies to plan & prioritize future investigations, agree on cost/benefit & monitoring priorities, enhance regional coordination and identify training needs – tied to budget cycle (27 Votes)
- Find outside funding –TNC, TU, other friends (14 Votes)
- More coordination during investigations, co-author reports with USGS (10 Votes)

Should USGS explore the feasibility and potential benefits of taking a more regional/multi-state approach to monitoring networks and hydrologic investigations through the CWP?

- Regional approach could bring enhanced issue identification, project design & additional funding/expertise together from WSCs, OFAs and Cooperators into investigation of shared concerns (58 Votes)
- Don't lose focus on local/specific issues in order to serve national or regional concerns –make sure sufficient capacity aligns with Cooperators' needs (13 Votes)
- Need to get Water Census & other national programs involved with field offices (4 Votes)

2010 Cooperative Water Program Stakeholders' Strategy Conference

L'Enfant Plaza Hotel, Washington, DC

March 25, 2010

In cooperation with the US Geological Survey (USGS), the Interstate Council on Water Policy and Western States Water Council organized this conference to review the results of nine regional "Cooperators' Roundtable" meetings. The objective was to review these results with a broad cross section of water community leaders and determine what future actions (if any) are most needed to assure that the USGS Cooperative Water Program (CWP) will continue to serve its mission adequately and that the non-federal cost-share partners ("Cooperators") get the maximum value (in terms of the water data and science they need to support their planning, program decisions and project management) for their investment in this national program.

This was the third national meeting organized in support of the CWP and the needs of its many "customers," and was intended to report back on the progress made since the earlier meetings (held in March 2005 and January 2006). The results of those two national meetings and the nine regional meetings are available and can be downloaded from the ICWP website. In this meeting (and in most previous roundtable meetings), we were supported by generous contributions from both Hach and YSI, whose representatives also contributed useful perceptions and suggestions to the discussion.

A synopsis of the recommendations from all of the previous meetings was provided at the conference, which was attended by approximately 50 active participants[1]. The meeting was facilitated by Linda Manning (of The Council Oak) and opened with two panel presentations: one that provided three perspectives from Cooperators[2] who have attended one or more of the regional roundtables and one that provided the perspective of three USGS Water Science Center Directors[3] and the CWP National Coordinator who attended the regional roundtables. After a lunch break, the group was briefed on relevant policy, program and budget developments at the Interior Department by John Tubbs, Deputy Assistant Secretary for Water and Science. We spent the balance of the afternoon discussing water management and science concerns and (with Linda Manning's help) developing the following list of recommendations for future action.

[1] The participants represented (at least the following) states of CA, IL, MO, ND, TX, UT, VA & WY, the Delaware River Basin Commission, Interstate Commission on the Potomac River Basin, Upper Mississippi River Basin Association, Missouri River Association of States & Tribes, Council of Great Lakes Governors, Hach, YSI, PBS&J, the River Network, and USGS, EPA, Bureau of reclamation and the Department of Interior.

[2] The Cooperators on the first panel were: **Arlan Juhl**, Manager, Division of Planning, Illinois DNR Office of Water Resources; **Scott Kudlas**, Director, Office of Surface & Groundwater Supply Planning, Virginia DEQ; and **Sue Lowry**, Interstate Streams Administrator, Wyoming State Engineer's Office.

[3] The USGS panel participants were: **Cindi Barton**, Director, USGS Water Science Center in Washington State; **Bob Joseph**, Director, USGS Water Science Center in Texas; **Ward Staubitz**, National Coordinator, USGS Cooperative Water Program; and **Bob Swanson**, Director, USGS Water Science Center in Nebraska

Actions Recommended to Enhance the CWP Capability to Sustain Better Water Planning, Operation & Management Decisions

- The need for a stronger CWP is widely accepted among federal and non-federal experts, but has not been clearly presented to policy makers or to the public. The connection between insufficient data and the impairment of water supplies, flood protection, environmental protection/restoration, infrastructure capacity, recreation safety and navigation needs to be made more effectively.
    - Not just a responsibility of the USGS, we all need to take the initiative.
    - Develop specific examples to illustrate the local, regional and national consequences.
    - Articulate the importance in relation to climate change and the fiscal consequences to both USGS and the Cooperators; also in terms of national economic competitiveness.
    - Keep the message simple and direct (1 page with appropriate contact information).
    - Take advantage of 2009 Secure Water Act provisions (PL 111-11, Subtitle F, Sections 9501-9509).
    - Include assessment of budget constraints facing state, tribal and local agencies in relation to the recent shift of the financial burden in their direction.
    - Articulate the rationale for the 50/50 cost-share tradition.
    - Brief the USGS Director ASAP.
- The potential value of combining datasets collected by USGS and by many other agencies is believed to be substantial and growing, especially if more Cooperators and other federal agencies continue redirecting more of their budgets toward their own, independent data programs. Water community leaders need to understand the potential consequences of this fragmentation and develop more effective means (organizations, protocols, etc.) to characterize and enhance) the compatibility of data collected and maintained by different agencies.
    - Inventory existing monitoring sites and assess the need for data that isn't being collected.
    - Develop the means for "optimizing" the collective investment in data for increase/maximum the regional and national benefit.
- Much of the water data collected (at public expense) by other agencies (federal and non-federal) is difficult to find, understand and utilize in models and other decision support tools. Existing examples of data sharing, links and portals (e.g., in Texas and for the Bear River) need to be identified and studied.
    - Attribution of credit to the collecting agency(s) is always important.
    - The federal Advisory Committee on Water Information (ACWI, which is convened by the Interior Department and plans to meet next on July 13-14, 2010) may provide an appropriate forum for pursuing this set of opportunities.
    - Initiating pilot projects may be the best way to demonstrate the capabilities and value and to work through the difficulties.
    - Establishing the criteria for data collection and exchange (i.e., a "good streamgaging seal of approval") would be helpful.
- There are many examples of collaboration between Cooperators and their USGS Water Science Centers resulting in substantial cost savings and efficiency improvements in the collection and management of water data and in the development of interpretive science needed to support planning, management and policy decisions. Several states have water monitoring/streamgage coordination councils and the Cooperators (and USGS) in more states should consider their potential benefits.

April 2010

USGS Response to the 2010 Cooperative Water Program Stakeholders' Strategy Conference, March 2010

1. We fully appreciate the importance of having CWP stakeholders communicate the importance of the CWP program and benefits they receive to Policy Makers. We work with a variety of stakeholder groups in promoting the CWP message, and truly appreciate the leadership and support of ICWP. In today's budget environment we need to broaden the message to include support for all USGS Water Programs benefitting stakeholders so that increased support for one of our programs does not come at the expense of other valuable USGS Water Programs. We are working on improving our messages internally – and intend to fine tune and communicate those messages (internally and externally) with the help of ICWP and other stakeholders.

2. We agree with this recommendation and are embarking on a partnership effort with one or more Water Resources Institutes to conduct an economic analysis of industries and other stakeholders that substantively benefit from USGS streamgaging information. It is expected that this analysis will clearly demonstrate the economic importance of this valuable service to many industries across the Nation, such as, but not limited to, those associated with irrigated agriculture, water transportation, hydropower, and water supply/wastewater. We anticipate a peer reviewed reference able product to be available by this time next year. We intend to summarize the stream gage economic analysis in a one-page briefing sheet for distribution to stakeholders.

3. In the next year, we will be working to update CWP priorities and messages for increased succinct and direct communication with key stakeholders (internal and external to USGS). In addition, we will be developing specific (engaging) examples to illustrate the local, regional, and national benefits of the Program. Messages, priorities, and success stories will be communicated in multiple communication forums, including summary briefing sheets, and updates to existing CWP fact sheets and webpages. Communication of data networks, interpretative understanding, and activities associated with CWP and relevance to key water issues at regional and national scales will be a priority.

4. We have continued to communicate with the USGS Director, the Assistant Secretary for Water and Science, and other Administration Officials about the importance of the USGS Water Program and the strong stakeholder need and support for USGS water information.

5. We continue to evaluate the adequacy of our data networks and hydrologic analysis programs to identify information gaps. In recent years we identified a real need to improve our water-use information and worked to develop the National Water Census through Water Smart to address this identified need. Currently, we are working on a National Gap Analysis for the National Streamgaging Network and should have that analysis completed by next Fall. A similar effort is being conducted in the redesign of NAWQA for Cycle 3.

Analysis of non-USGS data networks is typically conducted under the authority of ACWI. The Subcommittee on Groundwater conducted such an analysis in designing the National Groundwater Network in recent years. The National Water Quality Monitoring Council also addresses this issue for Water Quality Monitoring Sites. A streamgaging network analysis was conducted as a part of the NSIP design.

6. We agree that Data Portals show promise in coordinating water resources information delivery. As noted in the recommendations, ACWI may be an appropriate forum for coordinating ongoing efforts. Portal (common web services) and coordinated data management efforts are underway through the Groundwater and Hydrology Subcommittees and the National Water Quality Monitoring Council. In addition, USGS is represented on the Hydrology Working Group of the Open Geospatial Consortium, which is pursuing national and international standards for multi-disciplinary (surface water, groundwater, quality, and biology) data integration and common services.

   USGS strongly supports state water monitoring councils and their benefit for defining data gaps, water priorities, and potential for collaborative projects. At this point, USGS (through Water Science Centers) participates on more than 15 State monitoring councils distributed across the Nation. USGS co-leads the National Water-Quality Monitoring Council, which communicates regularly with the state councils through webinars, newsletters, and web links.

Ward Staubitz
National Coordinator,
Cooperative Water Program

USGS Water Census

The National Water Census

The Nation faces an increasing set of water resource challenges. Aging infrastructure, rapid population growth, depletion of groundwater resources, impaired water quality associated with particular land uses and land covers, water needed for human and environmental uses, and climate variability and change all play a role in determining the amount of fresh water available at any given place and time. Water shortage and water-use conflicts have become more commonplace in many areas of the United States, even in normal water years. As competition for water resources grows – for irrigation of crops, growing cities and communities, energy production, and the environment – the need for information and tools to aid water resource managers also grows. Water issues and challenges are increasing across the Nation but particularly in the West and Southeast due to prolonged drought. The Department's WaterSMART program is working to achieve a sustainable water strategy to meet the Nation's water needs.

The USGS Water Census has three distinct objectives, which mainly follow mandates in the SECURE Water Act (P.L. 111-11). The first is to provide a nationally consistent set of indicators that reflect each status and trend relating to the availability of water resources in the United States. This objective includes substantial work on improving our knowledge of water use throughout the United States. The second objective is to provide information and tools that allow users to better understand the flow requirements for ecological purposes. And the third objective is to assess and report on competition over water resources in geographically focused areas where significant questions have been raised about water availability.

USGS Strategic Science Plan

The USGS published its Science Pan for the next decade in 2007 (Facing Tomorrow's Challenges— U.S. Geological Survey Science in the Decade 2007–2017; Circular 1309). This plan contained six technical "science directions", one of which was "A Water Census of the United States: Quantifying, Forecasting, and Securing Freshwater for America's Future". The National Water Census moves the USGS towards fulfilling that vision to inform the public and decision makers about: (1) The status of its freshwater resources and how they are changing; (2) A more precise determination of water use for meeting future human, environmental, and wildlife needs; (3) How freshwater availability is related to natural storage and movement of water as well as engineered systems, water use, and related transfer; (4) How to identify water sources, not commonly thought to be a resource, that might provide freshwater for human and environmental needs; and (5) Forecasts of likely outcomes of water availability, water quality, and aquatic ecosystem health due to changes in land use and land cover, natural and engineered infrastructure, water use, and climate.

SECURE Water Act

One of the most significant steps towards implementing the National Water Census came with the passage of the SECURE Water Act (P.L. 111-11) in 2009. Section 9508 of the Act calls for the establishment of a "national water availability and use assessment program" within the USGS. The statute calls for USGS:

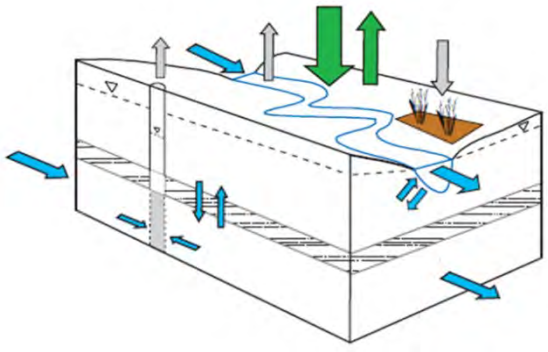
- to provide a more accurate assessment of the status of the water resources of the United States;
- to assist in the determination of the quantity of water that is available for beneficial uses;
- to assist in the determination of the quality of the water resources of the United States;
- to identify long-term trends in water availability;
- to use each long-term trend to provide a more accurate assessment of the change in the availability of water in the United States; and
- to develop the basis for an improved ability to forecast the availability of water for future economic, energy production, and environmental uses.

The SECURE Water Act serves as a blueprint for the formation of the National Water Census.

National Indicators of Water Availability

Water Budget Analysis

USGS begins its work on water availability through the use of a water budget. Water budgets are a way of accounting for the inputs, outputs, withdrawals, and changes in amount of water in each component of the water cycle. By quantifying the various components of a watershed's water budget, we take the first steps in assessing water availability.



Human water withdrawals and return flows can also be accounted in a water budget. By measuring or estimating the amount of water for each of these components over time for the watersheds across the nation, we can provide the user with the capability to calculate a water budget for their area of interest.

The size of watershed area for which the water budget is calculated and the time period which it is calculated over are of primary importance to the user. The United States is divided and sub-divided into successively smaller hydrologic units which are classified into six levels: regions, sub-regions, accounting units, cataloging units, etc. The hydrologic units are arranged within each other, from the smallest (12-digit HUCs) to the largest (regions). Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to twelve digits based on the six levels of classification in the hydrologic unit system. This coding system provides an orderly way to classify watersheds for the purpose of water availability analysis and it will be used by the Water Census. For purposes of the Water Census, the long-term objective will be to provide measured or estimated information for all relevant water budget terms at the HUC 12-digit scale. This information may then be aggregated up to the HUC 10-, 8-, 6-, 4-, and 2-digit scales.

For purposes of the Water Census, the long-term objective will be to provide measured or estimated information for all relevant water budget terms on a monthly basis. Some components of the water budget have a continuous time series of data, such as streamflow information from a surface water gaging station. Others have a daily time record, such as gridded precipitation coverages from the National Weather Service. Other components of the water budget, such as reported water withdrawals and discharges, are only available on a monthly basis in most states. For water budget purposes, we must use the longer, monthly time step in the calculations. Outside of the water budget analysis, there are other uses of continuous time series data and daily records that will be of use to Water Census users. This includes measured or estimated streamflow information from gaged and ungaged areas for ecological flow analysis, interpretation of water quality information; daily precipitation and evapotranspiration records for climate analysis and flood studies; daily changes in surface storage for water supply management; etc. The Water Census will provide, where available, coverages of these hydrologic indicators on a daily basis for those other uses.

Estimation of flows at ungaged stations

The Water Census will use the USGS streamgaging network, qualified flow records provided from other sources, coverages of basin characteristics and its statistical and deterministic modeling tools to provide an estimated daily hydrograph for all ungaged areas in the country. Because of the coverage of streamgages, the period of record, and the number of streamgages free of significant flow regulation, the accuracy of flow estimation will vary significantly from one part of the nation to another.

For estimates in ungaged areas the USGS will be conducting testing of various flow estimation models to determine the most accurate and efficient methods for these estimated. The model evaluation effort will include three statistical approaches: Drainage Basin Ratio, Flow Duration Transfer, and Analysis of Flow in Networks of Channels (AFINCH). USGS will also test two deterministic watershed models: Water Availability Tools for Environmental Resources (WATER) and Precipitation Runoff Modeling System (PRMS). These models will be tested in a variety of hydroclimatic terrains, including the Southeastern US, The Midwest, the Rocky Mountains, the desert Southwest, and the Pacific Northwest. These different locations will subject the models to varying conditions of humidity, snow melt, topography, and groundwater discharge. At the conclusion, the models will be evaluated for ability to produce accurate records of flow, model uncertainty, costs for deployment and input data requirements. A report will be issues at the conclusion, recommending the use of models in the different settings.

Where we are able to provide measured or estimated daily hydrographs, with definable and acceptable level of uncertainty, the USGS will produce gridded, area-referenced coverages of baseflow, runoff, and total flow. From this gridded coverage, the user will be able to develop baseflow- and runoff values for the water budget equation, for their watershed of interest.

Precipitation and Evapotranspiration Analysis

Precipitation record will largely be obtained from data available from the National Weather Service. Monthly precipitation and air-temperature data will be obtained from the U.S. Historical Climatology Network (HCN) dataset that was developed and is maintained at the National Climatic Data Center. The Water Census will work with the National Weather Service to provide gridded daily coverages of precipitation in the future. Monthly precipitation data or disaggregated monthly precipitation data will also to be used in the water budget analysis.

Evapotranspiration (ET) record will be provided through an assessment and modeling effort conducted by the Earth Resources Observation Systems (EROS) Data Center, utilizing remote sensing from the MODIS and LANDSAT satellite systems. These systems provide thermal infrared imaging that can be used in ET analysis. EROS will also obtain discrete measurements and information from ET networks currently in operation and from historical water budget analysis to validate the models. Evapotranspiration estimates will initially be provided on a monthly basis in a gridded format for the nation at the HUC-8 digit scale. Ultimately, EROS will develop methods to provide daily ET estimates at the HUC-12 digit scale. Crop field-scale ET estimates will also be used for investigating the consumptive use associated with irrigated agriculture.

Groundwater Availability

The WaterSMART availability and use assessment will require that regional groundwater availability studies be conducted in each of the 30 principal water-use aquifers of the U.S. These studies will be linked with surface water studies to improve our understanding of these as a single resource. The initial focus will be on the high priority Glacial Aquifer System of the northern states and to start a preliminary national assessment of brackish and saline groundwater resources.

Aquifer systems are complex, three-dimensional geologic features which move and store water recharged from the land surface. They cover great distances, often do not conform to surface water divides, and may obtain most of their recharge at locations quite remote from where the water discharges to a stream, estuary, or well. As USGS has stated previously, because of these complexities, we propose that groundwater systems be incorporated into the water budget analysis once that have been studied under the Survey's Regional Groundwater Availability Studies in the Groundwater Resources Program. These studies will provide the information related to seasonal and long-term changes in storage and recharge, relative to the watershed of interest.

For areas of the nation that have not yet been investigated by a Regional Groundwater Availability Study, different methods will have to be used for the estimates. If there is a groundwater observation well network in the watershed, the Census will have access to data showing the trend in groundwater storage. Coupling this information with water use data withdrawn from groundwater sources can provide an estimate of the terms for the water budget equation. One of the challenges of the final implementation plan for the Water Census will be to develop a method for estimating groundwater terms for the water budget equation where there is no groundwater study. These methods will be documented and used to develop groundwater estimates for the Water Census.

Reservoirs and water in storage

The Water Census will explore data sources to provide measurements of storage of water in man-made lakes and reservoirs. Not all man-made lakes and reservoirs measure and report volume or water level information, but many of the larger systems do. For water budget analysis, the change in storage is the factor that is most often sought and, from a water availability perspective, users usually want to know the trends in storage over the long-term. The Water Census will work with the Army Corps of Engineers, the Tennessee Valley Authority, and the Bureau of Reclamation to provide time series data on water in storage in lakes and reservoirs that those agencies control. Other information on man-made lakes and reservoirs will be basin-specific.

Snow and icefields

Information on snowfields in the Western United States will be obtained through the SNOTEL network coordinated by the USDA's Natural Resources Conservation Service. The products provided by SNOTEL include maps on month-to-date and year-to-date precipitation, which can be introduced as a change in snow storage factor in the water budget. In the Eastern US, the USGS will work with the National Weather Service and the relevant States who run snow surveys to provide information on the status of water in storage in snowpack. Glaciers in the western US mountain regions, and in Alaska, will be treated as a special case. Changes in storage in glaciers will be reported at the outflow of the glacier.

Human Water Use.

Improved national databases of human water use information will be one of the most essential outcomes of the Water Census. This will be a significant focus of approximately one-third of the resources of the Initiative. Our primary objective will be to better characterize how humans move, use, consume, and dispose of the water they withdraw, divert, or retain AND integrate that information with flows in the environment. Through this integrated approach, we will hope to describe how human use of water and natural flows influence one-another. This requires that we understand the sources from which water is withdrawn, the demand that the water is used to satisfy, the transport of the water to the demand location, the amount of water that is "consumed" in satisfying the demand, and the return flows to the environment. Each of these steps has a strong geospatial component – we need to know which watersheds are losing flows, which are gaining flows and the net exchange.

Cooling towers, Burke County, Georgia
Credit: Alan Cressler, USGS

The Water Census will initially focus its efforts on the top three categories of water withdrawals: Thermoelectric Cooling Water, Irrigation, and Public Supply Systems. For Thermoelectric Cooling Water, the Water Census has been working with the Energy Information Administration (EIA) of the Department of Energy to develop a detailed database of all thermoelectric plants. Plants will be categorized as to their withdrawal volumes, the type of physical operations at the plants and the type of cooling system utilized. USGS efforts will be to provide detailed information about withdrawals and consumptive uses by the end of calendar year 2013. For irrigation withdrawals, USGS efforts are focused on identifying all of the withdrawal locations, as well as better understanding consumptive uses. As stated earlier, the Water Census is working with EROS to develop the ability to

estimate field-specific evaportanspiration as it is enhanced by irrigation. The Water Census is also conducting a pilot study on mapping irrigation withdrawal points. These efforts are being conducted initially in the Colorado River Basin to refine the methodologies before extending these to other parts of the country. Finally, on Public Supply Systems, the Water Census is engaged in a four year effort to develop a complete site-specific database of all wells and intakes nationwide. It is estimated that there are over 57,000 public supply systems with over 170,000 wells and 6,000 intakes throughout the country, so this is a major undertaking in our efforts towards tracking human water use.

Ecological Water Needs.

A critical part of any water budget is to quantify the uses of water within the 'boundaries' of the water budget. Historically, "uses" were limited to the "human uses" of water and focused solely on human needs. More recently, the focus has changed to include the ecosystem uses for water. Practitioners today have a need to assess ecological uses and the environmental water needed to maintain those uses, and prevent degradation of freshwater ecosystems. The "Brisbane Declaration" defines environmental flows as the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems. For the purposes of this document, water flow is defined to include stream and river flows as well as variation in water levels in lakes, rivers, streams, and wetlands. It is recognized that variation in water levels can support distinct ecological values. The processes by which we determine the quantity and timing of water flows, and the variation in water levels in lakes, rivers, and wetlands required to sustain ecosystems is what we refer to ecological flow science. It is proposed that the Water Census has a distinct role to fulfill in ecological water science. That role is to develop tools for evaluating relations between flow variability of stream and riverine systems and ecological functions. The steps we propose include: (1) building a national hydrologic foundation of baseline hydrographs or hydrologic statistics for all ungaged streams using statistical or rainfall-runoff flow modeling tools; (2) derive and serve a set of ecologically-relevant flow attributes that can be used to classify streams into distinctive regional and national flow regime types; (3) development of classification tools that allow environmental flow practitioners to evaluate a region of interest at the scale necessary for sound management; and 4) development of a user-driven and web-available hydrologic assessment tool that can compare natural and altered hydrologic regimes, and can be applied to any designated region.

Information Delivery.

The final objective USGS must achieve for this national system is the development of an on-line, web-based tool for the water budgets. The Water Census envisions that this tool will look similar to the StreamSTATS application. The user would bring up a webpage, click on a segment of a river or stream, and the system will automatically delineate the watershed of interest above that point. Once the watershed is delineated, the system would bring up the water budget equation, with all of its relevant terms displayed. Then the system would provide access to the current and historical databases of the various terms in the equation. The web tool would allow the user to access information and construct a water budget that ranges from a single month to multiple years. The user will be able to export and save their water budget information.

Geographic Focus Area Studies.

Throughout the United States there are areas where competition for water resources has reached a level of national attention and concern. Sometimes the competing interests are multiple human needs – needs for potable water, for irrigation, for energy, for industrial processes or for other uses. In other circumstances, the competition is between human and aquatic ecosystems needs. Through the USGS WaterSMART Availability and Use Assessment initiative, the USGS proposes a series of studies, focused on selected watersheds, where there is a desire on the part of watershed stakeholders to conduct a comprehensive technical assessment of water availability with the best available tools. These are critical to land and water resource managers to provide a comprehensive technical analysis of the factors affecting the availability of water. In 2011, the USGS proposed geographically focused studies of water availability and use in the Colorado River (CO, UT, WY, NV, NM, AZ, CA), Delaware River (NY, PA, NJ, DE), and Apalachicola, Chattahoochee, and Flint River Basins (AL, FL, GA). The USGS will work with watershed stakeholders and

the various agencies involved in these geographic focus areas to scope and conduct these studies. Each study will take place over a three year timeframe, starting in Fiscal Year 2012, and will receive $1.5M in funding to conduct these efforts. Future geographic focus areas will be identified through the application of criteria being developed by USGS.

Water Availability Studies –

- Colorado River Basin – This region has one of the fastest-growing populations in the Nation combined with the potential for expanded development of renewable energy and fossil fuels. The river supports fragile ecosystems and provides the backbone for hydroelectric power, irrigation, industry, and recreation throughout the region. River flows have been progressively decreasing over the last decade, and future projections of consumptive use along the river pit the water supply needs of the upper basin States against those in the lower basin and Mexico.
- Delaware River Basin – The basin is the subject of the largest inter-basin withdrawal of water east of the Mississippi River and provides water to over 15 million people, more than five percent of the Nation's population. Two Supreme Court decrees and coordination by an interstate river basin commission including the States of Delaware, New Jersey, New York, and Pennsylvania, are just part of the history of allocating scarce resources in the basin. In the upper portions of the basin, concerns over the effects of new natural gas development and the freshwater requirements for a recently-discovered endangered mussel species have added new complexities to managing water resources in the basin.
- Apalachicola, Chattahoochee, and Flint River Basin – Competition for scarce water resources is occurring in the southern region of the country. In the ACF Basin, comprising portions of Alabama, Florida, and Georgia, severe drought has exacerbated an ongoing issue driven by increased public water supply demands associated with growth in the Atlanta region and increased agricultural withdrawals in the southern portion of the basin. This basin is a prime example of where competing demands for water have resulted in litigation between States to determine who gets how much water and when.

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USGS WaterSmart Focus-Area Study in the Colorado River Basin, 2012-2014—Proposed Plan

The U.S. Geological Survey (USGS) will be investigating water availability and use of water in the Colorado River Basin through 2014. This investigation is part of the USGS National Water Census, which is supported through the Department of Interior WaterSMART (Sustain and Manage America's Resources for Tomorrow) Initiative. The Colorado River Basin was selected as one of three Focus-Area Studies in which new techniques for water-availability assessment will be developed and applied. The long-term goal is to develop techniques and methods that will have high transferability to other areas of the Nation.

Water availability and use in the Colorado River Basin will be assessed through a "water budget" approach at different temporal and spatial scales. A water budget balances inflows of water to the Basin (including precipitation, streamflow, and groundwater) against outflows from the Basin (such as through evapotranspiration and water flows). Differences between these summed positive and negative budget terms are accounted for by changes in storage within the Basin. Water budgets are very effective for water-resource and environmental management, such as in identifying major water uses, consumptive use of water, and possible areas of resource stresses and shortages over time.

The Colorado River Basin Focus-Area study will capitalize upon the already extensive infrastructure and efforts related to surface-water monitoring and analysis, and focus new resources on other water-budget components for which information is less certain. Consultation with a broad set of stakeholders in the Colorado River Basin has helped to identify those components in need of improved quantification, including consumptive use of water, regional evapotranspiration and the sublimation of the snowpack, and groundwater flow (particularly as related to groundwater/surface water interactions).

Specific activities in the USGS Colorado River Basin WaterSMART Focus-Area Study include:

- **Water-Use Assessment -** The USGS national 5-year compilation of water-use data for the 2010 water year is underway. Associated with this Focus Study area is a re-aggregation of water-use data at watershed and sub-basin scales throughout the Colorado River Basin – an enhancement to the typical compilations by states and counties. In addition, this study will improve water use estimates for large types of users in the region, including agriculture and thermoelectric power generation. New remote sensing methods will be used to better estimate consumptive use of water associated with agriculture and refined statistical methods will be employed to assess uncertainties and relative error in water-use estimates.
- **Hydroclimatic Variables –** Remote sensing methodologies will be used to estimate the temporal and spatial distribution of evapotranspiration, an important component of the water budget and consumptive use across the region. In addition, temporal and spatial distribution of snowpack water equivalence and the role of sublimation on the snow-water balance will be studied over the seasonal cycle and incorporated in water budgets for snowmelt dominated sub-basins.
- **Groundwater Discharge to Streams –** Preliminary estimates suggest that groundwater discharge accounts for 20-60 percent of streamflow in the upper Colorado River Basin and, therefore, assessment of groundwater/surface water relations will be a major focus of this pilot. Hydrogeologic framework information will be compiled to identify stream reaches with large groundwater contributions, followed by synoptic sampling of natural tracers to determine relative groundwater contributions in identified stream reaches.

The USGS is still seeking stakeholder input on this proposed plan of study. Please contact:

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National Streamflow Information Program

USGS
science for a changing world

National Streamflow Information Program Implementation Status Report

… from the National Streamflow Information Program

This Fact Sheet is one in a series that highlights information or recent research findings from the USGS National Streamflow Information Program (NSIP). The investigations and scientific results reported in this series require a nationally consistent streamgaging network with stable long-term monitoring sites and a rigorous program of data collection, quality assurance, management, archiving, and synthesis. NSIP produces multipurpose, unbiased surface-water information that is readily accessible to all.

Introduction

The U.S. Geological Survey (USGS) operates and maintains a nationwide network of about 7,600 streamgages designed to provide and interpret long-term, accurate, and unbiased streamflow information to meet the multiple needs of many diverse national, regional, state, and local users. The National Streamflow Information Program (NSIP) was initiated in 2003 in response to Congressional and stakeholder concerns about (1) the decrease in the number of operating streamgages, including a disproportionate loss of streamgages with a long period of record; (2) the inability of the USGS to continue operating high-priority streamgages in an environment of reduced funding through partnerships; and (3) the increasing demand for streamflow information due to emerging resource-management issues and new data-delivery capabilities. The NSIP's mission is to provide the streamflow information and understanding required to meet national, regional, state, and local needs.

Most of the existing streamgages are funded through partnerships with more than 850 other Federal, state, tribal, and local agencies. Currently, about 90 percent of the streamgages send data to the World Wide Web in near-real time (some information is transmitted within 15 minutes, whereas some lags by about 4 hours). The streamflow information collected at USGS streamgages is used for many purposes:

- In water-resource appraisals and allocations—to determine how much water is available and how it is being allocated;
- To provide streamflow information required by interstate agreements, compacts, and court decrees;
- For engineering design of reservoirs, bridges, roads, culverts, and treatment plants;
- For the operation of reservoirs, the operation of locks and dams for navigation purposes, and power production;
- To identify changes in streamflow resulting from changes in land use, water use, and climate;
- For streamflow forecasting, flood planning, and flood forecasting;
- To support water-quality programs by allowing determination of constituent loads and fluxes; and
- For characterizing and evaluating instream conditions for habitat assessments, instream-flow requirements, and recreation.

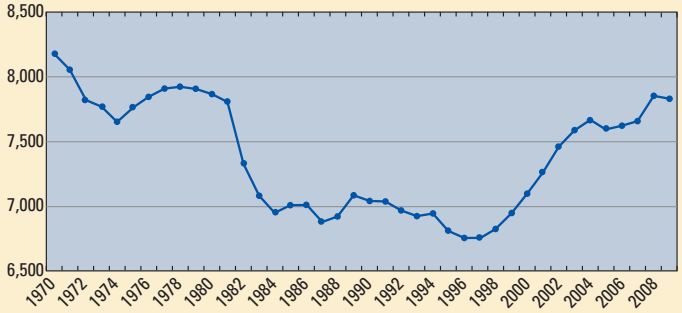

Figure 1. Number of active U.S. Geological Survey streamgages, 1970–2009.

Streamgage-Network Instability

The number of streamgages operated by the USGS over the past 40 years (fig. 1) has varied from a high of about 8,300 in 1970 to a low of about 6,800 in 1998. Over this 40-year period, the number of streamgages has decreased by more than 660 even though the need for streamflow information has increased due to increasing population, required habitat assessments, new water-quality requirements such as total maximum daily loads, and the need to understand the effects of climate change. The instability of the streamgage network over the past 40 years can also be illustrated by the loss of streamgages that had at least 30 years of information when they were discontinued (fig. 2). Data from long-record streamgages are critical for identifying changes in the amount and timing of streamflow caused by changes in land use, water use, and climate.

Much of the streamgage-network instability is directly attributable to variations in funding. For example, funding sources for the USGS streamgage network in fiscal year 2009 are shown in figure 3. The USGS has direct control of only about 15 percent of the funds required to operate and maintain the network (the NSIP funds). The USGS contributes another 17 percent of the streamgage-network funding through the USGS Cooperative Water Program (CWP), which requires at least a 50-percent match from the cooperating partner for the USGS to invest the CWP funds for streamgaging. Funds from state and local agencies for streamgaging are not being matched dollar for dollar by the USGS CWP; those agencies are currently providing about $2.6 for every $1 provided by the CWP. Consequently, when partner funding is reduced, the water community often loses streamgages because there is inadequate funding to maintain them. As a result, the network's ability to meet long-term Federal needs for streamflow information is uncertain.

To respond to this issue, the USGS developed a plan for the National Streamflow Information Program (U.S. Geological Survey, 1999). This fact sheet briefly describes the current status of the NSIP and the progress that has been made in implementing the five goals outlined in the NSIP plan. Because the needs for and uses of streamflow information are ever-changing and technology is constantly advancing, the NSIP plan must be modified over time to ensure its continued usefulness and relevance.

The five goals of the program, the objectives associated with each goal, and the implementation status of each objective are described below.

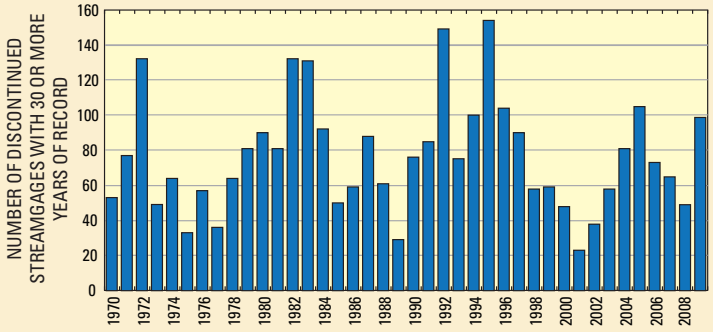

Figure 2. Number of discontinued U.S. Geological Survey streamgages with 30 or more years of record, 1970–2009.

Goal 1: Stable Streamgage Network

Currently NSIP's priority goal is to establish a stable "backbone" streamgage network to fulfill the five Federal needs for streamflow information (described in the box on the next page). A total of 4,756 streamgage locations strategically distributed across the country have been identified to meet these needs; more than 900 of these streamgages will meet more than one of the Federal needs. The NSIP's plan is for the total operation and maintenance costs of this core set of permanent, continuously operated streamgages to be provided by the USGS. This stable Federal funding will ensure that real-time delivery of critical streamflow information is uncompromised by fluctuating funding. The plan is also for all streamgages to be modernized and hardened to withstand both floods and extreme weather so the data are reliably available when they are most needed.

Objective 1

Add new (or reactivate discontinued) streamgages at specific identified critical locations to establish the complete federally funded "backbone" network of 4,756 streamgages. As of 2001, 484 new streamgages and 864 reactivated streamgages were needed to complete the network as designed.

Status. Currently, 3,032 (64 percent) of the 4,756 NSIP "backbone" streamgages are operated year round by the USGS. An additional 323 (5 percent) are operated by the USGS for less than a full year (partial record), and 186 (4 percent) are operated by a non-USGS agency. Currently (2010), 323 new and 877 reactivated streamgages are needed to complete the network as designed, indicating that 67 additional streamgages have been lost from the NSIP network since 2001. The priority to date for the limited funds available has been to sustain the operation and maintenance

Critical Federal Needs for Streamflow Information

Five critical Federal needs for streamflow information that would be met by the core set of 4,744 USGS-funded streamgages in NSIP have been identified:

- **Interstate and International Waters**—Interstate compacts, court decrees, and international treaties mandate long-term, accurate, and unbiased streamgaging by the USGS at State-line crossings, compact points, and international boundaries.

- **Streamflow Forecasts**—Real-time stage and discharge data are required to support flood and other streamflow forecasting by the National Weather Service and other Federal agencies across the country.

- **River Basin Outflows**—Resource managers need to account for the contribution of water from each of the Nation's 350 major river basins to the next downstream basin or other receiving water body (estuary, Great Lake, or ocean).

- **Sentinel Watersheds**—A network of streamgages is needed to document and evaluate streamflow characteristics in 800 watersheds across the country that are relatively unaffected by flow regulation or diversion and typify major ecoregions and river basins to determine effects of changes in land use, water use, and climate.

- **Water Quality**—Streamgaging stations are needed to provide the stream-discharge information in support of the three USGS national water-quality networks. Through these three networks, the USGS monitors and documents water quality in the Nation's streams, from the largest river basins to the smallest watersheds.

of existing streamgages threatened with discontinuation rather than to fund new or reactivated streamgages.

Objective 2

Upgrade equipment at existing streamgages that do not currently have the capability to transmit data in real time, and upgrade to high data rate (HDR) transmitters at all streamgages. The expected outcomes are that additional streamgages will deliver real-time information to the World Wide Web at shorter time intervals, and that compliance with the directive that all transmitters to the Geostationary Operational Environmental Satellite (GOES) be equipped with HDR transmitters by 2013 will be achieved.

Status. The USGS streamgage network currently (2009) is at about 90-percent real-time capability; nearly all of those streamgages are equipped with the new HDR transmitters.

Objective 3

Implement the NSIP network of federally funded streamgages as authorized in Public Law 111.11, for the operation and maintenance of a stable network of 4,756 streamgages. The NSIP network of federally funded streamgages to meet national needs would be in conjunction with partner-funded streamgages to meet additional state and local needs and make up the National Streamgage Network. The expected

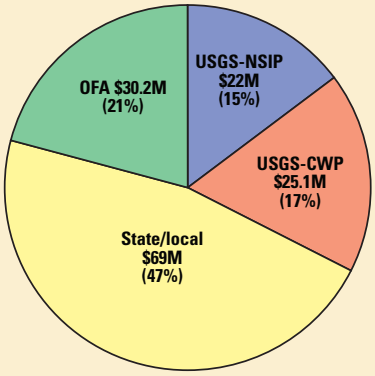

Figure 3. Funding sources for the U.S. Geological Survey streamgaging network, 2009. (Values are in millions of dollars; total funding $146.3 million; OFA, other Federal agencies; NSIP, National Streamflow Information Program; CWP, Cooperative Water Program)

outcome is that NSIP funding for critical streamgages currently operated under the CWP or with other Federal agency funds would be secure and would ensure the uninterrupted delivery of critical streamflow information to meet Federal needs. Moreover, CWP and associated state and local funds released as a result of the NSIP funding of streamgages would be available to support additional streamgages to meet local needs and to supplement the core set of federally funded streamgages.

Status. Currently, 3,032 (64 percent) of the 4,756 NSIP "backbone" streamgages are operated year round by the USGS. NSIP currently fully funds

A typical U.S. Geological Survey streamgage, Little Walker River near Bridgeport, Nevada.

only about 378 (12 percent) of these streamgages; NSIP shares costs with partners for another 965 streamgages (32 percent). The remaining 1,689 existing NSIP streamgages are completely funded by other Federal, State, tribal, and local agencies and the CWP. Nearly 1,200 additional streamgages, which will also require Federal NSIP funds to operate and maintain, remain to be added to complete the planned network.

Objective 4

Flood-harden streamgages at National Weather Service forecast locations to the 200-year-flood level to ensure that they continue to provide critical data during floods. The expected outcome is that approximately 3,600 streamgages used for forecasts would be flood hardened under full NSIP implementation.

Status. NSIP resources have not been sufficient to meet this objective to date, as all available resources have been invested in higher priority NSIP objectives. However, approximately 140 NSIP streamgages were flood-hardened with supplemental funding obtained as a result of Hurricanes Katrina and Rita.

Objective 5

Federally fund infrastructure costs of the entire national streamgage network. Supporting additional streamgages to meet state and local needs, funded through the CWP, adds little to overall infrastructure costs. These incremental added costs include those for activities such as national database development and maintenance, local database administration and project oversight costs, and the USGS Office of Surface Water, which provides technical guidance and oversight for all USGS surface-water activities at the national level.

Status. USGS Water Science Centers (WSCs) have been allowed to apply their NSIP funding allocation to this objective for several years, but the overwhelming percentage of WSC funding allocations are used to fund the operation and maintenance of NSIP Federal-goal streamgages. It is estimated that less than 10 percent of the allocated NSIP funds are used to help meet this objective.

Recreating on a river. Streamflow information is used by many recreationists to help ensure a safe and enjoyable experience.

Goal 2: Improved Delivery of Streamflow Data to Users

Developing new, state-of-the-art methods to transmit, store, and distribute streamflow information is an essential component of the NSIP. Improving the delivery of streamflow data includes a wide spectrum of activities, such as the automatic transmission of data from the streamgage on the river bank into the database, analysis of the rating curve, and reporting of and access to the data on the World Wide Web. Also included is ensuring the information is available when needed by establishing backup data-delivery systems and providing enhanced data-storage, -retrieval, and -analysis capabilities.

Objective 1

Implement a system to help ensure uninterrupted delivery of streamflow information under all conditions.

Status. The USGS made this objective a high priority and was able to achieve it by implementing a national system of backup servers. All existing streamflow information, both real-time and historical, is available for the entire Nation 24 hours a day, 365 days a year, regardless of conditions. The USGS also worked with other Federal agencies to establish a back-up receiver site for satellite data transmissions through the GOES system at the Earth Resources Observation Systems (EROS), in South Dakota.

Objective 2

Develop enhanced systems and processes for quality assurance of streamflow information to provide high-quality data in a timely and efficient manner. This objective includes the development of a process for the real-time quality assurance of streamflow information, as well as computer programs and techniques to more rapidly and cost effectively compute streamflow.

Status. The USGS has developed and implemented a system that automatically detects when a streamgage may be transmitting erroneous data and sends an e-mail notice to the responsible office for evaluation. A method to automatically correct erroneous data is planned. The USGS has developed numerous computer applications to assist hydrographers in processing raw streamflow information in order to reduce the time required to finalize the streamflow record.

Objective 3

Maximize the usefulness and accessibility of streamflow information to users of the information. This objective includes providing confidence intervals for the data, increasing the availability of instantaneous-value data, and developing new products to present the information.

Status. The USGS developed a database (Instantaneous Data Archive, or IDA), available through the World Wide Web, that currently (March 2011) contains more than 3 billion

instantaneous values of streamflow information from 47 states. The USGS has also developed a powerful streamflow-information synthesis tool on the World Wide Web called WaterWatch. WaterWatch allows the user to compare real-time streamflow information with historic streamflow information to obtain a current assessment of hydrologic conditions. The ability to apply confidence intervals to the streamflow data has not yet been achieved.

Goal 3: Regional Assessments of Streamflow Characteristics

Although the USGS National Water Information System (NWIS) database contains billions of pieces of streamflow information, there has been no systematic process to evaluate and analyze those data. In cases where data have been analyzed, the effects of changes in land use, water use, and climate are commonly observed. Although the USGS currently operates about 7,600 streamgages, there are many more river reaches that are not measured; being able to estimate the streamflow at these ungaged locations is critical. In addition, for many uses of the data, trends in streamflow need to be identified. The NSIP's goal of regional assessments includes providing a means to estimate flow at ungaged locations, a mechanism for identifying trends in streamflow, and information required to assess the adequacy of the streamgage network.

Objective 1

Evaluate appropriate methods for utilizing streamflow information to perform regional streamflow assessments. These evaluations will be designed to (1) estimate streamflow at ungaged locations, (2) identify any trends in streamflow, and (3) attempt to determine the cause of any trends detected.

Status. Because other goals and objectives had a higher priority for the funding available, efforts toward this objective have been minimal.

Objective 2

Utilize the streamflow information available in the NWIS database to determine regional streamflow characteristics based on the methodology developed in Objective 1. These analyses will produce, at a minimum, streamflow statistics (mean and median streamflows, streamflow per unit area, low flows, peak flows, and trends), as well as explanatory causes and effects, if possible. This objective also includes an assessment of the adequacy of the streamgage network in the region to provide both the data to conduct these types of assessments and predictive equations for estimating streamflow at ungaged sites. When these regional assessments have been completed nationwide, they will be compiled, a national synthesis will be produced, and the process will begin again.

Status. The USGS has been developing a "point-and-click" tool that, as equations become available, will provide the ability to select any location on any river in the country and obtain estimates of the streamflow characteristics at that location. This tool, called StreamStats, has been or is currently being implemented in 34 states. Much additional work is needed to update regression equations for estimating flow at ungaged locations and to implement StreamStats nationwide. Because other goals and objectives had a higher priority for the funding available, efforts toward this objective beyond implementing StreamStats have been minimal.

Goal 4: Expanded Data Collection During Floods and Droughts

Maximizing data collection prior to, during, and following both floods and droughts is critical to improving our understanding of and predictive capability with regard to hydrologic extremes. The spatial and temporal scales at which streamflow information is collected during extreme events need to be expanded. In addition, new and creative analysis techniques must be utilized. The new techniques will improve our understanding of floods and droughts and the risks they pose to life and property. The ultimate goal is to improve the prediction of extreme events with improved accuracy and increased lead time.

Objective

Increase the intensity of data collection, improve data analysis, and produce interpretive reports to improve the understanding of, and response to, floods and droughts.

Status. Although few NSIP funds have been available to invest in enhanced data collection during floods and droughts, the NSIP has been able to provide funds for analyses of existing flood data. These efforts have provided increased understanding of floods and their occurrence through reports such as O'Connor and Costa (2003), O'Connor and Costa (2004), Perry (2005), and Costa and Jarrett (2008).

In addition, the USGS has been a leader in applying hydroacoustics technology for use in measuring streamflow. Although hydroacoustics can be used to measure much more than flood flows, this technology allows flood measurements to be made much more quickly and safely, thereby allowing additional measurements to be made. This also results in more accurate flood-flow estimates because flows at fewer locations need to be estimated by non-measurement techniques.

Severe drought. Data from the streamgage network are used to help predict droughts, define their extent, and provide information on recovery.

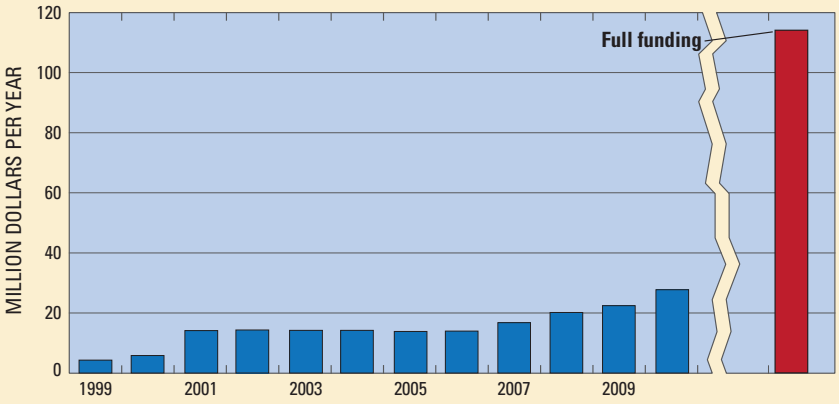

Figure 4. Annual National Streamflow Information Program funding, 1999–2010 Full funding for the program would require $117 million per year.

Goal 5: Research and Development

In many cases, the collection of streamflow data today is much the same as it was in 1889, when the first USGS streamgage began operation. Recent technological advances have provided new tools that allow the USGS to do a more efficient, more effective job of obtaining the streamflow information required for the safety and well-being of the Nation. Continued research and development of new tools, technologies, and methodologies will minimize cost increases while improving data quantity and quality.

Objective

Perform basic and applied research to develop new tools and technologies that (1) improve the way surface-water information is obtained and analyzed and (2) improve the understanding of surface-water flow. It is expected that this research will be conducted by scientists within and outside the USGS.

Status. Although only minimal NSIP resources have been applied to this objective to date, the USGS has made significant progress in the application of hydroacoustic instruments for the measurement of streamflow. The USGS has worked closely with hydroacoustic instrument vendors to further the development of hydroacoustic instruments to meet the USGS's operational needs for streamflow measurements in a variety of physical settings. The USGS is viewed as the world leader in the application of hydroacoustic technology to the measurement of streamflow. In addition, the USGS used radars in a series of "proof-of-concept" experiments to measure stream discharge directly and with no physical contact with the water. The experiments showed that it was possible to measure streamflow in this manner, but that technological advances would be required to utilize the technique in many locations.

Future Priorities

Currently (2011), the NSIP is funded at about $27.7M (fig. 4). The complete program is estimated to require about $117 million per year. The majority of any new funds received will be targeted toward stabilizing and furthering the implementation of the streamgage network in support of the five critical Federal streamflow-information needs. The USGS will give a high priority to maintaining an awareness of, and attentiveness to, the needs and expectations of partner agencies, advancing technologies, and additional uses to which the streamflow information can be applied.

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Design of a National Streamflow Information Program
Report With Recommendations of a Committee

By National Streamflow Information Program Committee (J.D. Bales, J.E. Costa (chair), D.J. Holtschlag, K.J. Lanfear, S. Lipscomb, P.C.D. Milly, R. Viger, and D.M. Wolock)

U.S. Geological Survey Open-File Report 2004-1263

U.S. Department of the Interior
U.S. Geological Survey

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PREFACE

The Committee that prepared this plan for a National Streamflow Information Program (NSIP) met and worked in 1998-1999. The results of the Committee's meetings and deliberations are contained in this document, which is a product of the circumstances of the U.S. Geological Survey streamgaging program as of 1999. Over the next several years as partial funding for NSIP became available, parts of the plan presented here were adopted, other parts were revised, and some have never been implemented. Although this report was completed and reviewed in 1999, personnel changes, planning, and implementation of this important new program has delayed publication until now. A brief summary was published in 1999 (*Streamflow Information for the Next Century, 1999, U.S. Geological Survey Open-File Report 99-456, 13 p.*). The NSIP program today (2004) is similar but not identical to the program outlined herein. This report is published since it provides the only detailed documentation of the thinking and workings of the Committee who developed and designed the program. From a larger perspective, this report also serves to document the vision of the Water Resources Discipline for the future of streamgaging in the U.S. Geological Survey. A more recent description of NSIP is provided in *Hirsch, R.M. and Norris, J.M., 2001, National Streamflow Information Program: Implementation Plan and Progress Report: U.S. Geological Survey Fact Sheet FS-048-01*, and National Research Council, 2004, Assessing the National Streamflow Information Program: National Academy Press, Washington, D.C., 146 p.

The NSIP web page contains these reports, and others, as well as the most current information about NSIP. The web page can be found at http://water.usgs.gov/nsip/.

1. Introduction to the National Streamflow Information Program

1.1. Background

The Nation needs accurate and timely information about the movement of water through its network of streams. This information is needed to support many and broad purposes to:

- improve the scientific understanding of the environment and how it is changing over time;
- provide reliable, objective information that will support development and monitoring of international and interstate agreements on allocation of water resources;
- provide streamflow data to manage and improve water quality, as required by the Clean Water Act, and to assess changes in the riverine environment that affect the quality of river and riparian habitat;
- assess streamflow conditions in support of long-term watershed planning so that plans can be made, and water infrastructure designed, that will balance considerations of off-stream water use, aquatic habitat, water quality, recreation, navigation, and hydropower;
- provide current streamflow information and forecasts, at time scales of days to months, in order to enable water users and water managers to make effective operational plans and decisions regarding water withdrawals for municipal, industrial, and agricultural uses, hydropower production, and navigation;
- assess flood risks, in support of effective mitigation strategies such as flood zoning, flood-proofing of structures, flood-insurance rate setting, and design of structures (bridges, culverts, and dam spillways) that will safely pass flood flows with known reliability; and
- provide flood warnings and forecasts of streamflow conditions in support of public and private decisions regarding evacuations, movement of property, flood fighting, reservoir releases, rescues, and recovery.

Since 1889, the U.S. Geological Survey (USGS) has operated a multi-purpose streamgaging network supported primarily by other Federal, State, and local agencies. With the passage of the Clean Water Act, advent of the Internet, and continuing increases in flood damages, the demand for and value of streamflow information has grown, and information users have developed increased expectations for reliability and timeliness of the information. Moreover, there is an increased need for long-term, high-quality records and analysis of streamflow data to provide necessary information for natural-resource managers. In the last 30 years, the overall size of the USGS streamgaging program first leveled off and has since begun to decline (for example, fig. 1). Furthermore, the share of the streamgaging program supported by Federal funding has dropped disproportionately with consequent loss of representation of Federal interests in the siting of streamgages and reduced ability to meet Federal needs.

To meet the many varied streamflow information needs of the Nation, the USGS will ensure the effective collection, processing, interpretation, and dissemination of streamflow information for Federal needs into the future through a comprehensive **National Streamflow Information Program (NSIP)**. NSIP will consist of the following components, many of which are consistent with recent recommendations of the National Research Council (1991, 1999):

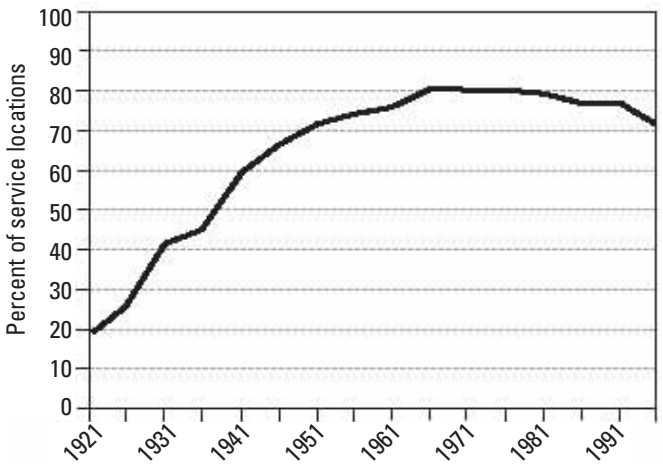

Figure 1. Percent of 1996 National Weather Service flood-forecast locations having active streamgaging stations, as function of year (U.S. Geological Survey, 1998).

1. A nationwide system of streamgages for measuring streamflow and related environmental variables (for example, precipitation and temperature) reliably and continuously in time;
2. A program for intensive data collection in response to major floods and droughts;
3. A program for periodic assessments and interpretation of streamflow data to better define national and regional statistical characteristics and trends;
4. A system for real-time streamflow information delivery to customers that includes data processing, quality assurance, archival, and access; and
5. A focused program of techniques development and research.

1.2. Overview

This report provides detailed information in support of the report "Streamflow Information for the Next Century—A Plan for the National Streamflow Information Program of the U.S. Geological Survey (U.S. Geological Survey, 1999). The aforementioned five elements of NSIP are described in detail in this report. The rationale for each element is provided, and desired features of each element are given in some detail. Major sections of this report are ordered to follow a logical sequence of :

- *Data collection*—Section 2 describes the design of a streamgaging network to meet Federal needs for streamflow information, and Section 3 addresses new requirements (upgrades) for streamgages in the USGS streamgaging program; Section 4 describes the program for the collection of streamflow information for floods and droughts
- *Data processing*—In Section 5 the data system and data processing for streamgage data are described,, with additional information provided in Appendix B;
- *Information delivery*—Section 6 presents a vision for delivery of information products to customers.
- *Analysis and interpretation*—In Section 7 a national program of regular assessments is described.
- *Research*—In Section 8 development and research needs motivated by these various initiatives are described.
- *Implementation*—In Section 9 a draft implementation plan with prioritized actions is described.

1.3. Recommendations

Concise statements of important features of the NSIP design are shown in bold type throughout this report. The most important features of NSIP are summarized here to give an overview of the program.

Streamgaging Network:

- "Base" information needs are those that should be met by the USGS streamgaging program even in the absence of any other support from funding partners. Base needs include streamgages associated with
  - existing compacts and decrees,
  - existing National Weather Service (NWS) flood-forecast sites,
  - accounting-unit water budgets,
  - estimation of conditions at ungaged sites (regionalization) and determination of trends at gaged sites, and,
  - support of water-quality initiatives.

  The addition of about 2,100 streamgages to the current (1996) network could satisfy the base Federal information needs.
- Streamgages required to satisfy the base Federal streamflow information needs will be fully supported by Federal funds. For other streamgages in the USGS network, Federal appropriations should fund the fixed (or indirect) cost of all streamgages. Fixed costs cover maintenance and enhancement of the national capability to gage streams, and to store and disseminate the data from the streamgaging network, and include such items as database support, equipment purchase and maintenance, training, facilities, vehicles, and salaries for management and technical support. The annual indirect (or fixed) costs are on the order of 40 percent of the total annual cost for operation of a single streamgage. Funding partners will then pay all or

some part of the direct annual streamgaging operational cost (labor, travel, etc.), depending on whether the streamgage is cost-shared through the Cooperative Program.

- NSIP will include a program to modernize and flood-harden existing streamgages in the Federal network. Every USGS streamgage will be equipped to provide real-time data dissemination by the USGS. Continuous monitoring of stream-water temperature, air temperature, and precipitation at most streamgage sites will be phased in over time. All existing streamgages in the Federal network will be upgraded to withstand failure under conditions of the estimated 200-year flood, and all new streamgages will be built to withstand the estimated 200-year flood.

- The location of every station will be determined to an accuracy of 2 meters (m) using Global Positioning System (GPS) technology. Rating curves for all streamgages in the Federal network will be extended out to the 200-year flood level using best-available techniques.

- The USGS will report to Congress every year on the status and effectiveness of the streamgaging program.

Data Collection for Floods and Droughts:

- The NSIP response to floods and droughts will be to supplement routine streamflow records with systematic field surveys throughout the affected area.

- The focus during floods will be to measure discharge at a large number of widely dispersed gaged and ungaged sites. Systematic field surveys will include hydraulic, hydrologic, water-quality, geomorphologic, sedimentary, and biological measurements. Aerial photography will be used as soon as conditions permit to locate sites for subsequent measurements and detailed investigation, and to document locations of channel avulsion, sediment deposits, and erosion.

- The focus of data collection during severe droughts will be on direct measurement of streamflow and selected water-quality parameters at a large number of widely dispersed gaged and ungaged sites in the affected area.

- A network of volunteer Water Watchers will be mobilized in cooperation with local watershed organizations to assist in the extensive data-gathering activities for critical hydrologic events

Information Delivery, Data Processing, Quality Assurance, Archival, and Access:

- NSIP will provide convenient, reliable access to all USGS streamflow-information products via the Internet through a variety of interfaces tailored to the needs of interactive users, batch users, push customers, and USGS hydrographers. Current important modes of information delivery however, will not be terminated without agreement of customers.

- All available data will be served at the temporal resolution of actual measurements ("unit values"), and as user-requested time averages (daily, monthly, and annual) through an interface that unifies "historical" and "real-time" databases.

- Statistical methods of uncertainty analysis will be used to assist with quality control, construction of rating curves, determination of rating-curve shift application, and quantification of confidence limits on stage and streamflow data. Quantitative measures of the estimated uncertainty of data will then be routinely served along with the data.

- A detailed, comprehensive, and internally consistent geospatial framework for streamflow information will be created. to achieve many of the NSIP objectives for information delivery and data interpretation.

- USGS streamflow information products will be linked with other USGS products, including user-customized maps, graphs, and information reports, and with relevant products of other Federal agencies. In particular, the USGS will provide unified graphical presentations of NWS forecasts at streamgaging stations in the context of USGS measurements and streamflow characteristics. The USGS will seek to build a partnership with the Federal Emergency Management Agency (FEMA), NWS, and other agencies to design an integrated program to modernize techniques for the generation and revision of flood-risk maps, and provide near real-time maps of current and forecasted flood inundation areas.

- The database and software systems for receiving and processing streamflow data will move from District-based computers to a centralized multi-server system that will contain separate components for data collection, review, routing, archival, and access. Redundant processing databases will be housed in physically separate locations with independent data feeds. Collection and review of the data will continue to occur at locations remote from the centralized multi-server systems used for storage and access.

Assessments of Streamflow Characteristics:

- The USGS will establish a permanent, federally funded program of regional (based on major physiographic provinces of the Nation) and national streamflow assessments to address at-site streamflow characterization, trend analysis, and regionalization. The assessment program will have a strong national, interpretive focus, will run on a staggered 10-year cycle (assessments for one or more provinces will be underway at all times), and will include analyses of numerous streamflow characteristics.
- Regional assessments will investigate the potential to derive useful information on the stream environment from all available environmental information, such as rating curves, velocity distributions, climate data, and land-use information. Assessments will include an evaluation of the presence of trends and other deterministic controls on temporal variations in streamflow.
- Information from the assessment program will be used to continually refine the streamgaging network so that the base Federal needs are more fully met, particularly with regard to Regionalization and Trends.
- The program for assessment of streamflow characteristics will address the streamflow-information needs created by Federal water-quality legislation. Close collaboration with the USGS National Water-Quality Assessment (NAWQA) Program and the EPA will ensure maximum relevance of NSIP streamflow-characteristic products with investigations of water chemistry and aquatic ecology.

Development and Research:

- NSIP will pursue research and development of new and emerging technologies, including non-contact measurement of stream velocities, stage, and total discharge, and understanding streamflow at smaller timescales (e.g. 15 minutes).
- NSIP will include experimental and theoretical research to develop new, more cost-effective methods for indirect estimation of flood flows, and will develop guidelines for identification and interpretation of ancient flood deposits to enhance estimates of extreme flood characteristics.
- Quality-assurance techniques will be developed to quantify the uncertainty of streamflow data.
- High-resolution streamflow prediction models will be developed for a small number (two to five) of river basins having areas on the order of 8,000 square miles (mi2). A medium-resolution streamflow prediction model will be developed for the entire 48 contiguous States and adjacent, contributing drainage areas in Mexico and Canada. The models will be to assist in the estimation of streamflow at ungaged sites.
- Versatile, two-dimensional, non-steady channel flow models will be developed for use in flood inundation prediction and analysis.

2. Streamgage Network for Federal Needs

2.1. Federal Needs for Streamflow Information

The overall objective of the NSIP is to meet the Federal need for streamflow information, in cooperation with the needs of state and local customers. More specifically, in order to meet the Federal needs, NSIP will provide streamflow information that will have broad utility to the Nation—information that is needed for multiple purposes and by multiple parties, in contrast to information that will likely meet one particular purpose or serve the interests of a few parties. Among the parties that should be served by the NSIP are individual citizens, the private sector, local governments, State agencies, tribes, and Federal agencies. The goal of NSIP is to provide information that can be used for many decisions by many parties. Key attributes of NSIP include the following:

- Information is shared freely;
- Information is readily accessible for current use;
- Information is centrally archived for future use;
- Information is quality-assured; and
- Information is viewed as neutral, objective, and high quality by all parties.

Two important points arise from the notion of Federal need. First, streamflow information from a specific site that has the potential to meet multiple purposes does not meet Federal needs unless the information is freely shared, readily accessible, archived, quality-assured, and viewed as neutral and high quality. Thus, any analysis of the streamgaging network from the perspective of Federal needs must consider these attributes. Streamgages that do not have all five of these attributes should not be considered as contributing to the Federal need unless modifications to data management and delivery can be made. Second, *Federal agency needs* are a subset—albeit an important subset—of the full suite of *Federal needs*.

Important examples of *Federal needs* include:

- The need for long-term records that extend beyond the short-term requirements of other agencies.

- The need for a consistent level of quality that often exceeds that required by a single user.
- The need to conduct routine analyses of the streamflow data at a national level.
- The need to make data collected by other agencies available to all users.
- The need for national-level research to improve quality, efficiency, and the value of informational products.
- The need to document water-quality conditions in waters of the States and to provide streamflow data for estimation of TMDLs (Total Maximum Daily Loads), as required under Section 305b of the Clean Water Act;
- The need to define regional low-flow characteristics to enable multiple States to develop water withdrawal permits that protect off-stream water users and aquatic communities;
- The need to advance scientific understanding of the effects of various land-use practices, including agriculture, silviculture, and urbanization, on streamflow;
- The need to document long-term trends in streamflow—trends that may arise from global climate change—and the related need to provide data that will support efforts to predict potential effects of global change, both human-induced and natural, on water resources and aquatic habitat;
- The need to provide flow information that will support recreational activities and improved aquatic habitat quality in support of citizens across the Nation who have commercial and leisure interests in streamflow conditions; and
- The need to provide citizens and businesses with current information on streamflow and river levels to enable them to make informed decisions regarding evacuation and movement of personal property from flood-prone areas.

Some examples of *Federal agency* streamflow-information needs include the following:

- The National Weather Service (NWS) requires near-real-time data on stage and discharge in support of flood forecasting and the issuance of flood warnings to the public.
- The U.S. Army Corps of Engineers (USACOE) and Bureau of Reclamation (BOR) require information on streamflow characteristics to support design of dams and reservoirs for the purpose of flood control and navigation. They require real-time information on discharge to support operation of the reservoirs and other water-control structures.
- The Federal Emergency Management Agency (FEMA) requires information on flood stages in support of flood-damage assessment.
- The USGS National Water-Quality Assessment (NAWQA) Program requires discharge time series for the execution of water-quality studies.
- The FEMA National Flood-Insurance Program requires information on streamflow characteristics and related river stages in support of flood-risk assessments.
- The U.S. Environmental Protection Agency (USEPA) requires information on streamflow or streamflow characteristics to help define Total Maximum Daily Load (TMDL) allocations as mandated by the Clean Water Act.
- Seventeen interstate compacts, two Supreme Court decrees, and one international treaty mandate the collection of streamflow information by the USGS (Wahl and others, 1995).

2.2. Historical Approach to Meeting Federal Needs

Historically, Federal needs for streamflow information have been addressed in the streamgaging program through a variety of Federal funding mechanisms (Wahl and others, 1995). In 1994, 56 percent of streamgages were funded through the USGS Federal-State Cooperative Program (the Coop Program), under which the USGS provides up to half of the funding for any streamgage, with the balance paid by State or local agencies. The Federal cost share entitles USGS to a voice in the location of the streamgage, and this provides a mechanism for meeting Federal information needs. Streamgages are also fully funded directly by other Federal agencies, such as the USACOE and the BOR. In 1994, this funding by other Federal agencies accounted for 26 percent of streamgages. Approximately 8 percent of streamgages in 1994 (6 percent in 1998) were fully funded by the USGS, typically to support national programs of water-resource investigations or to satisfy legal mandates. The remaining 10 percent of streamgages were funded by some combination of these three mechanisms.

In response to a Congressional request, the USGS completed an evaluation of the ability of the streamgaging network to meet Federal needs for streamflow information (U.S. Geological Survey, 1998). The report defined several quantifiable measures of the degree to which a given national network of streamgages satisfied specific Federal information needs. Using these measures, the report determined the historical changes over time in the degree to which Federal information needs have been met. The evaluation focused on five key Federal objectives for streamflow information:

- Interstate and international transfers

tion of a sort that heretofore has not generally entered regional flow studies. Clearly, research on these problems could lead to new understanding of controls of streamflow processes and, consequently, to improved tools for predicting streamflow characteristics.

Controls on temporal variations in streamflow characteristics have received less attention than controls on spatial variations. Temporal variations result from long-term changes of the land surface and the stream network, usually associated with land and water development, and from low-frequency fluctuations and long-term changes in the climate system. Some factors associated with land and water development have been addressed in the analogous problem of spatial regionalization in urban basins. An initial problem for research is to determine whether the same relations that have been developed for spatial regression in urbanized areas can be applied to predict temporal changes. As mentioned in Section 7.3, multiple types of climatic fluctuations and transients have potential to explain temporal variations in streamflow characteristics. It is important to begin to sort out the separate effects of land and water development, natural climatic variability, and long-term climatic change (local, regional, and global) on variations in streamflow characteristics.

9. Implementation Plan

The current streamgaging network of the USGS is facing an important crossroads. The existing streamgaging program has significant merits, and has produced important data. Incremental new resources should be applied to changes in the information system organization, data delivery, and regional and national assessments first. Expansion of streamgaging stations should be a second-order priority after information delivery and software system upgrades are implemented.

As new funding for NSIP becomes available, it should be applied to three major program components in the following order:

- Redesign and upgrade of data collection, storage, and distribution systems as described in this report. Assessment and evaluation of regional and national flow characteristics capability of the current streamgaging station program.
- Partial coverage of the fixed costs for operating a national streamgaging station network, in proportion to the number of streamgages operated in the District compared to the national program.
- Partial coverage of the marginal costs for operating a Federal-base streamgaging network.

The following sections describe actions required regardless of the outcome of NSIP.

9.1. Headquarters-level Actions

- Prepare draft MOUs for cooperation with the NWS on sharing NWS flow forecasts with USGS real-time streamflow data on the Internet at streamgaging stations used as forecast stations. Begin discussions on revamping streamgaging station and forecast locations to correlate more closely with people at risk from flooding. Seek opinions of the NWS regarding locations of new streamgaging stations, as resources emerge. Begin to discuss similar MOUs with appropriate Federal agencies that have needs for streamflow data, such as the USACOE and BOR.
- Begin to procure the infrastructure to provide reliable web-based streamflow information following the recommendations of the NWIS-Web Committee.
- Identify personnel, and assign the work to begin the design and testing of an automated quality-assurance system to monitor streamflow data as it is transmitted from the field. This includes converting transmitted data to flow values, quality control of stage and flow data, and calculating estimates of uncertainty of stage and flow values. The ideas contained in the NSIP report could be a starting point.
- Distribute and implement the draft version of the National Flood Plan.
- Begin the process of designing and testing a new centralized database system that will provide redundant and efficient entering, accessing, archiving, and routing of streamflow data. Begin design of a database system that is hardened to interruptions of the data flow, which could include multiple data storage disks, cluster servers, and uninterrupted power supplies.
- Create a national unit-value database and begin the process to allow serving unit value data on the Internet in addition to daily values.
- Complete the NHD to a resolution scale that matches RF-3 and in concert with that complete the National Watershed Boundary data set to the 12-digit level in a manner that is tied to the NHD.
- Identify streamflow characteristics that will be used to address streamflow information needs of Federal water-quality legislation.
- Begin plans to host a series of workshops with FEMA, USACOE, NWS, BOR, and other appropriate agencies to coordinate work and share data to modernize methods of generating flood-risk maps, real-time maps of flood-inundation, and forecast maps of flood-inundation areas. Begin to acquire LIDAR (high-resolution Digital Elevation Model) data for the greatest flood-

risk areas of the country; prepare plan to integrate multi-dimensional streamflow models to demonstrate real-time inundation mapping with the ultimate goal of passing the technology to NWS.

- Actively seek support for additional federally funded streamgaging stations, and appropriated funds to support District infrastructure of streamgaging stations. Use the network evaluator tool as a guide in order to optimize the most Federal goals served by new streamgaging stations.
- Prepare map-serving requirements for the Mapping Discipline if National Atlas is to be portal to WRD streamflow information delivery system.
- Regularly update and publish GIS spatial database on streamgaging stations operated by the USGS, including features of the streamgage (type of equipment), costs, and Federal interests served. Include data on non-USGS streamgaging stations.
- Create real-time streamflow information Web pages that use color-coded symbols to report the current conditions of stage or discharge for each streamgaging station.
- Develop and publish a prototype annual report to Congress on the state of the Nation's rivers and streamgaging station program (NSIP).

9.2. District-level Actions

- As funding allows, begin to deploy non-contact laser stage-sensors as a means to begin flood-hardening streamgaging stations. Instrument NWS forecast locations first.
- In our future flood and drought responses, begin the process of acquiring data from a broader area. Obtain vertical aerial photographs of flood-inundation areas following all Category III floods.
- Following significant floods (50-100 year) at streamgaging stations that serve as NWS forecast sites, include the effort to extend ratings to the 500-year flood levels in damage and repair estimates that may be recouped from supplemental appropriations.
- In cooperation with other Federal and State agencies, initiate a process for post-audits of technical response, predictions, and preparation following major floods.
- Through meetings with stakeholders, identify needs to re-activate old stations, initiate new stations, and modernize existing stations that are critical to meeting base Federal needs.
- Develop District drought response plans.
- Identify and preserve readily available historical unit-value data for inclusion in the national unit-value database.
- Conduct preliminary streamflow data assembly and check for use in regional assessments of streamflow.

9.3. Research Actions

- Begin long-term effort to identify, test, and evaluate promising frontier technologies for non-contact estimation of stream velocity and stream discharge.
- Investigate improved and new methods for indirect discharge estimates.
- In one hydrological region of the country, design and test a pilot program of regional streamflow assessments to address at-site flow characterization, trend analysis, and regionalization.
- Expand current research into the physical causes of spatial and temporal variations in streamflow characteristics.

10. References

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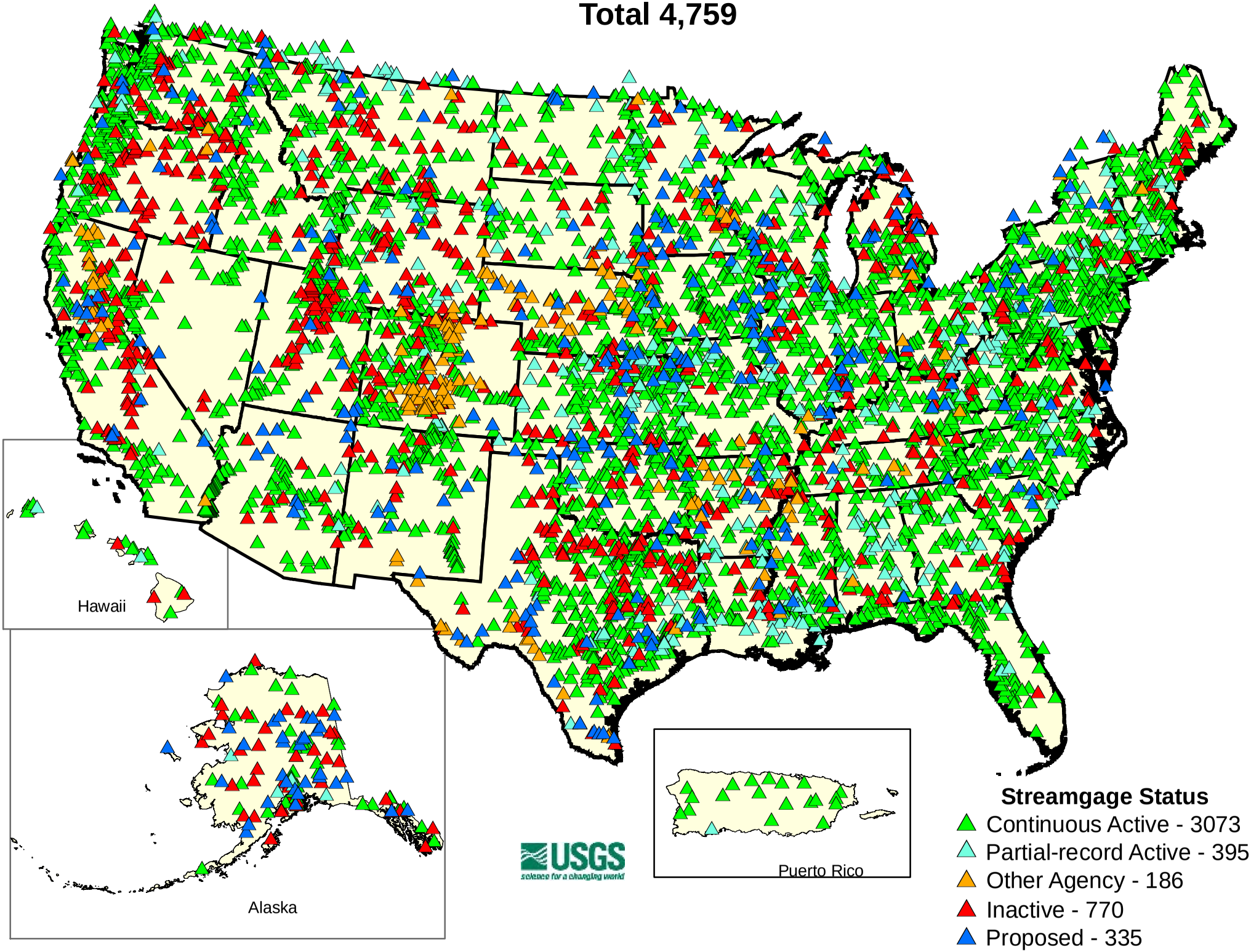
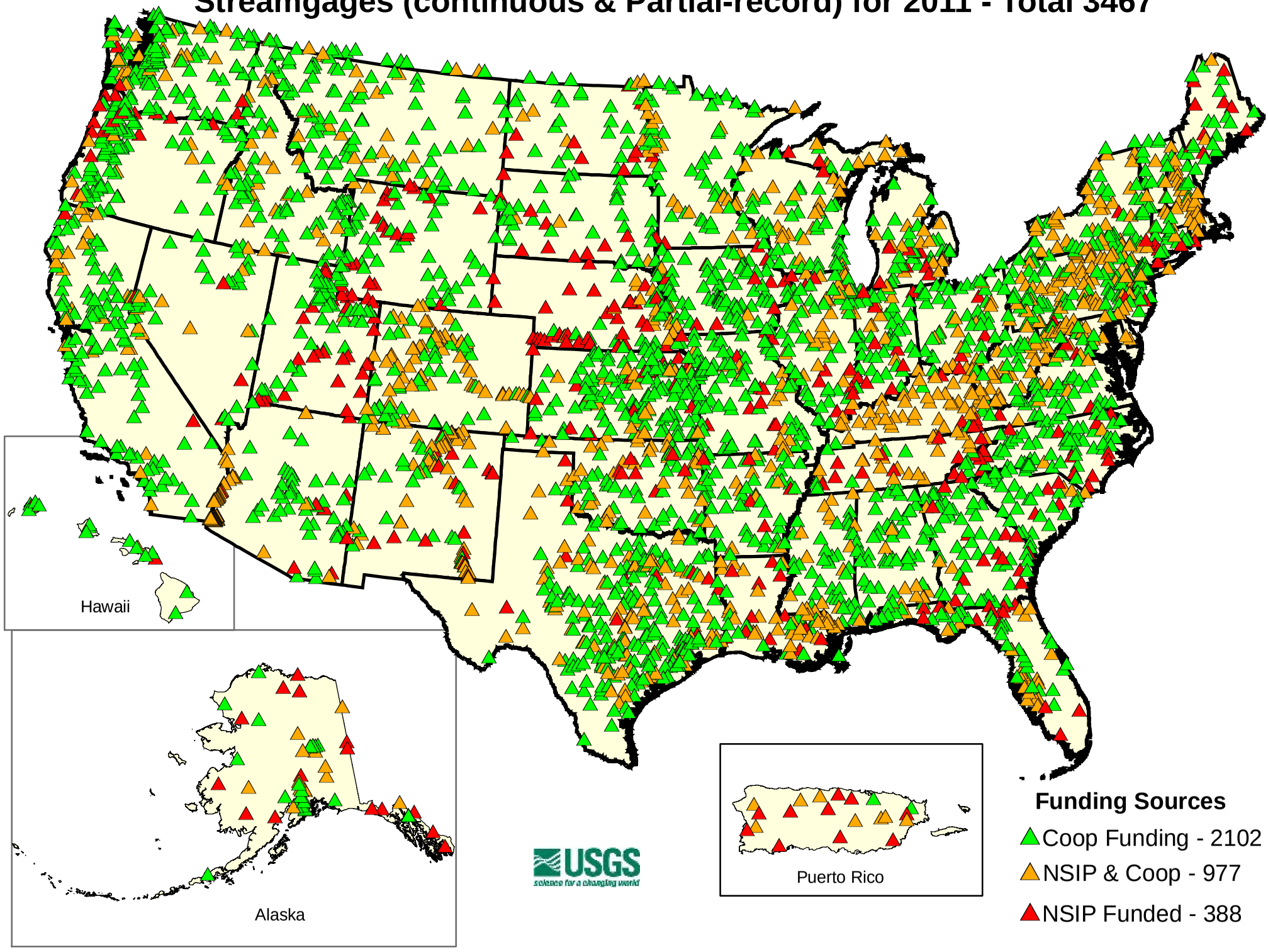
Fontaine, R. A., Moss, M. E., Smith, J. A., and Thomas, W. O., Jr., 1984, Cost effectiveness of the streamgaging program in Maine – A prototype for nationwide implementation: U.S. Geological Survey Water-Supply Paper 2244, 39 p.

USGS Streamgaging Networks – Across the Nation and in the Colorado River Basin

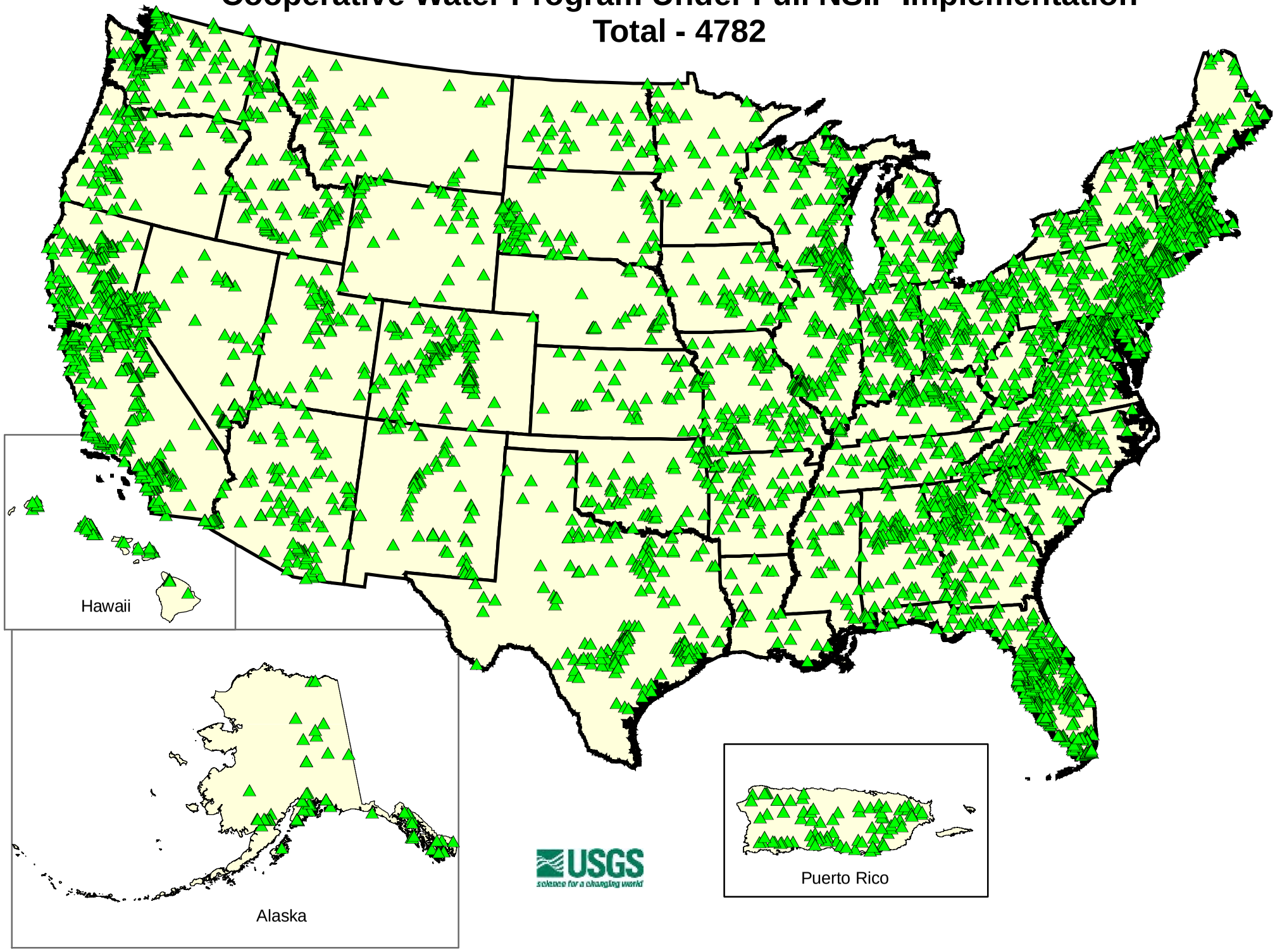
Status of USGS National Streamflow Information Program Streamgages
Total 4,759



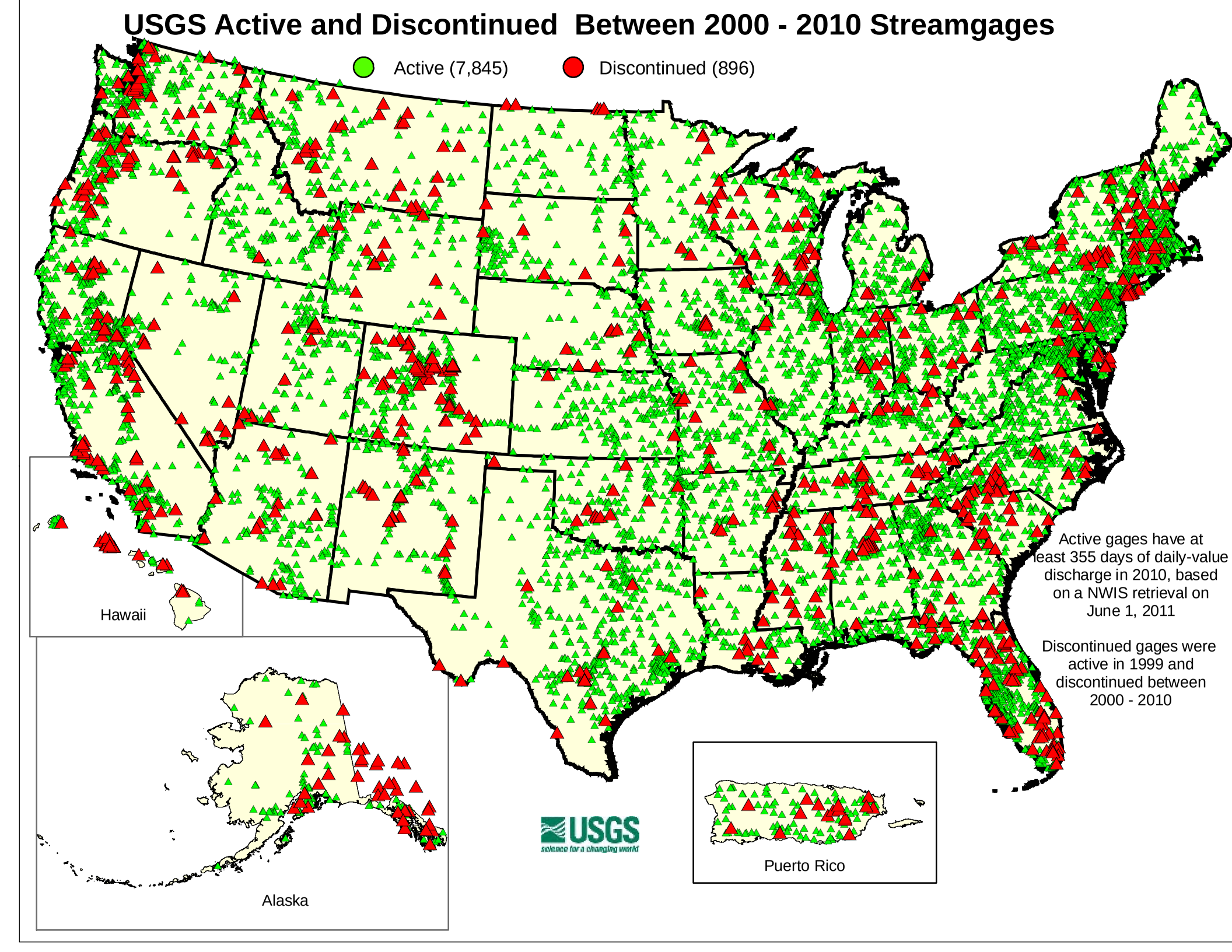
Funding Sources for Active USGS National Streamflow Information Program Streamgages (continuous & Partial-record) for 2011 - Total 3467



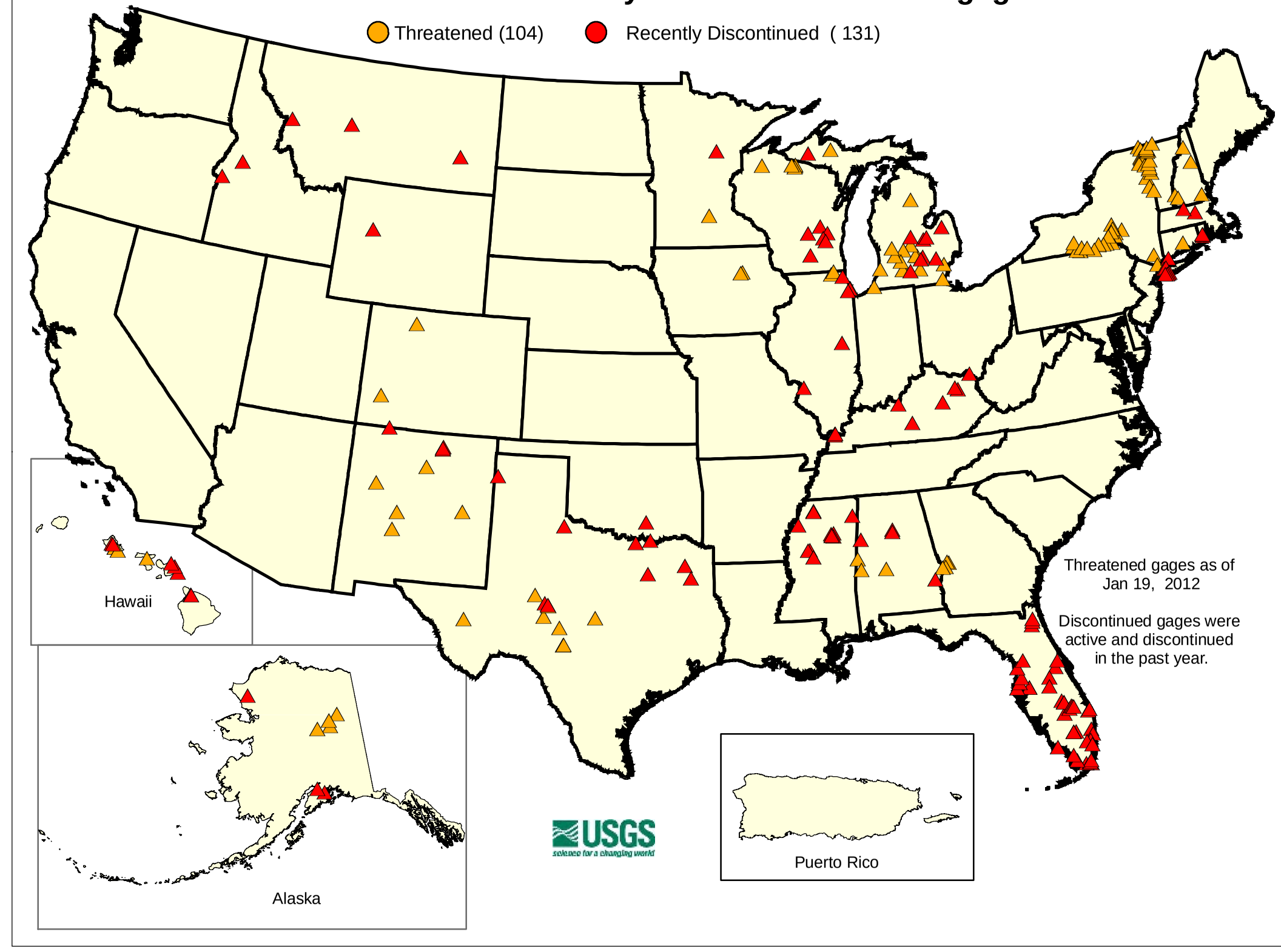
2011 Active Streamgages to Remain in the Cooperative Water Program Under Full NSIP Implementation
Total - 4782



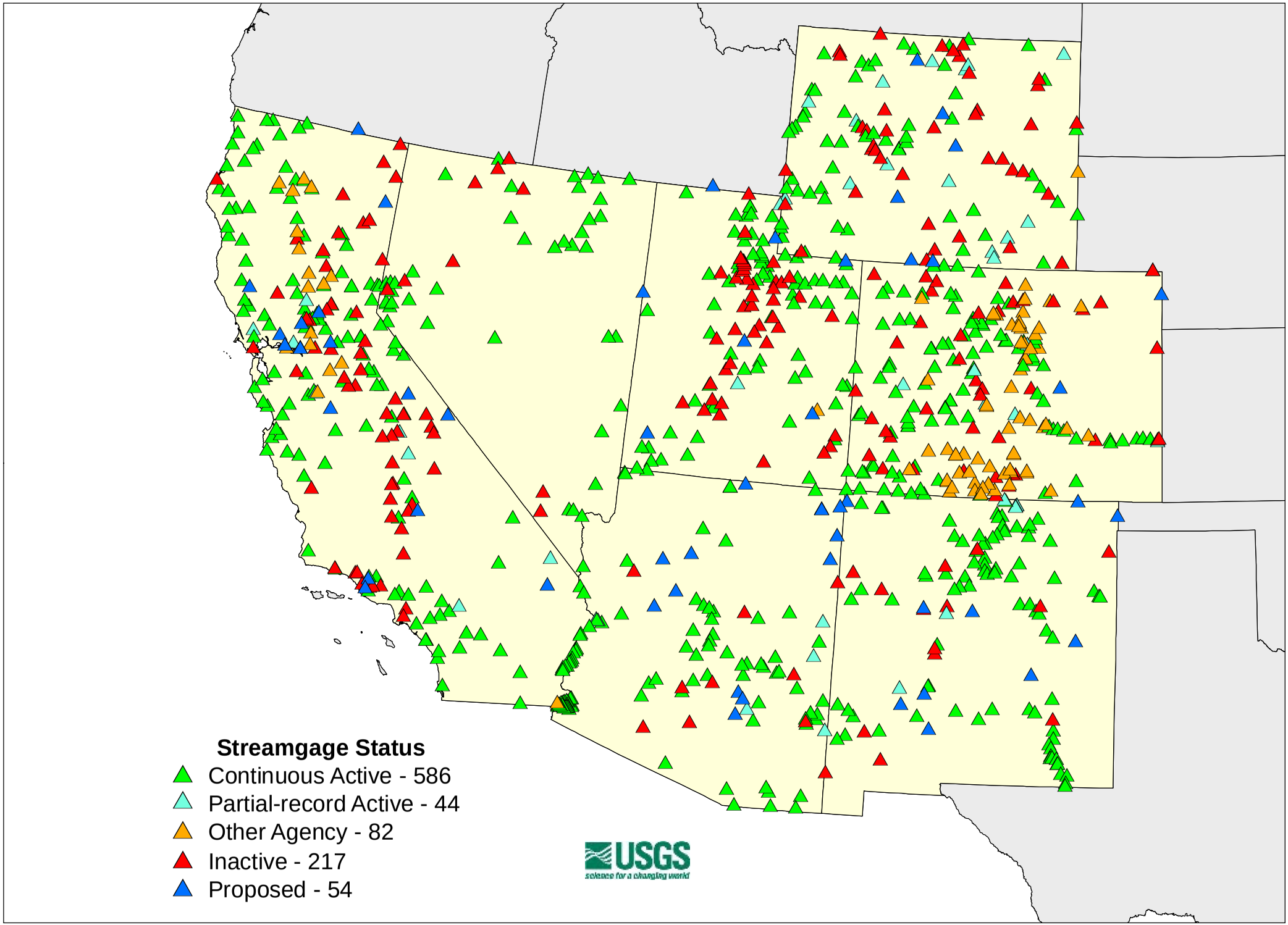
USGS Active and Discontinued Between 2000 - 2010 Streamgages



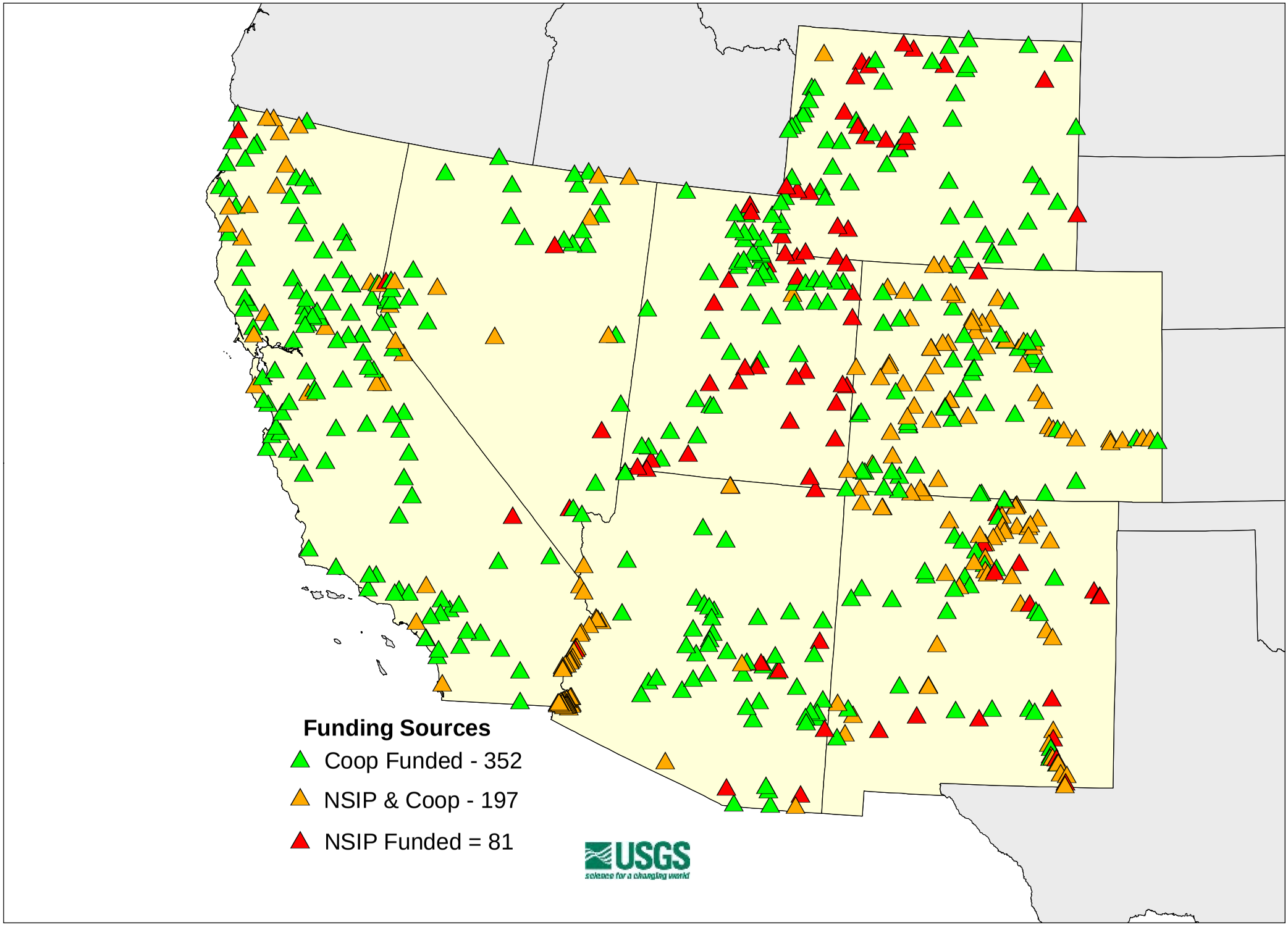
USGS Threatened and Recently Discontinued Streamgages



Status of USGS National Streamflow Information Program Streamgages in the Colorado River Basin States for 2011 - Total 983

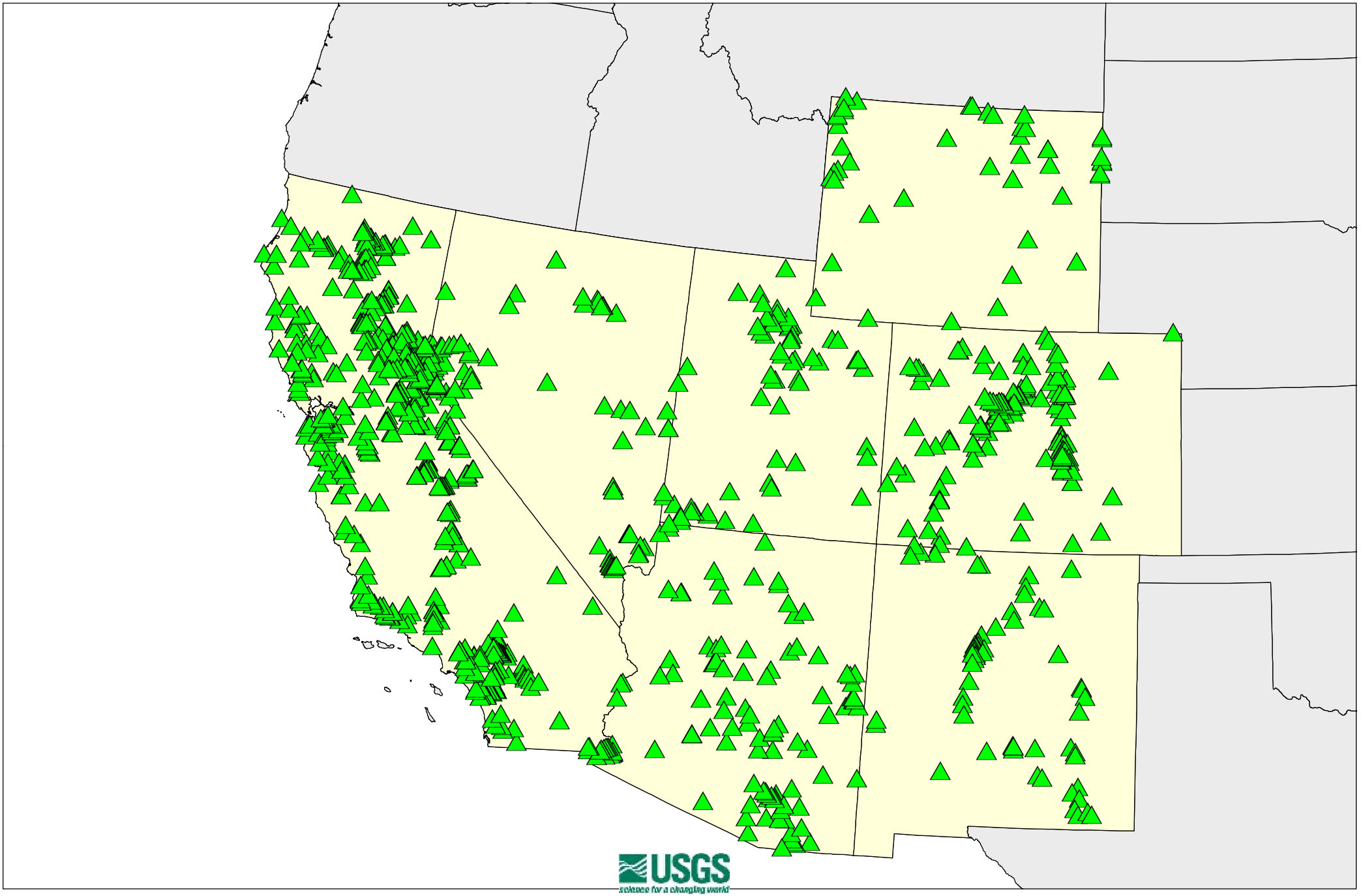


Funding Sources for Active USGS National Streamflow Information Program Streamgages in the Colorado River Basin States for 2011 - Total 630



2011 Active Streamgages in the Colorado River Basin States to Remain in the Cooperative Water Program Under Full NSIP Implementation

Total - 1105



Information Sheets

USGS –

Arizona Water Science Center
California Water Science Center
Colorado Water Science Center
New Mexico Water Science Center
Nevada Water Science Center
Utah Water Science Center
Wyoming Water Science Center

Western States Water Council Water Use Exchange

Western States Federal Agency Support Team (WestFAST)

Arizona Water Science Center

"To put it simply, the USGS is the nation's largest water, earth and biological science and civilian mapping agency.

Credibility, they've got."

—*The Daily Courier* editorial praising an important new groundwater model developed by the USGS Arizona Water Science Center, October 10, 2011

The mission of U.S. Geological Survey's (USGS) Arizona Water Science Center (AzWSC) is to collect, analyze, and disseminate the impartial hydrologic data and information needed to wisely manage water resources for the people of the United States and the State of Arizona. Reliable, impartial, and timely information allows decision makers and the public to minimize the loss of life and property resulting from water-related natural hazards, effectively manage groundwater and surface-water resources, protect and enhance water resources, and contribute to the wise physical and economic development of water resources.

The USGS has been an innovator in water science research for more than a century. Drawing on the experience of the USGS and developing new techniques, the AzWSC is noted for its expertise in the following areas:

- **Groundwater, surface-water, and water-quality monitoring and studies**
- **Geophysical investigation**
- **Groundwater modeling**

Working Cooperatively

Cooperative agreements with State and local governments and other stakeholders primarily support the work of the AzWSC, which receives additional funding from various Federal programs. AzWSC managers and scientists maintain close ties with their partners to ensure that project objectives and results are directly tied to local management needs. Federal and local cooperation is a hallmark of the USGS and AzWSC. For example, the USGS Cooperative Water Program provides Federal funding that can be matched by State, local, and Tribal agencies to develop water-resource information (http://water.usgs.gov/coop/).

As part of the USGS, the AzWSC also participates in research beyond the scope and scale of local entities but that has direct relevance to their interests. For example, a recently released study examined dissolved-solids concentrations, or salinity levels, in aquifers and streams in the Southwestern United States. The study, which was supported by the USGS National Water-Quality Assessment Program, examined a large geographic area to understand the reasons for high salinity levels in locations throughout the Southwest, including Arizona.

USGS science for a changing world — Reliable, Impartial, and Timely Information

The AzWSC is uniquely able to provide reliable, impartial, and timely scientific information about Arizona water issues because of its technical expertise and the unbiased role of USGS, which has no policy-making or regulatory responsibilities. Examples of some recent AzWSC efforts appear below.

Northern Arizona Uranium Mining Withdrawal

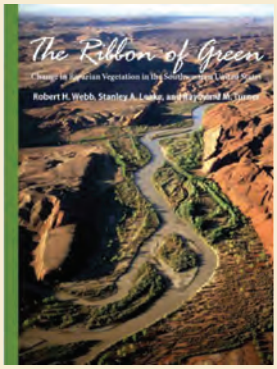
About 1 million acres of Federal land near Grand Canyon were temporarily withdrawn from new mining claims in July 2009 by the Secretary of the Interior because of concern that increased uranium mining could have negative impacts on the land, water, people, and wildlife. During a 2-year interval, a Federal team led by the Bureau of Land Management evaluated the effects of withdrawing these lands for extended periods. The AzWSC, as part of this team, conducted short-term studies to examine the potential effects of breccia-pipe uranium mining in the region. These studies provided estimates of uranium resources affected by the possible land withdrawal, examined the effects of previous breccia-pipe mining, summarized water-chemistry data for streams and springs, and investigated potential biological pathways of exposure to uranium and associated contaminants. On January 9, 2012, the Secretary signed a Record of Decision withdrawing all 1 million areas from new mining claims for the next 20 years.

Northern Arizona Regional Groundwater Flow Model

In 2011, following a multiyear development effort, the AzWSC released a model of the interconnected aquifers in central and northern Arizona that simulates how recharge from rainfall and snowmelt moves through the region's aquifers and eventually provides water to rivers, streams, and springs. The study area included the watersheds of the Verde, Salt, Little Colorado, and Colorado Rivers. Groundwater is the predominant source of water for the study area's more than 550,000 residents in Apache, Coconino, Gila, Mohave, Navajo, and Yavapai Counties. Because the model is regional, it allows decision makers to better assess how groundwater development in one area might affect flow to or from another area. In 2012, this model is at the center of discussions in the Verde River Basin about how development of groundwater resources for upstream users may affect downstream river flows, riparian ecosystems, farms, and cities, including the Phoenix metropolitan area.

San Pedro River Studies

The San Pedro River is one of the few remaining perennial rivers without dams in southeastern Arizona. Ecologically, the river serves as an important flyway and provides habitat for migratory birds and animals, including endangered species. In recognition of the San Pedro River's importance, Congress designated it as the first Riparian National Conservation Area on November 18, 1988. The Upper San Pedro Partnership is working to design a plan for the watershed that will ensure that a long-term water supply is available to meet the social and economic needs of area residents and preserve the riparian ecosystem. The AzWSC, a member of the Partnership, conducted a series of hydrologic studies designed to more clearly identify the linkages between groundwater and surface water in the basin. In 2008, the Upper San Pedro Partnership received the prestigious Cooperative Conservation Award from the Department of the Interior. The Partnership has demonstrated that working together, pooling available resources, and using the best available scientific information will ultimately lead to achievable, effective long-term solutions.



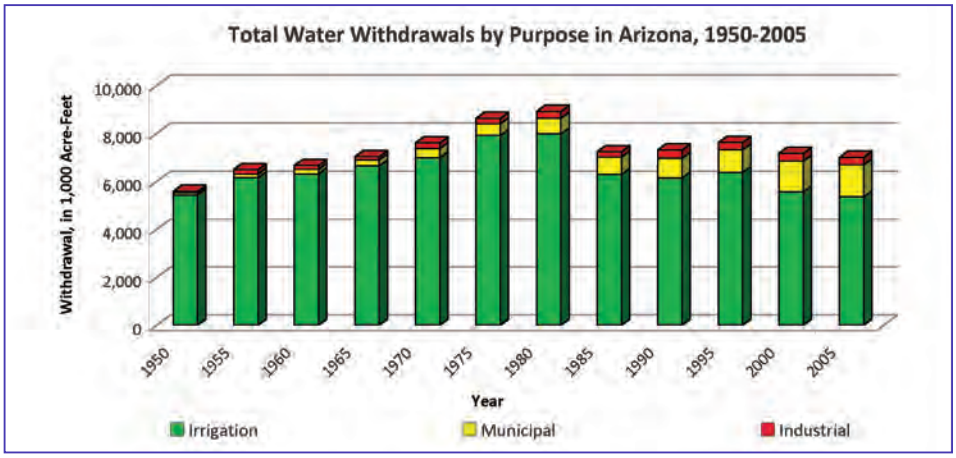
2007 Southwest Book of the Year

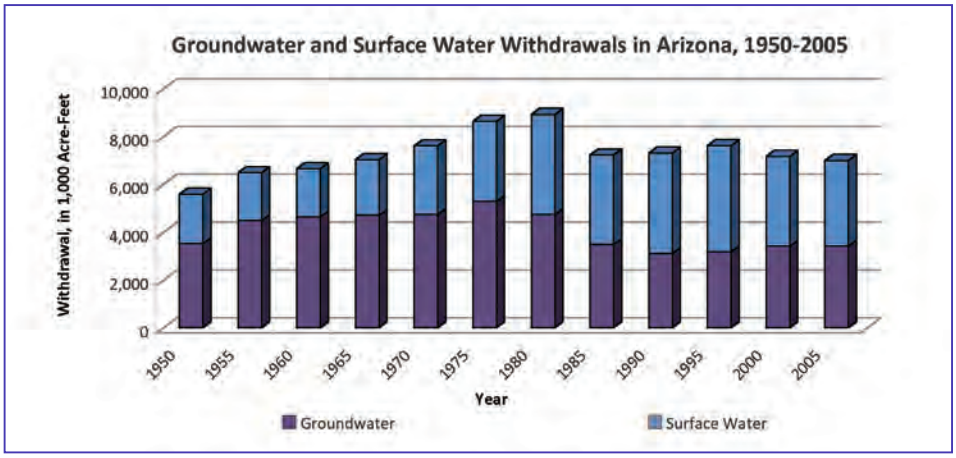
The Ribbon of Green examines the factors that affect the stability of woody riparian vegetation, one of the largest components of riparian areas. Although relatively small, riparian areas are critical components of Southwest landscapes.

***"The Ribbon of Green** will influence common perceptions of change in riparian ecosystems and how riparian restoration is practiced in the Southwest."* —Biology Digest

Arizona Water Use

Since 1950, the AzWSC has estimated water use by county at 5-year intervals, publishing the results in a series of reports since 1981. Water demand is met by pumping groundwater from aquifers or by conveying surface water to users through a system of reservoirs and canals. Because of the importance of water to Arizona's communities and future economic development, the AzWSC works cooperatively with the Arizona Department of Water Resources to collect data and estimate withdrawals annually. Withdrawals are estimated for five categories of use: irrigation, municipal, mining, drainage, and thermoelectric power. On the basis of the most recent published estimates in 2005, withdrawals are dominated by agriculture (76 percent) and municipal (19 percent) uses. For more information about Arizona water use, please visit http://az.water.usgs.gov/projects/9671-9DW/.





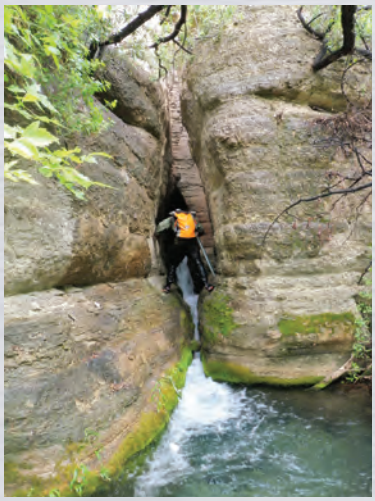
Tribal Programs

The AzWSC works cooperatively on water-resource issues with 10 of Arizona's 19 Federally recognized Native American Tribes (table 1). The water issues facing these Tribes range from drinking water availability and access to sustainability and water rights. Much of the work undertaken by the AzWSC through its Tribal programs focuses on activities that provide Tribal governments with the information they need to manage the resource. For example, the AzWSC currently operates 20 streamflow or springflow gages on or near Tribal lands. The AzWSC also operates two flood-alert gages on Havasu Creek upstream from the Havasupai village of Supai, which is in Grand Canyon and experienced severe flooding in 2008.

Table 1. Arizona Tribes working cooperatively with the USGS Arizona Water Science Center and the purpose of the various Tribal programs.

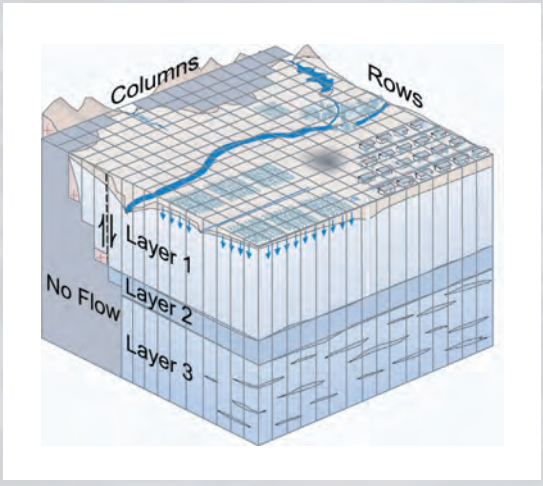
Tribe	Purpose of program
Havasupai Tribe	Springflow monitoring
Hopi Tribe	Streamflow monitoring and special groundwater studies
Hualapai Tribe	Streamflow and springflow monitoring
Kaibab Band of the Paiute	Groundwater monitoring
Navajo Nation	Technical assistance relating to streamflow gaging and records computation
Pueblo of Zuni	Streamflow and sediment-discharge monitoring
San Carlos Apache	Provide reviews of groundwater quantity and quality data related to surface mining
Tohono O'odham Nation	Streamflow monitoring
Yavapai-Prescott Tribe	Streamflow monitoring
White Mountain Apache Tribe	Streamflow flood warning and technical assistance

Groundwater Science Capabilities



The AzWSC has been collecting groundwater data in Arizona for several decades and maintains a publicly accessible database for water-level data for several thousand sites. With the data it collects and maintains, the AzWSC is able to produce groundwater models that assess future effects of groundwater development in the complex aquifers of Arizona. The following is a partial list of AzWSC groundwater science capabilities:

- **Aquifer Depth and Extent Studies**
- **Groundwater Availability Studies**
- **Groundwater/Surface-Water Relations Studies**
- **Land-Surface Subsidence Studies**
- **Aquifer Recharge and Storage Monitoring**
- **Real-Time Groundwater Level Monitoring**
- **Existing and New Well Inventories**
- **Basin-Scale & Regional Groundwater-Flow Models**
- **Aquifer Contaminant Transport**
- **Management-Optimization Simulations**
- **3-Dimensional Hydrogeological Model Development**



Water-Quality Science Capabilities

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The USGS has been collecting water-quality data in Arizona for several decades. The AzWSC maintains a database containing water-quality data for several thousand sites. These data are provided to local, State, Tribal, and Federal governments that use them to evaluate water chemistry, contaminant levels, groundwater age and movement, and spatial and temporal trends of water quality. The following is a partial list of AzWSC water-quality science capabilities:

Water-Quality Analysis at Parts-Per-Billion Levels

Emerging Contaminant Studies

Isotopic Analyses of Water

Biological and Microbiological Sampling

Sediment, Soil, and Core Chemical Analysis

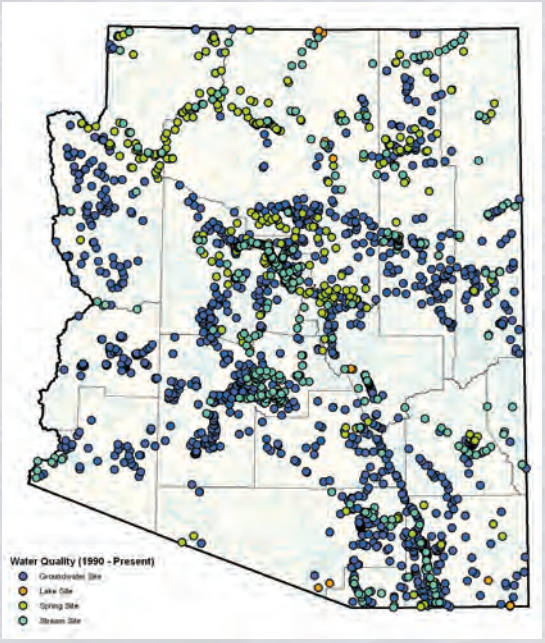
Point, Continuous, and Passive Sampling (including real-time monitoring)

Water Well Sampling and Monitoring

Remote Location Sampling

Data Interpretation Expertise:

- **Characterization of groundwater and surface-water chemistry**
- **Age dating and isotopic studies**
- **Assessment of source, distribution, and movement of contaminants**
- **Spatial and temporal trends in water quality**



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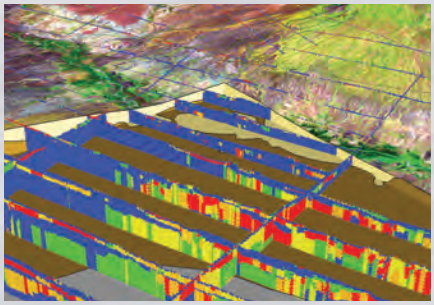
Geophysical Science Capabilities



The AzWSC has specialized expertise in land-surface and borehole geophysical survey methods used to characterize local hydrologic conditions, including monitoring groundwater storage and aquifer mapping. The USGS owns a wide variety of land-surface based and borehole geophysical equipment. The following is a partial list of AzWSC geophysical surveying capabilities:

Land-Surface Methods

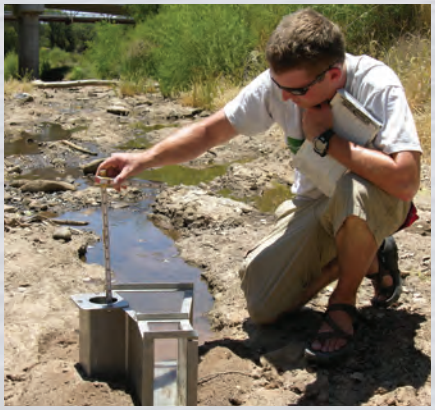
- Frequency-Domain Electromagnetic Methods
- Time-Domain Electromagnetic Methods
- Electrical Resistivity Methods
  - Detailed Shallow Surveys
  - Azimuthal Surveys for Fracture Mapping
- Gravity Methods
  - Absolute and Relative Gravimetry
  - Depth to Bedrock Mapping
  - Repeat Microgravity Surveys
    - Groundwater Storage Monitoring
    - Estimates of Aquifer Storage Properties
- Seismic Refraction Methods
- Ground Penetrating Radar

Borehole Methods

- Caliper
- Electromagnetic Flow Meter
- Electromagnetic Induction
- Natural Gamma Radiation
- Fluid Resistivity
- Temperature
- Magnetic Susceptibility
- Borehole Deviation

Surface-Water Science Capabilities

The AzWSC maintains a system of 217 streamflow gages in Arizona, providing data and producing information about hazard, stream, and water-supply conditions. The primary clients of this data and information are local, State, Federal, and Tribal governments. The public can also access these data, including real-time streamflow alerts, and reports through the USGS Web site. The following is a partial list of AzWSC surface-water monitoring capabilities:



- **Flood Warning Alert Networks (including areas affected by wildfires)**
- **Precipitation Gages**
- **Real-Time Stream Gages**
- **Flood-Frequency Estimation & Relations Analysis**
- **Innovative Methods Development**
- **Suspended-Sediment Measurements**
- **Ecological Flow Studies**
- **Hydraulic and Sediment-Transport Modeling**

Training Future Scientists

Since 1997, the AzWSC has been headquartered on the campus of The University of Arizona in Tucson. This arrangement has provided benefits to both the university community and the USGS. For example, the AzWSC has provided internships to more than 150 students, many of whom have gone on to join the USGS, government water resource agencies, or consulting firms. Through these internships, students gain real-world experience working on a wide-range of projects with practicing scientists. Students also acquire field experience and develop technical writing skills. The benefits that the USGS realizes from this collaboration include the following:

- **Increased Effectiveness and Cost Efficiencies**
- **Access to Scientific Expertise through Collaborations with Faculty**
- **Top-Quality, Long-Term Employees**

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USGS
science for a changing world

Science for Stewardship of California's Water Resources

CALIFORNIA WATER SCIENCE CENTER

The USGS California Water Science Center brings many capabilities and tools to the understanding, management, and protection of California's water and other natural resources. The Center's approximately 200 scientists and technicians are leaders in:

- **Conducting long-term monitoring of streamflow and water quality.**
- **Developing new sampling, analytical, and interpretive methods to assess groundwater quality.**
- **Studying the geology of groundwater systems to help managers protect and optimize supplies.**
- **Devising new computer models that can play a key role in everything from managing surface-water and groundwater supplies to assessing the impact of climate change on individual watersheds.**
- **Conducting multi-disciplinary ecosystem and watershed research, including large-scale studies in the Sacramento-San Joaquin River Delta and San Francisco Bay.**

The U.S. Geological Survey (USGS) is the primary Federal agency responsible for scientific evaluation of the natural resources of the United States, including its water. To meet the demands of a growing California, the U.S. Geological Survey's California Water Science Center provides essential science to help Federal, State, and local water agencies evaluate and manage California's critical water resources; adapt to a changing climate; assess, predict, and mitigate natural hazards, such as mudslides and debris flows; and protect the health of rivers, forests, wetlands, and other habitats.

The following are some of the ways the USGS is working with other agencies to protect California's water resources and assure that Californians have safe and reliable water supplies for now and in the future.

Keeping Watch on Groundwater Quality

Groundwater provides more than 40 percent of California's drinking water. To protect this vital resource, the State of California created the Groundwater Ambient Monitoring and Assessment (GAMA) Program. Under GAMA, the USGS is working with the State Water Resources Control Board to monitor and assess water quality in groundwater basins that are used for public supply. With the cooperation of local water agencies and well owners, the USGS is testing groundwater quality in those basins over a 10-year period. (http://ca.water.usgs.gov/gama/)

Meg Hurst prepares water-quality samples in a mobile laboratory.

Helping Agencies Manage and Protect Groundwater

USGS scientists are helping local water agencies throughout California better understand, manage, protect, and maximize the effective use of groundwater basins. Scientists are conducting water-quality assessments, developing groundwater computer models that simulate a variety of scenarios, and devising new strategies for replenishing groundwater basins and using them in conjunction with surface-water supplies. For instance, USGS scientists, working with the city of Victorville and the Mojave Water Agency, have found innovative new ways to recharge water through 400 feet of dry earth in California's Mojave Desert. Research could help the agencies use groundwater basins that were previously thought to be unavailable for municipal water storage. (http://ca.water.usgs.gov/news/release-March13_2008.html)

USGS geologist David O'Leary measures the depth to the water table at a pilot-study recharge pond near Yucca Valley.

Maintaining a Long-Term Stream Monitoring Network

The USGS, in cooperation with State, local and Tribal agencies, operates more than 500 stream gages in California for monitoring of streamflow and water quality. This statewide network is part of a nationwide program that provides streamflow

information for a variety of purposes, including drought and flood monitoring. It also provides long-term data to detect changes in streamflow caused by human activities or climate change. USGS streamflow gaging stations equipped with real-time telemetry are integral components of reservoir operations and river-forecast and flood-warning systems. Real-time streamflow information is available online at http://waterdata.usgs.gov/nwis/rt.

Understanding the California Delta

The Sacramento-San Joaquin River Delta is the hub of California's water system and also an imperiled habitat for fish and other wildlife. The USGS California Water Science Center is working with several Federal, State, and local agencies to develop the science for addressing a number of Delta issues. These issues range from fish migration and water flow to pesticides, water quality, and land-surface subsidence. In one of the largest projects, USGS scientists are conducting a high-tech study in cooperation with the California Department of Water Resources to gather data on route selection and survival of juvenile salmon as they make their way through the Delta to the ocean. This research involves many scientific disciplines and the use of emerging technologies in fisheries science and hydrodynamic measurement, including a remote-controlled boat (below) that gathers data on river flows (http://ca.water.usgs.gov/news/ReleaseNov14_2008.pdf).

Scientists release tagged juvenile salmon into the California Delta. A remote-controlled boat gathers stream data.

Planning for Climate Change

A changing climate will have profound and wide-ranging impacts across California. Water and environmental-resource managers need new scientific tools that will help them predict how a changing climate will affect local watersheds, groundwater basins, forests, and wetlands. USGS scientists are developing those tools. Using their knowledge of hydrology and physical processes, scientists are able to create a link between future climate scenarios and what may happen to ecosystems and water supplies.

The USGS is also developing a pilot project to potentially reverse, or minimize, one of the causes of global warming – the emission of greenhouse gases to the atmosphere. The project might also help save one of California's most-imperiled landscapes – the Sacramento-San Joaquin River Delta. Throughout the Delta, oxidation of the soils from farming practices has resulted in a steady loss of land-surface elevation. As a result, most of the farmed Delta islands – such as Twitchell Island, above – are more than 20 feet below the surrounding waterways and must be permanently protected by levees. The USGS, working with the California Department of Water Resources and the University of California, is conducting research on a new type of farming that traps atmospheric carbon dioxide and rebuilds lost soils (http://ca.water.usgs.gov/news/Release-July23_2008.html).

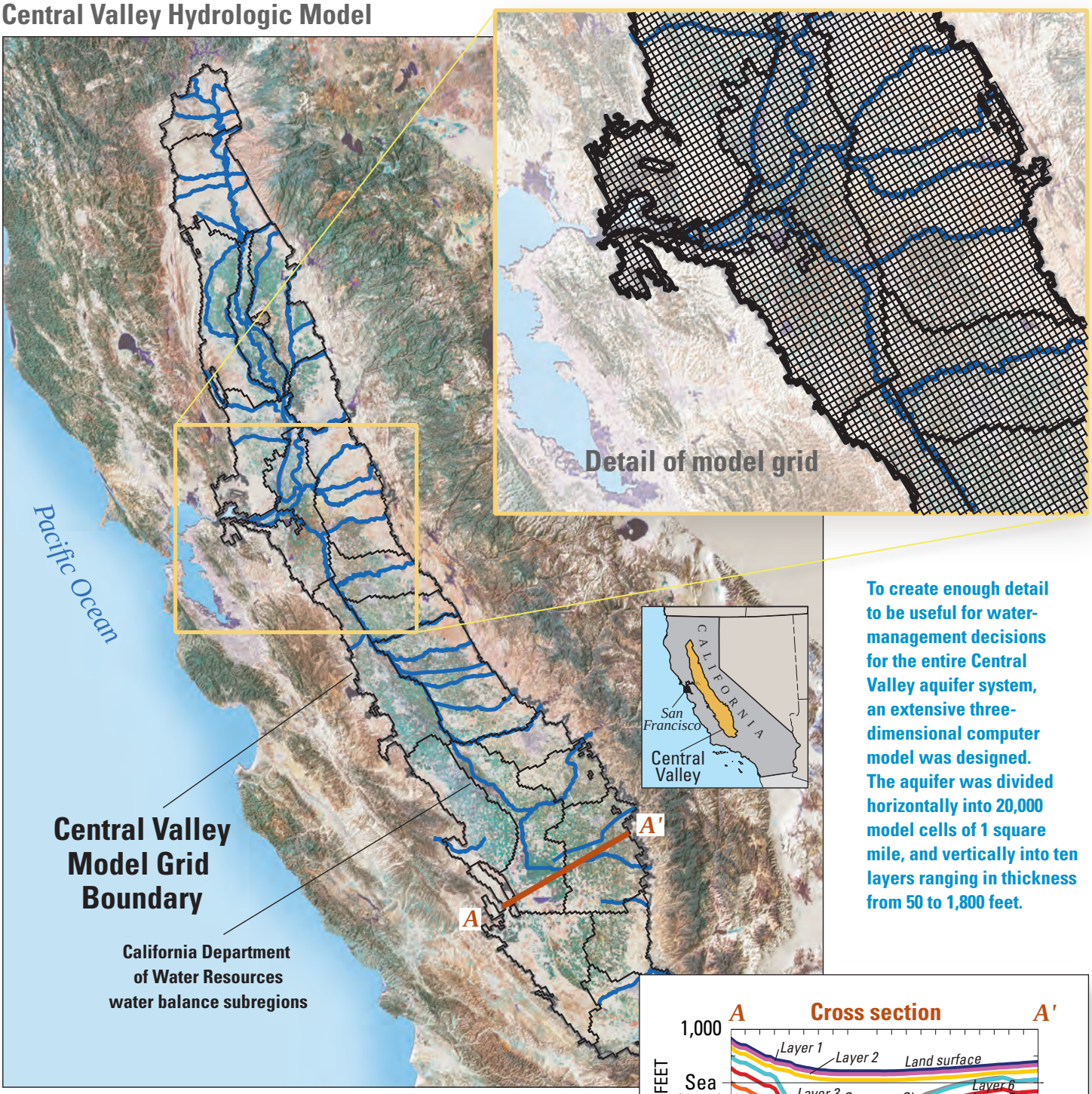
A test "carbon-capture" farm shows promise for making Delta islands less vulnerable to flooding.

Assessing Groundwater Availability in the Central Valley

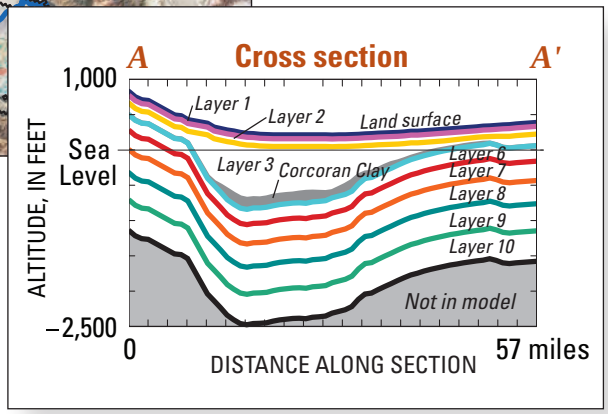
Managing the Central Valley's vast aquifer system – California's biggest water reservoir – is an increasingly complex endeavor that is critical to the water supply of the entire State. The USGS has created a new water-modeling tool, the Central Valley Hydrologic Model, to help local water managers assess, understand, and address the myriad of issues affecting Central Valley groundwater supplies. The model could be used by managers to:

- Effectively manage the interdependent use of surface water and groundwater.
- Conserve farmland.
- Assess the effect of land-use changes on water resources.
- Assess the effects of climate change on groundwater supplies.

Central Valley Hydrologic Model



To create enough detail to be useful for water-management decisions for the entire Central Valley aquifer system, an extensive three-dimensional computer model was designed. The aquifer was divided horizontally into 20,000 model cells of 1 square mile, and vertically into ten layers ranging in thickness from 50 to 1,800 feet.



This new tool simultaneously accounts for changing water supply and demand. It simulates irrigated agriculture and surface-water and groundwater flow across the entire Central Valley hydrologic system. The detail and breadth of this hydrologic model makes it invaluable to water-resource managers faced with increasing water-management challenges and constraints.

Real-Time Monitoring of Hydrologic Hazards

The USGS California Water Science Center has installed a network of webcams across California in conjunction with its stream gages. Several of the webcams are in watersheds in Santa Barbara, Ventura, Orange, Los Angeles, and San Diego Counties that, because of recent fires, are at high risk of flooding or debris flows during heavy rainfall. The webcams provide visual data to the National Weather Service, first-responders, and area residents of real-time conditions in creek channels. The webcams, which can be viewed and operated remotely by the public, can be accessed at http://ca.water.usgs.gov/webcams/.

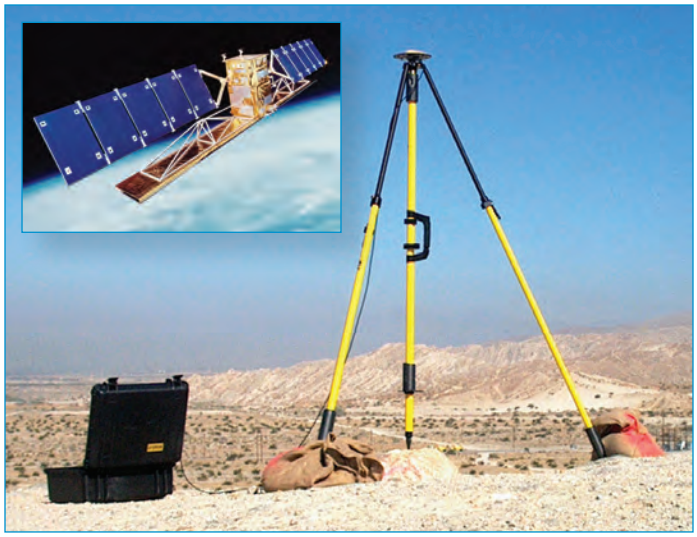
Assessing the Fate and Transport of Pesticides

The USGS Pesticide Fate Research project is a series of studies that assess the occurrence, transport, and fate of current-use pesticides in water throughout California, including the San Francisco Bay watershed, the Salton Sea, and central California coastal rivers. Working with toxicologists and ecologists, USGS scientists are focusing on the potential effects of compounds on aquatic organisms and human health. Scientists have developed analytical methods for measuring pesticide concentrations in water, sediments, and biological tissues at environmentally relevant levels. They are conducting field studies to track when and where these pesticides occur in waterways. Complementary laboratory studies are also under way to understand the factors controlling the breakdown rates of pesticides in the environment. (http://ca.water.usgs.gov/user_projects/toxics/)

USGS researcher Kelly Smalling gathers fish-tissue samples for a pesticide study on California's Central Coast.

Measuring Land Subsidence

The USGS is studying land subsidence in several regions, including the Coachella Valley in Southern California. Since the 1920s, groundwater has been a major source of agricultural, municipal, and domestic supply in the valley. Overpumping has caused underground water tables to drop as much as 100 feet. That has led to declining land-surface elevations, known as subsidence, which can disrupt surface drainage; reduce aquifer storage; cause earth fissures; and damage wells, buildings, roads and utility infrastructure. The USGS and the Coachella Valley Water District launched the research in 1996. USGS scientists are using Global Positioning System (GPS) surveying and a satellite mapping process known as Interferometric Synthetic Aperture Radar (InSAR) to document the drops in elevation. The data collected are helping the Coachella Valley Water District develop new water-conservation and management initiatives to eliminate overpumping. (http://ca.water.usgs.gov/news/release071217.html)



The USGS uses a Global Positioning System (GPS) to measure changes in the position of Earth's surface (subsidence) over time at 20 bench marks in the Coachella Valley.

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For more information on the California Water Science Center, visit our Web site at **http://ca.water.usgs.gov/** or call the **Sacramento Project Office at (916) 278-3000** or the **San Diego Project Office at (619) 225-6100.**

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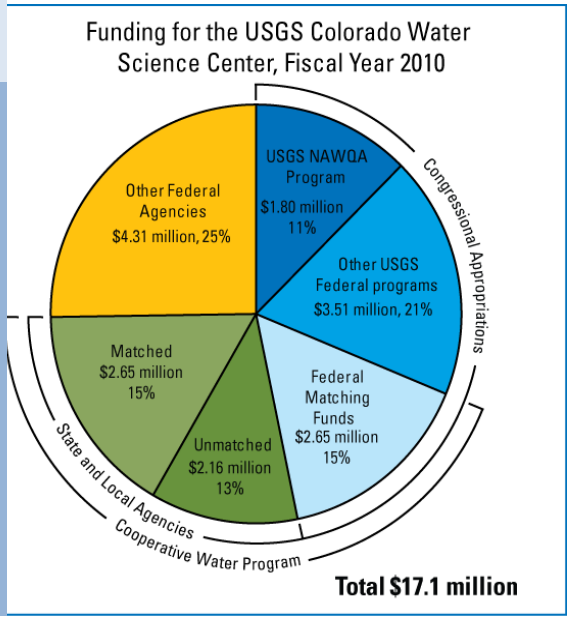
CALIFORNIA WATER SCIENCE CENTER

The U.S. Geological Survey Water Program in Colorado

Founded in 1879, the USGS today:

- Conducts monitoring, assessments, interpretive investigations, and research to inform the understanding of our Nation's natural resources.
- Provide reliable, impartial information in the form of data, maps, and reports – all increasingly available on the Internet.
- Produces information products used by managers, planners, and citizens to understand, manage, and use the Nation's water, energy, minerals, and biological resources.

The USGS proves to others the scientific basis for decision making.
The USGS has no direct resource-management role.



Water Resources Programs in Colorado

The U.S. Geological Survey (USGS) conducts water-resources activities in Colorado with more than 130 Federal, State, and local funding partners. These activities include data-collection and investigative studies to meet water-science data and research needs in Colorado (*http://co.water.usgs.gov/*). The USGS operates statewide data-collection networks for streamflow, water quality, and groundwater levels. In 2011, the USGS also is conducting more than 60 studies that are helping to address many specific issues of concern to Colorado water-management entities and citizens. Among these issues are:

- Sustainability of adequate good-quality water supplies for agricultural, municipal, and industrial uses.
- Environmental hazards – drought, wildfire, and floods.
- Remediation of water-quality effects from mining and waste disposal.
- Effects of human activities on pristine, high-elevation environments.
- Effects of energy development and urbanization on surface-water, groundwater, and biological

Program Highlights

- Operation of nearly 300 stream gages to support flood and drought management needs, water-rights administration, and water-project planning and operation requirements.
- Long-term collection of stream water-quality data at more than 175 sites.
- Analysis of groundwater availability and quality in the Denver Basin aquifer system with an emphasis on changes in aquifer storage, water levels, and streamflow depletion.
- Assessments of water quality in streams and aquifers in the South Platte, Rio Grande, and Upper Colorado River basins and the High Plains aquifer, emphasizing improved understanding of water-quality trends and the effects of human activities on water quality (National Water Quality Assessment (NAWQA) projects).
- Sampling and analysis of snowpack in the Rocky Mountains to evaluate regional atmospheric deposition of chemical constituents.
- Studies of snowmelt timing and peak streamflow in response to climate variability and change.
- Technical assistance to FEMA, USDA Forest Service, State, and local agencies to rapidly identify flood and debris-flow hazards and changes in streamflow and water quality following wildfires.

For additional information, please contact Jim Kircher, CWSC Director at 303.236.6900 or *jkircher@usgs.gov*

FEDERAL, STATE, AND LOCAL AGENCIES THAT SUPPORT USGS WATER PROGRAMS IN COLORADO

FEDERAL AGENCIES
Bureau of Land Management — Colorado State Office
Bureau of Reclamation — Upper Colorado Region
Federal Emergency Management Agency
Fort Carson
National Park Service
U.S. Army Corps of Engineers
U.S. Forest Service
U.S. Department of Energy Argonne National Laboratory
U.S. Environmental Protection Agency

STATE AGENCIES
Colorado Department of Public Health and Environment
Colorado Division of Parks and Outdoor Recreation
Colorado Water Conservation Board
State Engineer of Wyoming

WATER CONSERVANCY/CONSERVATION DISTRICTS
Colorado River Water Conservation Board
Lower Arkansas Valley Water Conservancy District
Northern Colorado Water Conservancy District
Southeastern Colorado Water Conservancy District
Southwestern Water Conservation District
Teton Conservation District
Upper Gunnison River Water Conservancy District
Upper Yampa Water Conservancy District
Yellow Jacket Water Conservancy District

COUNTIES
Clear Creek County
Delta County
Douglas County
Eagle County
El Paso County
Garfield County
Hinsdale County
Jefferson County
La Plata County
Mesa County
Pitkin County
Pueblo County
Rio Blanco County
San Juan County
San Miguel County

CITIES
City of Aurora
City of Black Hawk
City of Boulder
City of Brighton
City of Brush
City of Colorado Springs
City of Craig
City of Fort Lupton

CITIES – continued
City of Fort Morgan
City of Fountain
City of Fort Collins
City of Glendale
City of Golden
City of Gunnison
City of Idaho Springs
City of Lakewood
City of Longmont
City of Loveland
City of Pueblo
City of Westminster

TOWNS
Town of Breckenridge
Town of Collbran
Town of Crested Butte
Town of Georgetown
Town of Hotchkiss
Town of Meeker
Town of Monument
Town of Paonia
Town of Rangely
Town of Rico
Town of Telluride

OTHER LOCAL ENTITIES
Arapahoe County Water and Wastewater Authority
Arkansas River Compact Administration
Centennial Water & Sanitation District
Crested Butte South Metro District
Denver Water
Eagle River Water & Sanitation District
East Grand County Water Quality Board
Evergreen Metropolitan District
Lost Creek Groundwater Management District
Meeker Sanitation District
Metro Wastewater Reclamation District
Mt. Crested Butte Water & Sanitation District
North Front Range Water Quality Planning Association
Plum Creek Wastewater Authority
Pueblo Board of Water Works
Security Water District
Southern Ute Indian Tribe
St. Charles Mesa Water District
Stratmoor Hills Water District
Summit Water Quality Committee
Upper Eagle Regional Water Authority
Urban Drainage & Flood Control District
Western State College
Widefield Water & Sanitation District

USGS-Colorado Water Science Center Contacts

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David Brown	Western Colorado Office Chief	970.245.5257X14	*dsbrown@usgs.gov*

http://co.water.usgs.gov/

The USGS is a science organization that provides impartial information on the health of our ecosystems and environment, the natural hazards that threaten us, the natural resources we rely on, and the effects of climate and land-use change. As the Nation's largest water, earth, and biological science and civilian mapping agency, a diversity of scientific expertise enables the USGS to carry out large-scale, multi-disciplinary investigations and provide impartial scientific information to resource managers, planners, and other customers. The USGS Colorado Water Science Center works with over 130 Federal, State, and local funding partners to meet water-science research needs and data in Colorado.

Science Topics within the Colorado Water Science Center

Surface-Water Science
Real-Time Stream Gages
Acoustic Discharge Measurements
Peak Discharge - Indirect Measurements
Precipitation Gages and Flood-Warning Networks
Evaporation and Evapotranspiration Studies
Basin Characteristics
Gain-Loss Investigations
Precipitation Runoff Modeling
Streamflow and Flood Inundation Modeling

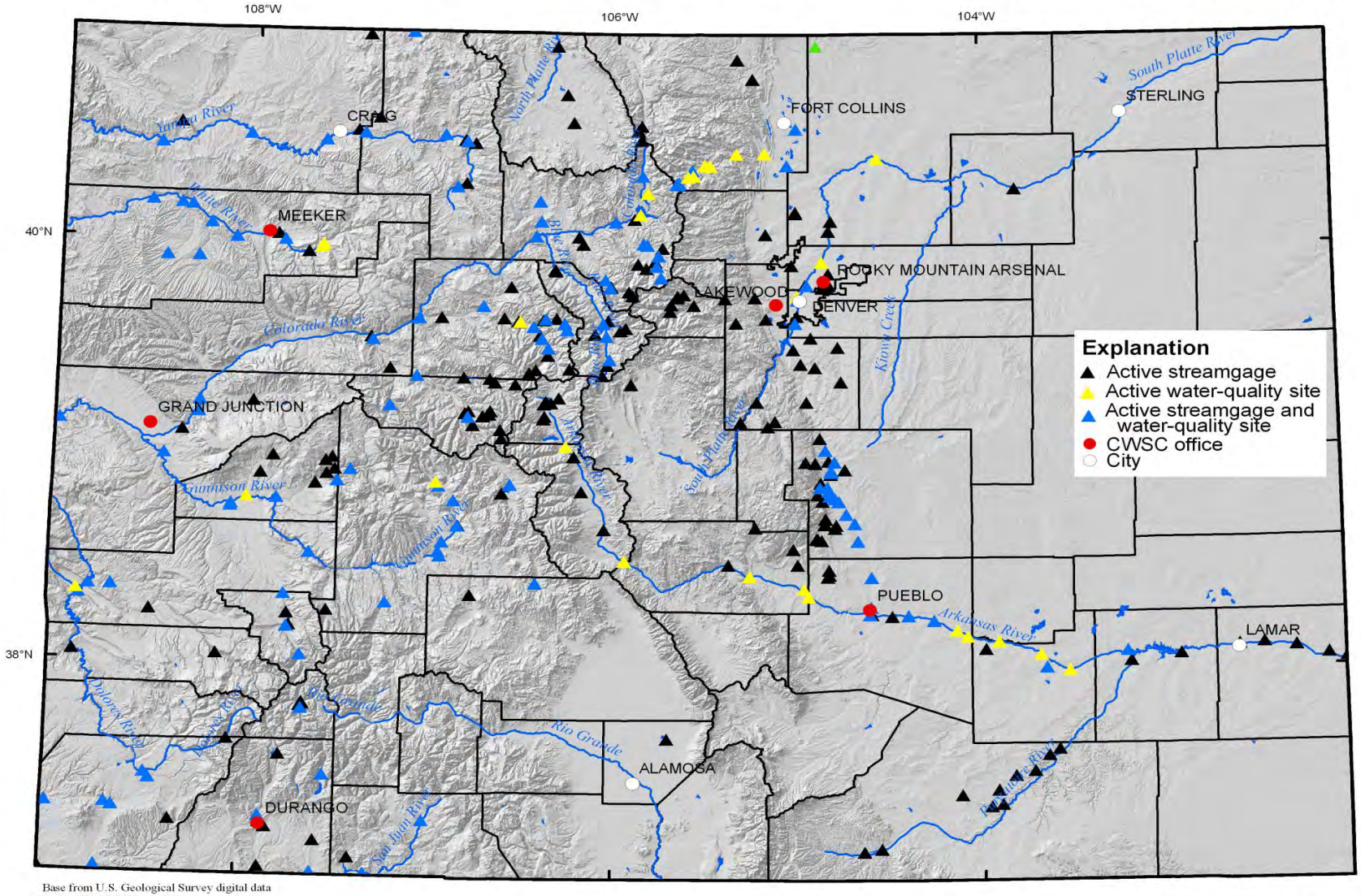
Water-Quality Science
Long-Term Water-Quality Monitoring:
  Total Maximum Daily Load (TMDL) Assessments
  Trends Analysis
Real-Time Monitoring of Surface Water, Groundwater,
  Lakes, and Reservoirs
Stormwater Monitoring
Microbiological Studies
Regression Analysis to Estimate Constituent
  Concentrations and Loads
Emerging Contaminant and Isotopic Analysis
Geospatial Database Development
National Water Information System (NWISWeb)

Biological Science
Fish, Benthic Invertebrate, and Algal Community Surveys
Stream-Habitat Assessment
Microbial Source Tracking
Reservoir-Plankton Dynamics
Aquatic Biota Response to Nutrients and Metals in Streams
Environmental Flows Assessments

Groundwater Science
Aquifer Characterization
Availability and Use
Real-time Groundwater-Level and –Quality Monitoring
Groundwater Flow Modeling
Solute Transport Modeling
Groundwater/Surface-Water Interaction
Monitoring Network Design
Permafrost/Frozen Groundwater Modeling
Age Dating and Isotopic Tracer Studies
Borehole and Surficial Geophysical Methods

Sediment Science
Debris-Flow Modeling
Suspended Sediments in Streams
  Sources and Contaminant Inputs
  Loads and Yields
  Relations between Streamflow and Sediment Transport
  Suspended Sediment Modeling
Streambed Sediments
Lake/Reservoir Bottom Sediments:
  Age Dating and Sedimentation Rates
  Reconstruction of Water-Quality Trends
Bathymetric Surveys

U.S. Geological Survey Streamgages and Water-Quality Sites in Colorado



Base from U.S. Geological Survey digital data
NAD 1983 UTM Zone 13N

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April 2011

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MISSION: To provide reliable, unbiased, and timely information that is needed to understand the Nation's water resources.

The Water Resources Program of USGS actively promotes the use of this information by decision makers to

- Minimize the loss of life and property as a result of water-related natural hazards, such as floods, droughts, and land movement
- Effectively manage groundwater and surface-water resources for domestic, agriculture, commercial, commercial, industrial, recreational, and ecological uses
- Protect and enhance water resources for human health, aquatic health, and environmental quality
- Contribute to wise physical and economic development of the Nation's resources for the benefit of present and future generations

U.S. Geological Survey National Water-Quality Laboratory

Water-Quality Science

Geochemical Characterization and Modeling
Age-Dating of Water
Emerging Contaminant Studies

Long-term Monitoring:
Total Maximum Daily Load (TMDL) Assessments
Trends Analysis

Geospatial Database Development
Isotopic Analyses of Water
Microbiological Studies

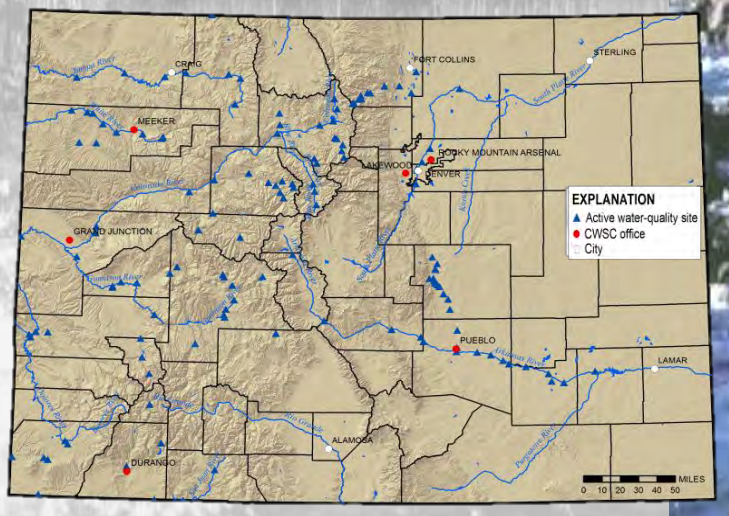
Real-Time Monitoring:
Groundwater, Surface Water, Lakes and Reservoirs

Regression Analysis and Real-Time Monitoring to Estimate Constituent Concentrations and Loads

Water –Quality Analysis at Part-Per-Billion Levels

National Water Information System (NWISWeb) Data Available Within 24 Hours of Receipt from Laboratory

Stormwater Monitoring



U.S. Geological Survey Water-Quality Sites in Colorado

Groundwater-Age Sampling

Equal Width Increment Surface-Water Sampling

The U.S. Geological Survey has been collecting water-quality data in Colorado since 1900. Today (2012) the Colorado Water Science Center database contains more than 18,828 sites with discrete water-quality data. In water year 2010, more than 6.850 water-quality samples were collected in Colorado. U.S. Geological Survey National Water System (NWISWeb) data are available on the World Wide Web, at URL://nwis.waterdata.usga.gov/co/nwis/qwdata

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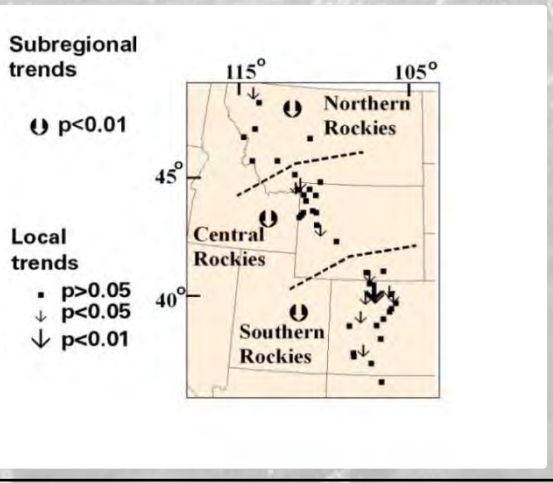
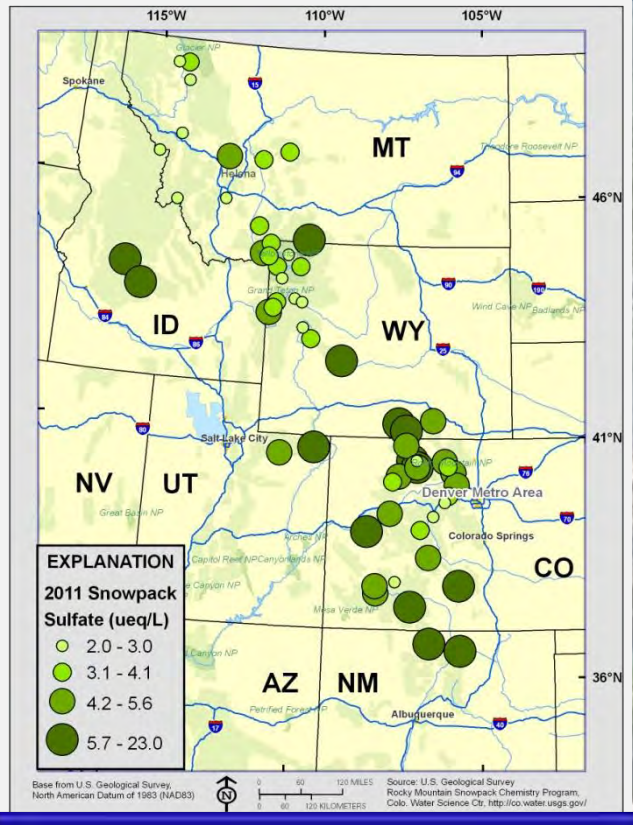
Rocky Mountain Snowpack Chemistry Program

- Cooperative partnership with the USDA Forest Service, National Park Service, Colorado Department of Public Health and Environment, Teton County Wyoming, and other organizations.
- Annual snow samples collected since 1993 to monitor long-term atmospheric deposition trends of mercury, nitrogen, sulfur, and others.
- Regional monitoring of network extending from Montana to New Mexico.
- Data available at program web site: http://co.water.usgs.gov/projects/RM_snowpack/ and at the USGS National Water Information System (NWISWeb) at:nwis.waterdata.usga.gov/co/nwis/qwdata.





Sulfate concentrations measured at 63 snowpack sites in the network

Annual snow samples capture wet- and dry deposition in a single sample

Worker in sampling snowpit points out deposition layers

Long-term (1993-2009) trends in sulfate concentrations—generally downward. P-values indicate statistical significance.

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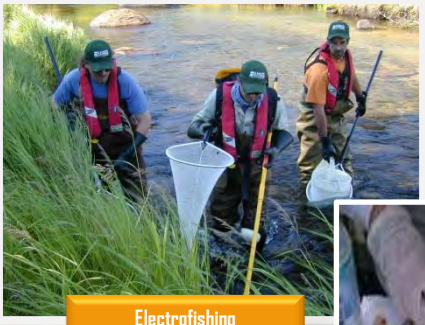
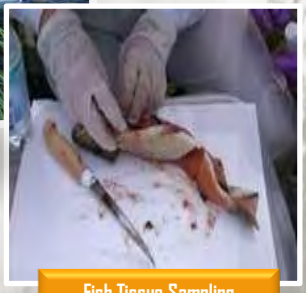


Electrofishing



Fish Tissue Sampling

Biological Science

Fish, Aquatic Invertebrate, and Algal Community Assessment

Contaminant Pathways in Aquatic-Terrestrial Ecosystems

Microbial Source Tracking

Stream Habitat Surveys

Biotic Response to Nutrients in Streams

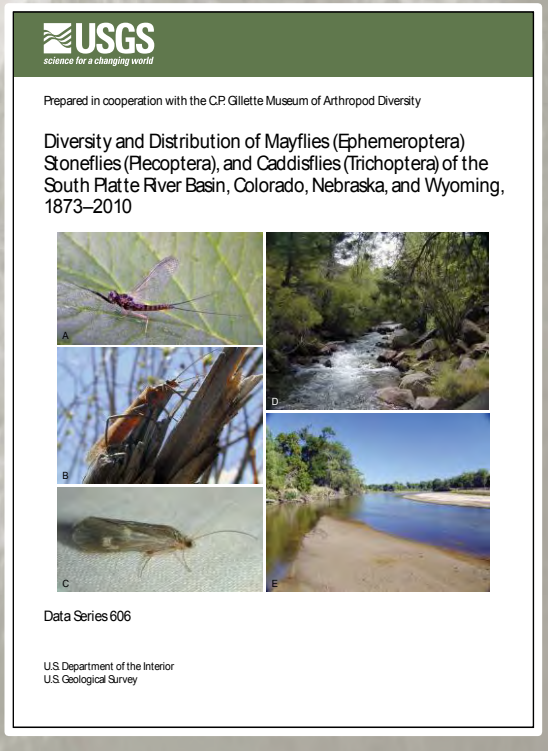
Environmental Flows Assessment

Use and Attainability Assessment (UAA)

Geographic Information System (GIS) Applications

Biological Database Design and Development

Field and Laboratory Ecotoxicology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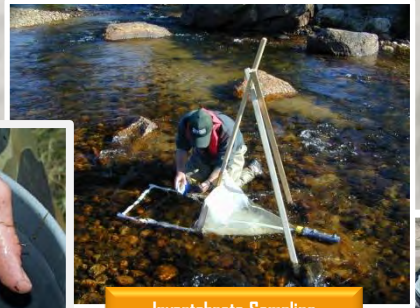
Prepared in cooperation with the C.P. Gillette Museum of Arthropod Diversity

Diversity and Distribution of Mayflies (Ephemeroptera) Stoneflies (Plecoptera), and Caddisflies (Trichoptera) of the South Platte River Basin, Colorado, Nebraska, and Wyoming, 1873–2010

Data Series 606

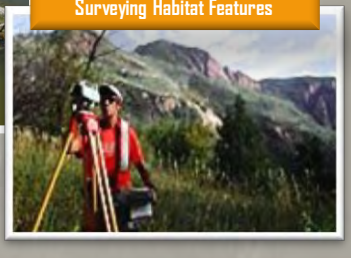
U.S. Department of the Interior
U.S. Geological Survey

Aquatic Community Surveys



Invertebrate Sampling

Algae Sampling



Surveying Habitat Features

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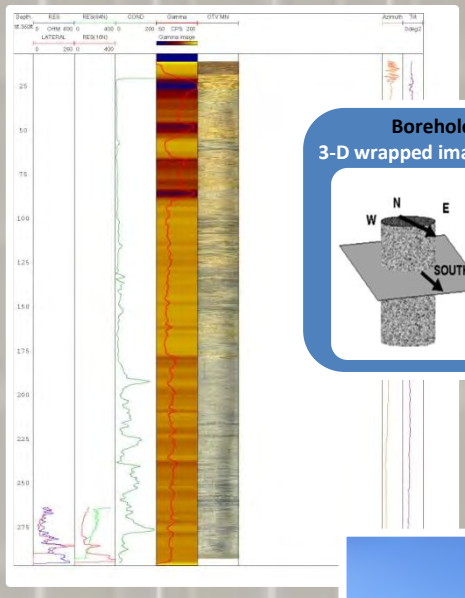
- Contribute to wise physical and economic development of the Nation's resources for the benefit of present and future generations

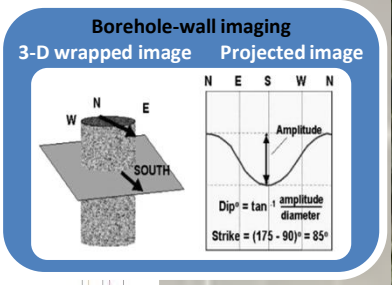
Deep Pump Deployment with Pipe and Pump Hoist

Geophysical data generated to address local issues are integrated and analyzed with data from other disciplines to address broader regional and national scale issues. Below are examples of site specific geophysical applications that generate data that both characterize local conditions and also contribute to efforts to understand larger scale science issues or research questions.

Borehole Geophysical Science

Borehole Geophysical Logging
Borehole Imaging and Fracture Analysis
Fluid Profiling – Resistivity and Temperature
Resistivity/gamma/Caliper
Neutron and Gamma-Gamma
Flow Assessment of Boreholes and Wells During Ambient and Pumping Conditions
Flowmeter Analysis to Determine Aquifer Hydraulic Properties





APPLICATIONS

Guide Monitoring Well Installation
Determine Construction Details of Existing Wells
Characterization of Strata Thickness and Lithology
Near –Surface Geophysics Ground-Truthing
Cross-Borehole Flow Experiments
Formation Porosity and Permeability
Determination of Water-Quality
Delineation of Water Bearing Fractures/Zones/Voids
Delineation of Formation Strike/Dip and Lithologic Contacts (Acoustic and Optical Televiewer)
Depth Dependent Sampling of Boreholes

Flowmeter Logging at Superfund Site

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- Contribute to wise physical and economic development of the Nation's resources for the benefit of present and future generations

Well Installation and Aquifer Characterization

Groundwater Science

Age Dating and Isotopic Tracer Studies

Aquifer Characterization

Availability and Use

Database Development

Freshwater/Saline-Water Relations

Groundwater-flow Modeling (MODFLOW, GSFLOW)

Groundwater/Surface-Water Relations

Land-Surface Subsidence Studies

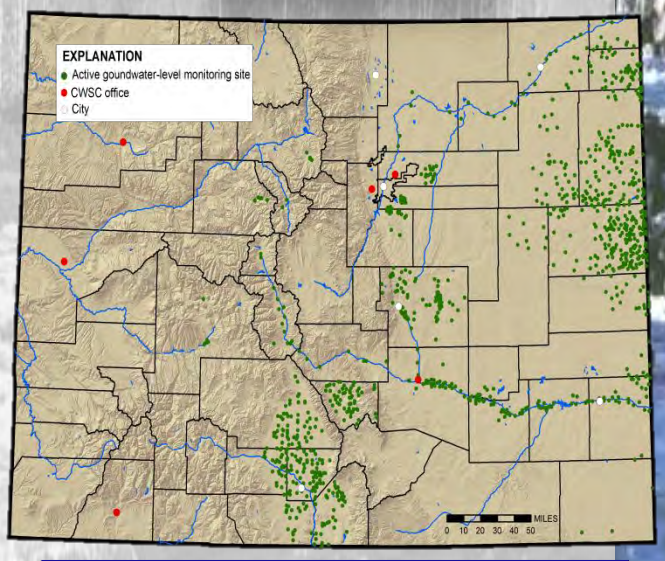
Monitoring Network Design

Real-Time Groundwater-Level and-Quality Monitoring

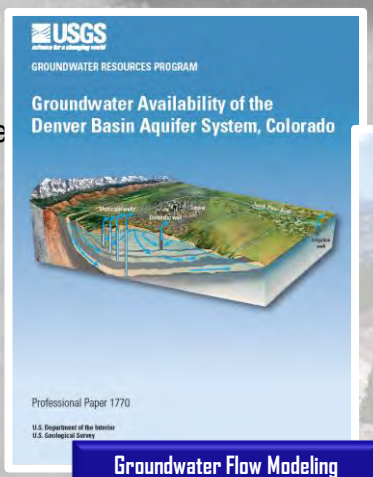
Recharge Assessment

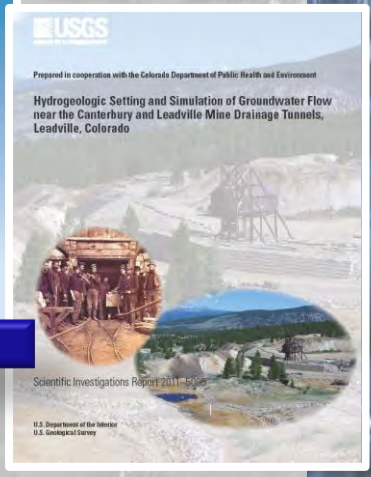
Source-Water Assessment

Subsurface Characterization Using Surface and Borehole Geophysical Methods



U.S. Geological Survey Active Groundwater-Level Monitoring in Colorado





Groundwater Flow Modeling

Water-Level Measurements and Groundwater Sampling

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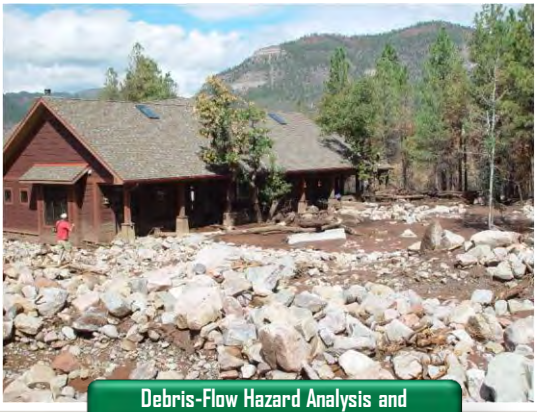


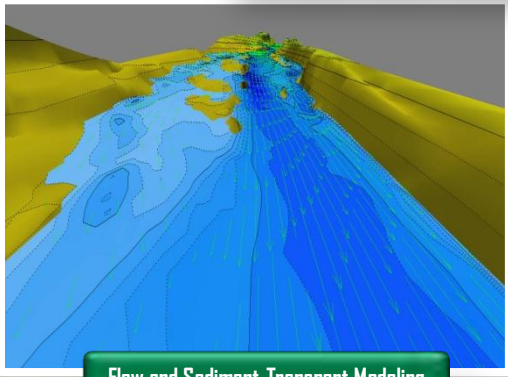
Debris-Flow Hazard Analysis and Modeling

Sediment Science

Suspended Sediments in Streams, Storm Runoff, and Impervious Surface Runoff:
Quantify Loads and Yields of Contaminants
Identify Sources of Sediment-Associated
Trace Elements and Hydrophobic Organic Contaminants
Understand Relations Between Streamflow, Sediment, and Contaminant Transport
Characterize Relations Between Land-Use and Sediment Quality

Streambed-Sediment Sampling

Streambed Sediments:
Characterize Sediment Quality
Identify Source(s) of Contaminant Inputs
Post-fire Debris-Flow Analysis



Flow and Sediment-Transport Modeling

Lake/Reservoir Bottom Sediments:
Age Dating of Sediments to Calculate Deposition Dates and Sedimentation Rates
Reconstruct Water-Quality Trends of Sediment-Associated Trace Elements and Hydrophobic Organize Contaminants
Describe Effects of Land-Use and Regulatory Changes and Urbanization on Water-Quality

Lakebed-Sediment Sampling

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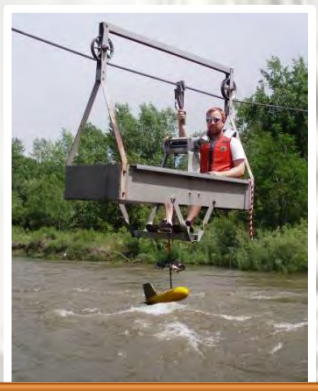
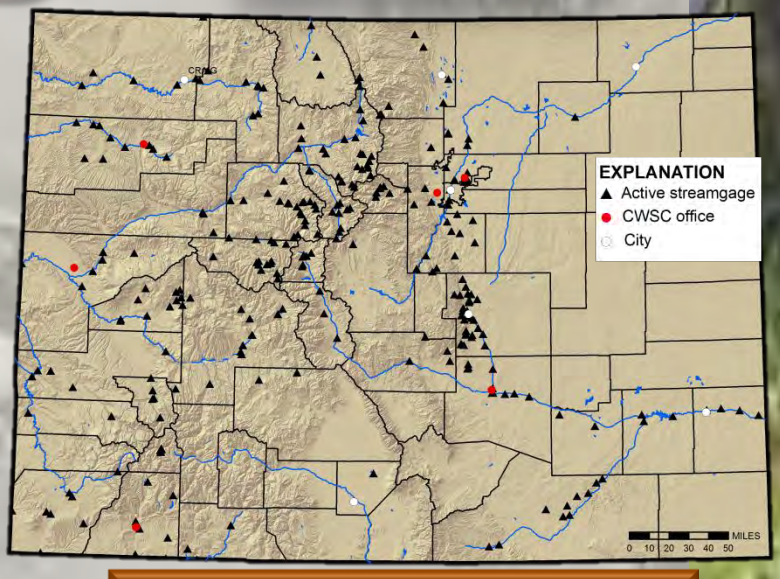


Cable-Car Stream-Flow Measurement

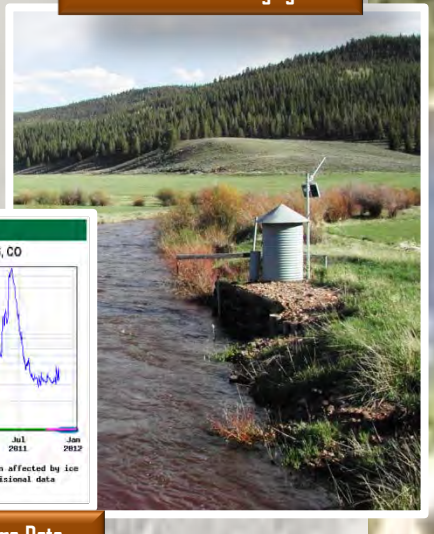
Surface-Water Science

Acoustic Discharge Measurements
Annual Peak Discharge
Basin Characteristics
Flood Frequency Estimation
Flood Frequency Estimation
Flood Warning Networks
Flow Duration Analysis
Gain-Loss Surveys
Watershed Modeling
Hydraulic Analysis
Geographic Information system (GIS) Applications
Precipitation Gages
Real-Time Stream Gages
Evaporation and Evapotranspiration (ET) Gages
Time-or-Travel Studies
High-Water Marks and Indirect Measurements of Peak Discharge

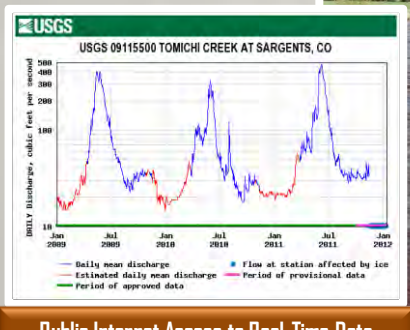


U.S. Geological Survey Active Stream Gaging Sites in Colorado

Real-Time Stream Gaging Site



Release of Rhodamine Dye for Time-of-Travel Study



Public Internet Access to Real-Time Data

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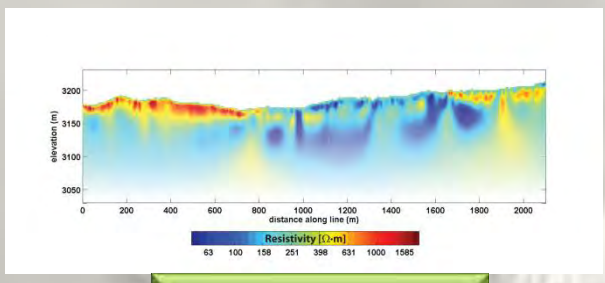
Electrical Resistivity Tomography (ERT) Survey

Geophysical data generated to address local issues are integrated and analyzed with data from other disciplines to address broader regional and national scale issues. Below are examples of site specific geophysical applications that generate data that both characterize local conditions and also contribute to efforts to understand larger scale science issues or research questions.

Surface Geophysical Science

Leakage Potential Along Irrigation Canals
Groundwater/Surface-Water Interaction along Rivers and Streams
Freshwater/Saline-Water Transition Zone Delineation
Hydrostratigraphic Characterization
Hydrogeologic Framework Development for Groundwater Models
Groundwater Susceptibility to Contamination
Near-Surface Fracture and Void Detection GPR (Ground-Penetrating Radar)
Geologic Characterization, Strata Thickness and Top of Bedrock

Direct-Current Resistivity Survey



Direct-Current Resistivity Results

Airborne Geophysical Tools

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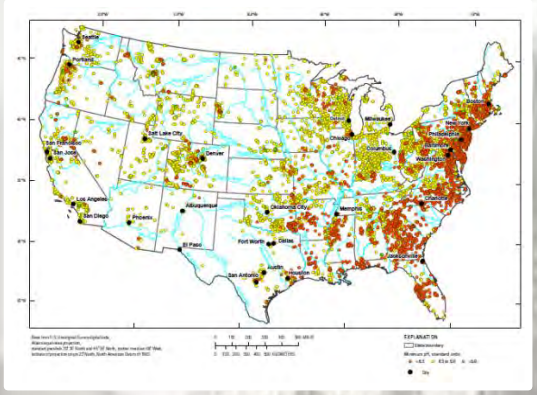
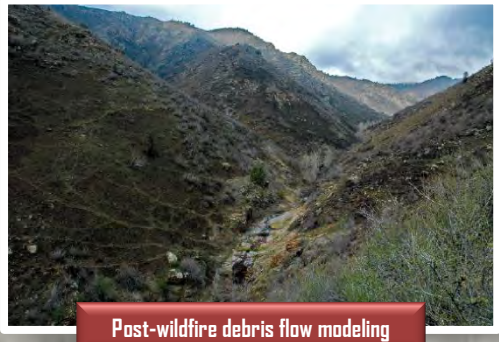
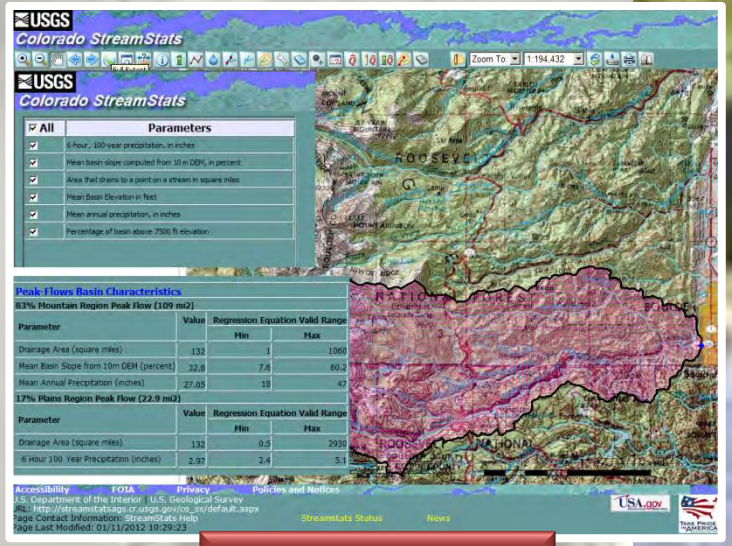


Geographic Information Systems and Spatial Analysis

- Colorado Water Science Center GIS Work Group is a multi-disciplinary group comprised of hydrologists, geographers, geologists, foresters and engineers who specialize in spatial data production, interpretation and analysis.
- We collaborate with other CWSC scientists as well as external cooperators on a diverse range of projects.
- Technical capabilities include:
    - Spatial data analysis and modeling
    - Watershed delineation & characterization
    - Web mapping applications
    - Programming and custom tool development
- Recent projects:
    - National database and maps of pH and other water-quality constituents
    - Post-wildfire debris-flow modeling in Colorado and Arizona
    - Flood-inundation mapping and tool development
    - Watershed delineation and characterization for various applications
    - Low-head hydropower assessment for natural streams in U.S.



Post-wildfire debris flow modeling



Basin delineation and characterization

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U.S. Geological Survey Water-Resources Programs in New Mexico, FY 2011

The USGS is a science organization that provides impartial information on the health of our ecosystems and environment, the natural hazards that threaten us, the natural resources we rely on, the impacts of climate and land-use change, and the core science systems that help us provide timely, relevant, and usable information.

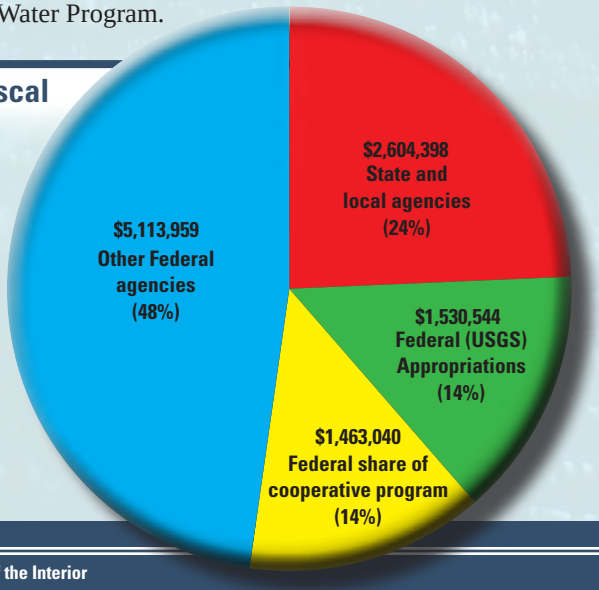
Water-Resources Programs in New Mexico

The U.S. Geological Survey (USGS) has collected hydrologic information in New Mexico since 1889, beginning with the first USGS streamflow-gaging station in the Nation, located on the Rio Grande near Embudo. Water-resources information provided by the USGS is used for

- Issuing flood warnings to protect lives and reduce property damage
- Managing water rights and interstate water use
- Protecting water quality and regulating pollution discharges
- Designing highways and bridges
- Planning, designing, and operating reservoirs and water-supply facilities
- Monitoring environmental conditions and protecting aquatic habitats
- Planning recreational activities

For more than 100 years, the Cooperative Water Program has been a highly successful cost-sharing partnership between the USGS and water-resources agencies at the State, local, and tribal levels. It would be difficult to effectively accomplish the mission of the USGS without the contributions of the Cooperative Water Program.

Funding Fiscal Year 2010



Selected USGS Partnerships in New Mexico

Local

- Albuquerque Metropolitan Arroyo Flood Control Authority
- Canadian River Municipal Water Authority
- Canadian River Riparian Restoration Project
- Cities of Albuquerque, Las Cruces, Raton, Ruidoso, Santa Fe, and Santa Rosa
- Compact Commissions: Canadian River, Costilla Creek, Pecos River, and Rio Grande
- Counties of Bernalillo, Lea, Lincoln, Sandoval, San Miguel, and Union
- Elephant Butte Irrigation District
- Zuni Indian Nations
- La Cienega Acequia
- Pecos Valley Artesian Conservancy District
- Southern Sandoval County Arroyo Flood Control Authority

State of New Mexico

- Bureau of Geology & Mineral Resources
- Department of Agriculture
- Department of Transportation
- Energy, Minerals, and Natural Resources Department
- Environment Department
- Interstate Stream Commission
- New Mexico State University
- Office of the State Engineer
- Water Resources Research Institute

State of Texas

- Commission on Environmental Quality

Federal

- Army Corps of Engineers
- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Reclamation
- Environmental Protection Agency
- Forest Service
- International Boundary and Water Commission
- White Sands Missile Range

New Mexico Water Science Center Activities, 2011

- Implementation of the National Water Quality Assessment of surface water and groundwater in the Rio Grande Basin. *Federal Program of the USGS*
- Determination of potential groundwater-flow pathways in the vicinity of the San Juan Mine near Farmington, N.M. *Cooperator: Mining and Minerals Division of the New Mexico Energy, Minerals, and Natural Resources Department*
- Assessment of groundwater resources of the Salt Basin in south-central New Mexico; estimating groundwater recharge. *Cooperator: New Mexico Interstate Stream Commission*
- Collection of rainfall, discharge, and water-quality data in the storm drainage system of the Albuquerque metropolitan area. *Cooperators: Albuquerque Metropolitan, Arroyo Flood Control Authority, Bernalillo County, and City of Albuquerque*
- Analysis of the magnitude and frequency of peak flows and estimation of flow characteristics in unregulated streams throughout New Mexico. *Cooperator: New Mexico Department of Transportation*
- Characterization of the effects of increased groundwater withdrawals on streamflow and determination of sources of nutrient input to surface-water and groundwater systems in the Upper Hondo Basin, Lincoln County, N.M. *Cooperator: Lincoln County*
- Collection of precipitation, groundwater levels, and groundwater-quality data to improve the understanding of groundwater resources in eastern Bernalillo County, Central New Mexico. *Cooperator: Bernalillo County*
- Documentation of the seasonal, annual, and long-term variations in water quality in the Rio Grande upstream of the City of Albuquerque surface-water diversion, an element of the San Juan-Chama Drinking Water Project. *Cooperator: Albuquerque Bernalillo County Water Utility Authority*
- Assessment of groundwater and surface-water resources of San Miguel County. *Cooperator: San Miguel County*
- Characterization of the surface-water flow within the Upper Rio Grande Basin through development of a basin-wide water-operations model that can account for the deliveries, use, and routing of the different sources of water to the Rio Grande and forecast different water-operation scenarios within the basin. *Cooperators: U.S. Army Corps of Engineers and U.S. Bureau of Reclamation*
- Quantification of the magnitude of shallow groundwater flow between the Rio Grande and riverside drains at three selected locations. *Cooperator: U.S. Bureau of Reclamation*
- Identification of the most important factors affecting the transport of natural and human-related contaminants to public-supply wells in the Albuquerque area; this effort supports the national NAWQA objective of improving overall assessments of groundwater susceptibility and vulnerability. *Federal Program of the USGS*
- Implementation of an interactive Web-based tool for quickly estimating streamflow statistics and obtaining basin characteristics for stream locations in New Mexico; this tool would be used by Federal, State, and local agencies. *Cooperators: N.M. Department of Transportation and U.S. Forest Service*
- Improving the understanding of hydrologic processes within the Mesilla Basin through implementation of the Transboundary Aquifer Assessment; the assessment is designed to characterize, map, and model priority transboundary aquifers along the U.S.-Mexico border. *Federal Program of the USGS*
- Real-time hydrologic monitoring of streamflow of approximately 180 stations for flood forecasting, interstate stream compacts, and drought tracking. *Cooperators: local, State, and Federal agencies and the National Streamflow Information Program—a Federal program of the USGS*
- Collection of groundwater and water-quality data. *Cooperators: local, State, and Federal agencies*
- Assessment of soil and groundwater contamination, and fate and transport of contaminants at Fort Wingate. *Cooperator: U.S. Army Corps of Engineers*

For additional information, please contact:
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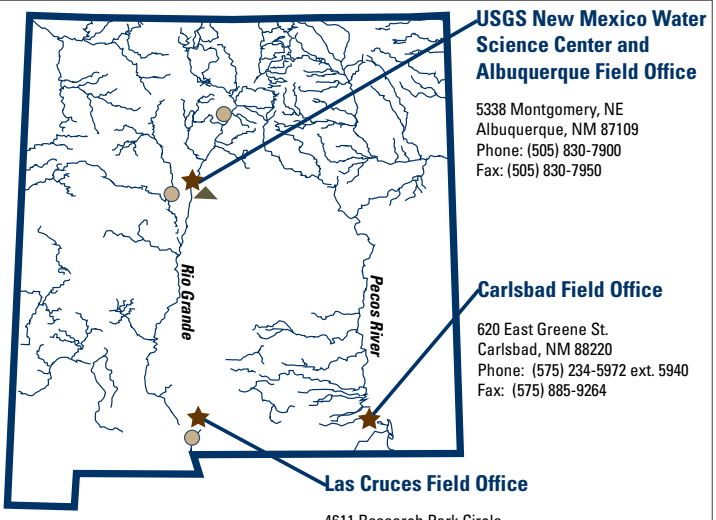
U.S. Geological Survey Offices in New Mexico



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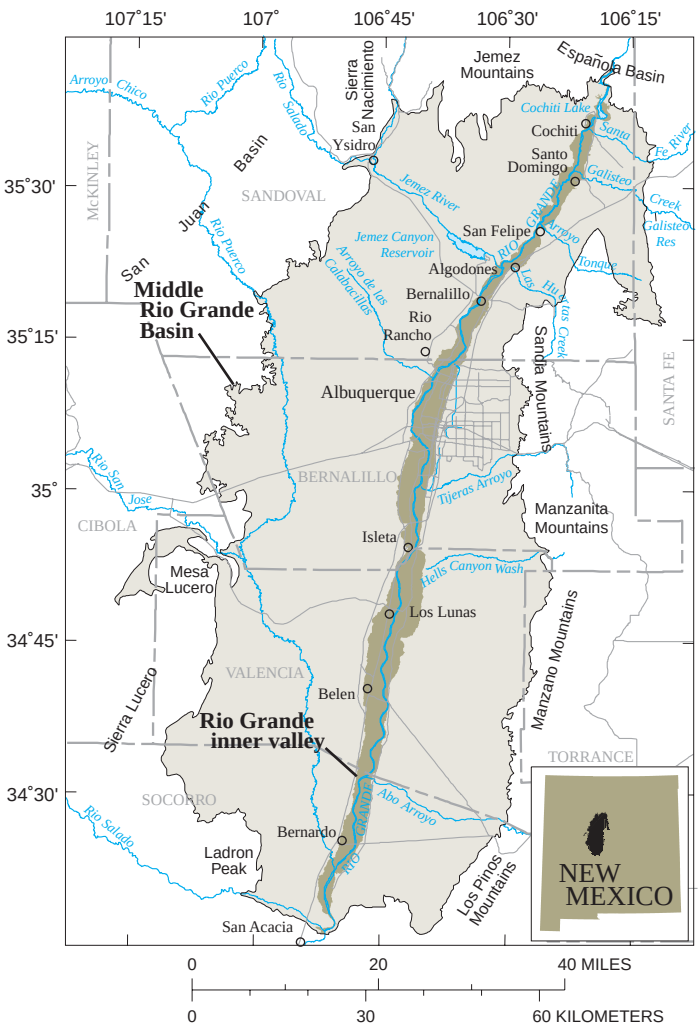
Ground-Water Resources of the Middle Rio Grande Basin



Major physiographic and hydrologic features of the Middle Rio Grande Basin.

What is the Middle Rio Grande Basin?

The Middle Rio Grande Basin, as defined for this study, is the area within the Rio Grande Valley extending from about Cochiti Lake downstream to about San Acacia. It covers approximately 3,060 square miles in central New Mexico, encompassing parts of Santa Fe, Sandoval, Bernalillo, Valencia, Socorro, Torrance, and Cibola Counties and includes a ground-water basin composed of the Santa Fe Group aquifer system. (It is equivalent to the Albuquerque Basin referred to by other authors.) The climate over most of the basin is semiarid. In 2000, the population of the Middle Rio Grande Basin was about 690,000 or about 38 percent of the population of New Mexico. Currently (2002), the source of water for municipal and domestic supply is almost exclusively from ground water.

What is the USGS Middle Rio Grande Basin Study?

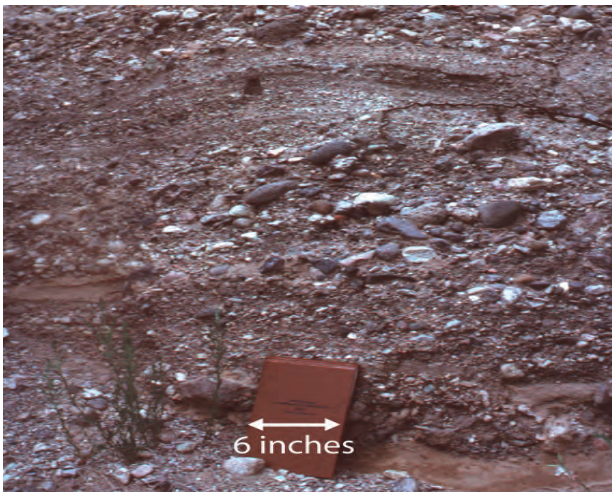
The U.S. Geological Survey (USGS) Middle Rio Grande Basin Study was a 6-year effort (1995-2001) by the USGS and other agencies to improve the understanding of the hydrology, geology, and land-surface characteristics of the Middle Rio Grande Basin in order to provide the scientific information needed for water-resources management. The Santa Fe Group aquifer system is the main source of municipal water for the region, and the main purpose of the study was to improve the understanding of the water resources of the basin. The New Mexico Office of the State Engineer (NMOSE) administers the appropriation and use of the water resources of New Mexico and has declared the basin a “critical basin”; that is, a ground-water basin faced with rapid economic and population growth where there is less than adequate technical information about the available water supply (New Mexico Office of the State Engineer, written commun., 1995).

In addition to the USGS, many other Federal, State, and local governments and agencies contributed resources to or cooperated in the Middle Rio Grande Basin Study. These governments and agencies include the City of Albuquerque, New Mexico Office of the State Engineer, New Mexico Bureau of Geology and Mineral Resources (NMBGMR), Middle Rio Grande Council of Governments (MRGCOG), and a number of pueblos and other Federal, State, and local agencies.

What is the Santa Fe Group aquifer system?

Most water-bearing units of the Middle Rio Grande Basin are unconsolidated deposits of the Tertiary Santa Fe Group. Post-Santa Fe Group deposits (piedmont fan and valley fill) of Quaternary age formed during the last 1.6 million years. These deposits are present on mountain slopes, in the incised valley of the Rio Grande, and along flood plains of tributaries to the Rio Grande. They are considered part of the Santa Fe Group aquifer system, although these deposits are generally saturated only in flood plains or the inner valley of the Rio Grande. Because the Santa Fe Group and

post-Santa Fe Group deposits are hydraulically connected, they are commonly grouped together as the Santa Fe Group aquifer system. Though the aquifer is under confined conditions locally, it is considered to be an unconfined aquifer as a whole.



Santa Fe Group sediments exposed near Bernalillo. Such deposits form some of the most productive zones of the aquifer.

The thickness of the Santa Fe Group in the Middle Rio Grande Basin is highly variable because of complex faulting during sedimentation; total thickness ranges from about 1,400 feet at basin margins to approximately 14,000 feet in localized areas in the center of the basin (Hawley and Haase, 1992; Grauch, Gillespie, and Keller, 1999). The Santa Fe Group is divided into three parts: upper (less than 1,000 to 1,500 feet thick), middle (250 to 9,000 feet thick), and lower (less than 1,000 to 3,500 feet thick). In places, either the upper part or the upper and middle parts have eroded away. Because of the types of sediments in the lower part of the Santa Fe Group, much of it may make a poor aquifer (though most of Rio Rancho's water is withdrawn from very productive areas of the lower Santa Fe Group). For this reason and economic reasons, ground water is thus withdrawn mostly from the sands and gravels of the upper and middle parts; only about the upper 2,000 feet of the aquifer is used for ground-water withdrawal. The depth to water in the aquifer system varies widely, from less than 2 feet near the Rio Grande to as much as 1,180 feet in an area west of Albuquerque.

What kinds of scientific information were collected?

Many scientists from different agencies collected a wide variety of information as part of the Middle Rio Grande Basin Study. Some individual scientific projects had direct application to furthering the understanding of the water resources of the basin, whereas other projects were indirectly related. Though the individual studies are too numerous to list in this publication, some examples are:

- Water samples from 275 wells in the basin were analyzed for environmental tracers and 30 chemical constituents to date ground water, to define zones of differing water quality, and to locate areas of recent recharge. This sampling has made the basin one of the most intensively sampled basins in the world for environmental tracers. Among the tracers used were hydrogen, helium, oxygen, carbon, and sulfur isotopes; dissolved gasses; chlorofluorocarbons; and sulfur hexafluoride. This sampling has defined areas of water along the western edge of the basin to be about 20,000 years old as well as areas of water that have been recharged in the past 50 years, such as in the inner valley of the Rio Grande and along some arroyos and mountain-front areas. These ground-water ages have also provided calibration data for ground-water-flow models of the basin (Plummer and others, 2001).

- Early in the study, non-linear regression methods were applied to a ground-water-flow model of the basin to evaluate six different hypotheses about the hydrogeologic framework of the basin. The resulting information was used to further refine the understanding of the hydrology of the basin. In addition, the resulting model served as a basis for an NMOSE management model of the basin (Tiedeman, Kernodle, and McAda, 1998; Barroll, 2001).

- Geophysical methods were used to interpret different properties of the aquifer system. Gravity techniques were used to estimate the total thickness of the Santa Fe Group deposits, which are less dense than the underlying and surrounding bedrock. High-resolution aeromagnetic surveys delineated faults that offset water-bearing units in the aquifer system and showed the extent of buried igneous rocks, which have different hydraulic properties than the surrounding sedimentary deposits. Airborne time-domain electromagnetic surveys were used to determine changes in the electrical resistivity of the Santa Fe Group related to variations in grain size and hydraulic properties (Grauch, Rodriguez, and Deszcz-Pan, 2002).

- Because of the limitations of ground-water levels measured in or near production wells, the USGS in cooperation with the City of Albuquerque, NMOSE, and Bernalillo County began a program in 1996 to install specialized monitoring wells in the Middle Rio Grande Basin. Most of these wells are groups, or nests, of two or more wells completed at different depths in the aquifer. Currently (2002), 59 such monitoring wells have been installed at 23 sites. Continuous water-level recorders have been installed on nearly all these wells, and all wells have been incorporated into the City of Albuquerque ground-water-level monitoring program.

- To estimate the degree of ground- and surface-water interaction between the Rio Grande and Santa Fe Group aquifer system, studies that use a variety of techniques were applied, including analyses of the distribution of

water temperature, electromagnetic surveys, and streamflow losses. These techniques have supplied estimates of the direction and amount of water moving between the river and aquifer system at selected sites (Bartolino, 2002).

- Research on mountain-front recharge applied a variety of techniques, including water-temperature methods, steady-state centrifuge analysis of cores, chloride mass-balance methods, and geochemical analysis of core samples and pore water. These studies have helped confirm that there is substantially less ground-water recharge along mountain fronts in the Middle Rio Grande Basin than previously estimated (Bartolino and Constantz, 2002).

- In the Middle Rio Grande Basin, three methods are being used to check for the onset of land subsidence related to ground-water withdrawals: (1) a high-precision survey network in the Albuquerque area, (2) an extensometer in northern Albuquerque, and (3) Interferometric Synthetic Aperture Radar (InSAR) analysis. The first two methods have not detected land subsidence greater than the detection threshold of 0.5 inch. However, InSAR analysis, in conjunction with water-level data, shows reversible and possibly permanent land subsidence from aquifer-system deformation in parts of the Middle Rio Grande Basin (Heywood, Bartolino, and Galloway, 2002).

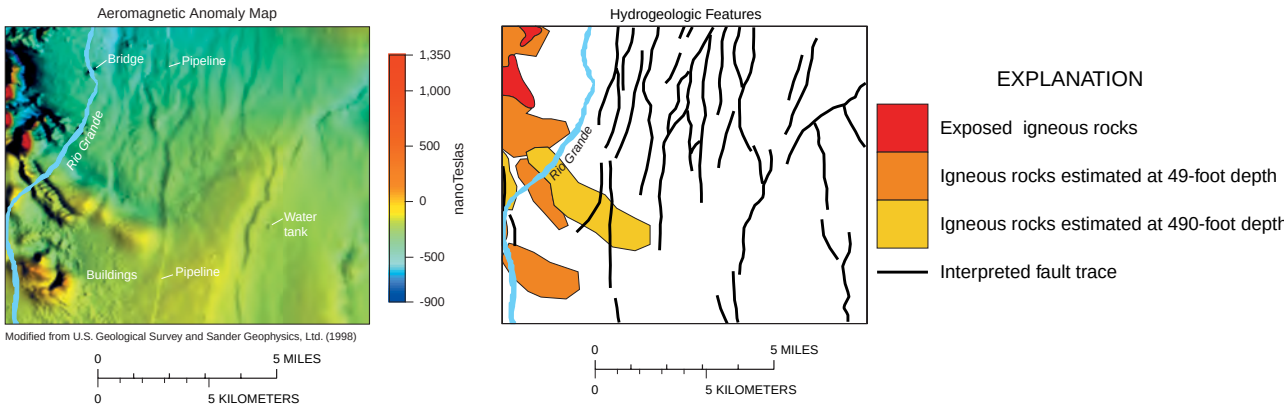
- The conceptual geologic framework of the Middle Rio Grande Basin was revised and updated by mapping the surficial deposits and bedrock outcrops of the Middle Rio Grande Basin and adjoining areas. A number of new maps (1:24,000 scale) are now available in digital form from the Internet (Bauer, 2001).

- The Albuquerque area was modeled using an urban-growth model to project the potential urbanized-area extent in 2050 to help managers form sound policies for guiding sustainable growth. Because the availability of water may ultimately be limited, decisions on growth can be improved by realistic and scientific projections of growth patterns and changes (Hester and Feller, 2002).

What is the ground-water-flow model of the basin?

Throughout the Middle Rio Grande Basin Study, a revised ground-water-flow model of the basin has been viewed as the culmination of the study. The revised model incorporates new information collected since 1995 into a “state-of-the-art” understanding of the hydrogeology of the basin.

Ground-water-flow models attempt to reproduce, or simulate, the operation of an actual ground-water system with a mathematical counterpart (a mathematical model). The use of such models has provided an opportunity for water managers to quantitatively understand how ground water moves and to estimate the effects of human use of the water (Reilly and McAda, 2002).



Aeromagnetic anomaly map of an area south of Albuquerque and simplified map of important hydrogeologic features. Many geologic features and manmade structures can be seen on the anomaly map, which is displayed in color and shaded as though it were a relief map illuminated from the east. The most important hydrogeologic features expressed in the aeromagnetic map are faults and igneous rocks, depicted on the simplified map. Depths to the buried igneous rocks were estimated by analysis of the aeromagnetic data. Note the shallow, buried igneous rocks near the Rio Grande that probably affect ground-water flow.

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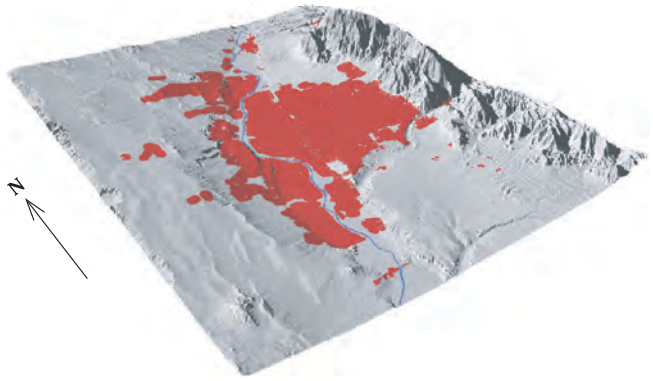

Urban area in the vicinity of Albuquerque in 2050 projected using the Slope Land use, Exclusions, Urban, Transportation, and Hillshade (SLEUTH) urban-growth model.

McAda and Barroll (2002) constructed a new ground-water-flow model of the Middle Rio Grande Basin to incorporate the large volume of new hydrogeologic data collected since 1995. This model consists of nine layers, and each layer is divided into a grid of cells containing 156 rows and 80 columns. Each cell is 3,281 feet (1 kilometer) on a side. Thus, the model contains 112,320 cells, 50,449 of which actively simulate ground-water flow. The model encompasses the entire thickness of the Santa Fe Group in order to reproduce probable flow paths in the lower portions of the aquifer. In addition, the orientation of this model grid is north-south (parallel to the dominant trend of faults and the Rio Grande in the main part of the basin) to better align with the principal directions of hydraulic conductivity in the basin.

Among the most important findings and features of this new ground-water-flow model of the basin are:

- Prior to installation of the riverside drains along the Rio Grande, the river was losing flow in most of the basin. This water probably was being evapotranspired and (or) was recharging the Santa Fe Group aquifer system. Currently (2002), the drains intercept much of this flow that would have been lost to evapotranspiration and divert it back into the river.

- In much of the Santa Fe Group aquifer system throughout the basin, water removed from storage is partially replaced, particularly during the nonirrigation season.

- The substantially smaller rates of mountain-front recharge to the aquifer estimated by other studies have been implemented in the model.

The table below shows the annual water budgets simulated by the ground-water-flow model for steady-state conditions and for 1999. Steady state refers to the natural hydrologic conditions before ground-water development and large-scale alteration of the surface-water system.

Though the McAda and Barroll (2002) ground-water-flow model of the Middle Rio Grande Basin does not make any projections of future conditions, it could be modified to do so. The model does provide water-resource managers a more realistic and powerful tool to evaluate the potential effects of management decisions.

Simulated annual water budget for the ground-water-flow model of McAda and Barroll (2002). All values are in acre-feet per year [--, 0 or not applicable. One acre-foot is the amount of water needed to cover 1 acre 1 foot deep in water or about 325,829 gallons]

Mechanism	Steady-state conditions		1999 conditions	
	Inflow (to aquifer)	**Outflow** (from aquifer)	**Inflow** (to aquifer)	**Outflow** (from aquifer)
Mountain-front recharge	12,000	--	12,000	--
Recharge from intermittent tributaries	9,000	--	9,000	--
Underflow from adjacent basins	31,000	--	31,000	--
Canal seepage	--	--	90,000	--
On-farm irrigation seepage	--	--	35,000	--
Rio Grande main stem and Cochiti Lake	63,000	--	317,000	--
Rio Grande riverside drains	--	--	--	-208,000
Rio Grande interior drains	--	--	--	-134,000
Jemez River and Reservoir	--	--	16,000	--
Ground-water withdrawals	15,000	--	--	-150,000
Septic-field return flow	--	--	4,000	--
Riparian and wetland evapotranspiration	--	-130,000	--	-84,000
Aquifer storage	--	--	110,000	-49,000
Totals:	130,000	-130,000	624,000	-625,000

What are the key points regarding water resources in the basin?

The most prominent hydrologic feature in the largely semiarid Middle Rio Grande Basin is the Rio Grande, whereas the sole source of water for municipal, domestic, and non-agricultural commercial supply is currently (2002) the Santa Fe Group aquifer system. The water resources of the Middle Rio Grande Basin are a combination of the surface- and ground-water systems, which are intimately linked through a series of complex interactions. These interactions often make recognizing the boundary between the two systems difficult, and changes in one system often affect the other. The most important points in our present understanding of the water resources of the Middle Rio Grande Basin are:

- When ground water is pumped from an aquifer system, water is removed from aquifer storage and ground-water levels decline. Ground-water levels have declined with population growth in the Middle Rio Grande Basin. The effects of ground-water pumping are evident when comparing historical (1960-61) and the most recent (1994-95) ground-water-level maps; water-level declines are more than 160 feet in an area beneath eastern Albuquerque.

Riverside drains such as the Bernalillo Riverside Drain at Bernalillo form part of a complex irrigation network that is intimately linked with the Rio Grande and Santa Fe Group aquifer system.

- Years of water-management policy were based on the assumption that the Rio Grande is well connected hydraulically to the Santa Fe Group aquifer system. Recent studies of the interaction between the river and aquifer (including ground-water-flow models) indicate that the hydraulic connection is less than previously thought.

- As Albuquerque grew, most of the new municipal supply wells were completed in highly productive parts of the Santa Fe Group aquifer system. The quantity and quality of the water led to the popular belief that the entire Middle Rio Grande Basin was underlain by a high-quality aquifer; it is now known that such areas of high-quality aquifer are relatively limited and that much less water is available for municipal supply than previously believed.

- Geophysical studies of the Middle Rio Grande Basin, in conjunction with computer modeling of the Santa Fe Group aquifer system, indicate that faults are more numerous than previously thought and that they can affect ground-water movement, particularly when they juxtapose aquifer materials of substantially different hydraulic properties.

- Previous estimates of mountain-front recharge were based on indirect calculations from water budgets and computer modeling of the Santa Fe Group aquifer system. New studies using direct and indirect measurements and ground-water age dating have shown that mountain-front recharge is substantially less than previously believed.

- The bosque assumed its present character in about the past 60 to 70 years, developing in an area that was formerly semibarren flood plain with scattered stands of predominantly cottonwood and willow. The present character was caused by the spread of exotic plant species and the construction of bank stabilization and flood-control structures, including dams and levees. Though estimates vary, a substantial amount of ground and surface water is consumed by evapotranspiration from the bosque.

By increasing the understanding of the water resources of the Middle Rio Grande Basin, water-resource managers and planners will have additional tools to make sound, scientifically based decisions on the future of water in the basin.

-- J.R. Bartolino[1], J.C. Cole[2], and D.J. Hester[3]
U.S. Geological Survey

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Additional information

This USGS Fact Sheet is a brief summary of USGS Circular 1222—"Ground-water resources of the Middle Rio Grande Basin, New Mexico" by J.R. Bartolino and J.C. Cole, 2002.

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Additional information on the Middle Rio Grande Basin Study can be found at: *http://nm.water.usgs.gov*

To learn more about the USGS and its products call: 1-888-ASK-USGS or go to *http://www.usgs.gov*

An index of geologic maps of the Middle Rio Grande Basin and surrounding area is available on the WWW from the New Mexico Bureau of Geology and Mineral Resources at: *http://geoinfo.nmt.edu/statemap/quads/index/home.html*

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Frequent and consistent measurements of ground-water levels are crucial for understanding the aquifer system and tracking water-level declines.

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Nevada Water Science Center

The U.S. Geological Survey's (USGS) mission is to provide reliable scientific information about the Nation's natural resources. An integral part of that mission is to provide consistent, long-term water-resources data to customers, cooperators, and the public. To accomplish our mission, we operate a widespread surface- and ground-water data collection network as well as research a wide range of scientific issues throughout Nevada.

What We Do

- We operate local and statewide networks to collect high-quality data that define natural and human-induced hydrologic conditions.
- We analyze hydrologic processes through investigations and research to increase understanding of important water-resource issues and to promote informed decision making.
- We maintain real-time and historical data bases and publish peer-reviewed interpretive and data reports to disseminate unbiased hydrologic information.

Wash near Red Rock Canyon National Conservation Area, Nevada

To assure that our work is relevant and useful, we form partnerships with Federal, State, and local agencies, and other public organizations. Funding for the Nevada Water Science Center comes from a variety of sources, including direct Federal appropriations, other Federal agencies, and a cooperative program that allows the Nevada Water Science Center to partially match funding with state and local agencies.

Data Collection

Surface Water

Stream levels, stream-flow (discharge), reservoir and lake levels, surface-water quality, and rainfall.

Ground Water

Site inventory, ground-water level, and water-quality data for wells and springs.

Water Quality

Physical and chemical characteristics of water.

Contact

Nevada Water Science Center State Director, John Sciacca *(775-887-7650; jsciacca@usgs.gov)*

Featured Studies

Southern Nevada –

- Studies at Nevada National Security Site (formerly Nevada Test Site)
- Evapotranspiration (ET) and Evaporation Studies:
  - High-Altitude ET and Climate Transects, Spring Mountains
  - ET of Xerophytic Vegetation, Nye County
  - ET of Riparian Vegetation and Ecological Flows, Amargosa River
  - Lake Mead Evaporation
- Spring/Ephemeral River Source-Water Studies:
  - Colorado River Springs at Black Canyon
  - Lower Amargosa River and Nearby Springs
- Regional-Local Embedded Groundwater Flow Models, Southern Amargosa Area
- Regional Aquifer Deep-Well Drilling Program
- Clark County Springs and Water-Level Data Gaps
- Lake Mead Near-Real-Time Data-Collection Platforms
- Lake Mead Endocrine Disruption
- Vegetation Mapping using High-Resolution Imagery - BLM ACECs
- Desert Hydrology - Amargosa Desert Research Site

Lake Mead and Hoover Dam, Nevada and Arizona

ET station in Dixie Valley, Nevada

Central and Northern Nevada –

- Multidisciplinary Basin Studies:
  - Upper Walker Basin Water Budget
  - Dixie Valley Groundwater and Hydrogeology
  - Hydraulic Connection of Spring and Snake Valley Aquifer Systems
  - Diamond Valley Flow System
  - Carson Valley Nitrogen Budget
- Integrated Groundwater/Surface Water Modeling Studies:
  - Carson Valley
  - Middle Carson River Basin
  - Lower Walker Basin
- Great Basin National Park Groundwater Model
- Lake Tahoe Studies:
  - Tributary Discharge and Water-Quality Monitoring
  - Lidar and Multispectral Imagery
  - Monitoring for Organic Compounds
- Groundwater/Surface Water Interaction along Tracy Segment of Truckee River
- Upper Humboldt Water Resources
- Mercury in the Carson River
- National Water-Quality Assessment (NAWQA) Studies

Find more at: *http://nevada.usgs.gov/water*

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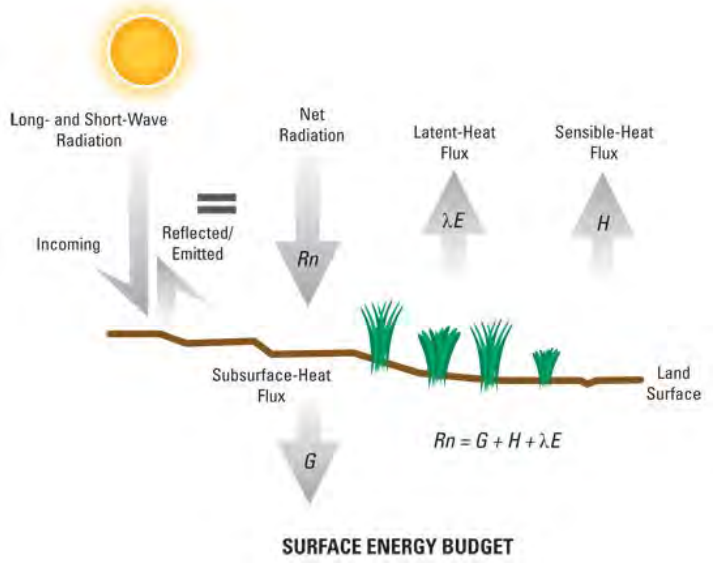
Evapotranspiration Studies

What is evapotranspiration?

Evapotranspiration (ET) is the process by which water is transferred from the Earth's surface to the atmosphere as evaporation from open water, soil, and plant canopies; and as transpiration by vegetation. ET is measured by scientists for many different reasons. Hydrologists from the Nevada Water Science Center (NVWSC) typically measure ET to help quantify water budgets. ET has been measured by USGS hydrologists in Nevada since the early 1960's.



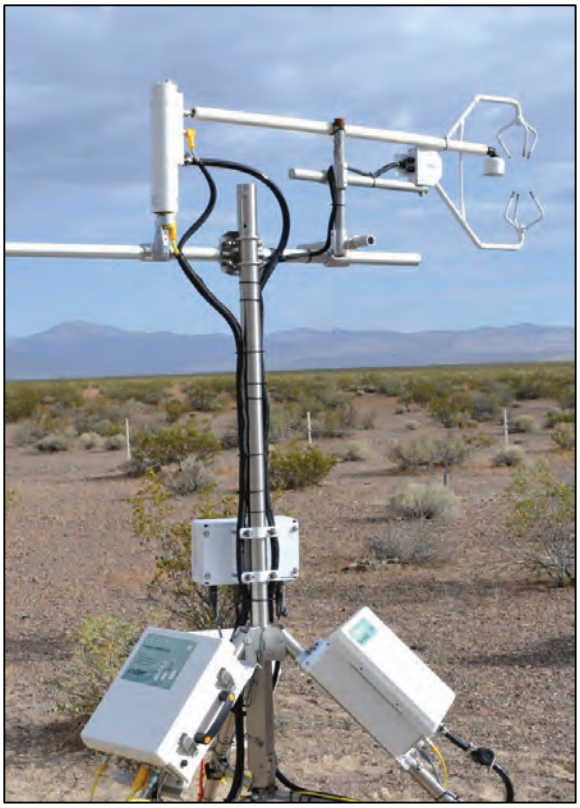
SURFACE ENERGY BUDGET

upward into the atmosphere (sensible-heat flux), or is used to convert water from the solid or liquid to vapor phase (latent-heat flux). This partitioning process is described by the surface energy budget.

The NVWSC currently applies the eddy-covariance method to measure ET rates. Eddies are turbulent airflow caused by wind, surface roughness, and convective heat flow at the boundary between the Earth and the atmosphere. ET occurs when water vapor in upward moving eddies are greater than in downward moving eddies. Water vapor, heat, and other scalars like carbon dioxide transferred by eddies can be measured directly using the eddy-covariance method.

How is ET measured?

The rate at which water evaporates from the earth's surface and is transpired by plants is referred to as the ET rate. The ET rate is driven by available water and solar energy. Available solar energy is the difference between incoming and outgoing long- and short-wave radiation. This energy difference is defined as net radiation. Net radiation (Rn) is absorbed at the Earth's surface, and then is partitioned into energy that is transferred by heat conduction downward into the subsurface, by heat conduction or convection


Eddy covariance evapotranspiration and CO_2 flux monitoring station at Amargosa Desert Research Station.

How are ET data and estimates used?

ET data typically are used by the NVWSC to better understand those hydrologic processes most critical for defensible water-budget estimates and water-availability forecasts. For example, ET data collected in high-altitude areas that receive significant snowfall are used in water-budget calculations to determine infiltration and potential groundwater recharge. For valley-floor areas in Nevada, ground-based measurements of ET frequently are combined with remotely-sensed image-processing products to estimate evaporative discharge from open-water areas, bare-soil surfaces, agricultural fields, and phreatophytic-vegetation communities. Ground-based ET data also are used to estimate ecological flows – the amount of water required to maintain healthy stands of riparian vegetation. In recent years there has been an increased demand for continuous, high-quality, ground-based measurements of ET and major surface-energy-balance components to evaluate the accuracy of satellite-based estimates of consumptive use from crops and naturally-occurring phreatophytes; moreover, in-situ ground-based measurements can be used to validate or calibrate any particular model of evaporative discharge.

Where can I find more information on ET studies in Nevada?

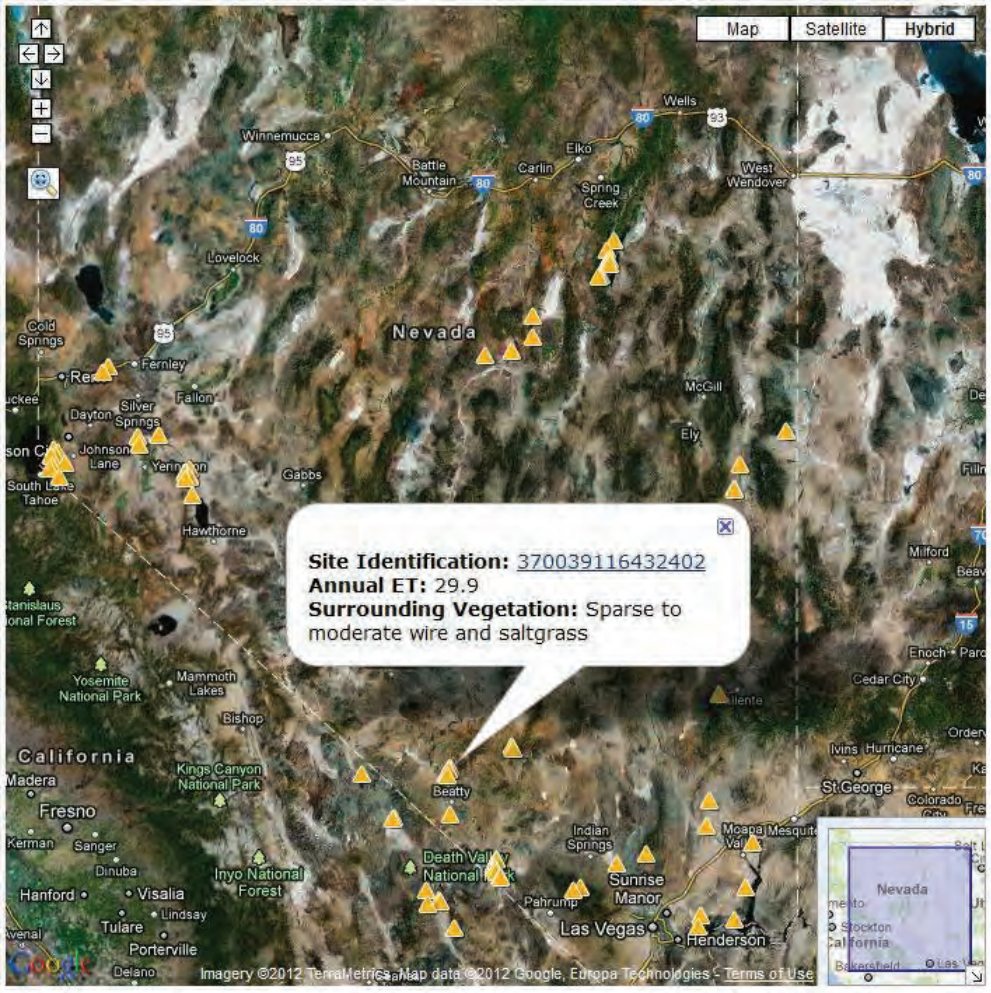
The NVWSC has developed an interactive web site on completed ET studies in Nevada. Summarized graphic and tabular information on historic and on-going ET sites are available at the site, including links to data stored on the National Water Information System (NWIS). The web site contains information about the site, data plots, and photos; data collected and associated calculated parameters and estimated ET rates are available using NWIS links.

The ET web site:

http://nevada.usgs.gov/water/et

For additional information contact:

Mike Moreo (702-564-4625; mtmoreo@usgs.gov)



Sample screenshot from the ET web site showing the interactive map interface. Base map courtesy of Google Maps. References to non-U.S. Department of Interior (DOI) products do not constitute an endorsement by the DOI.

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Lake Mead Evaporation

Principle Investigator: Mike Moreo (mtmoreo@usgs.gov)
Cooperator: U.S. Bureau of Reclamation
Period of project: 2010 - Ongoing

The Nevada Water Science Center (NVWSC), is partnering with the U.S. Bureau of Reclamation (Reclamation), Lower Colorado Region, to compute near-real-time evaporation from Lake Mead. Lake evaporation estimates will assist Reclamation with their efforts to forecast water-resource availability on the Lower Colorado River. Moreover, by refining estimates of evaporation and reducing uncertainty of water-availability forecasts, Reclamation can develop more accurate management guidelines for reservoir operations.

Eddy covariance evapotranspiration monitoring station, Lake Mead.

Objectives

The objectives of this study are to measure monthly evaporation rates and estimate monthly evaporation volumes. Evaporation estimates will be based on in-situ, continual measurements of water and atmospheric parameters needed to estimate near-real-time evaporation for Lake Mead.

Strategy and Approach

The study applies two methods to estimate evaporation at Lake Mead – the eddy-covariance method and the energy-budget method. Eddy covariance has long been used for estimating evapotranspiration from phreatophytic vegetation or crops, but has not often been used to estimate lake evaporation. An eddy-covariance station was established on a small island exposed by the historically low lake stage in March 2010, and subsequently was moved to successively higher islands as the lake stage rose throughout 2011.

The energy-budget method is a more traditional method for computing lake evaporation. By applying this method, the energy used for evaporation is estimated as a residual in the energy-budget calculation. To fully account for all terms in the energy budget, data are needed on net radiation and water-temperature profiles – these parameters are measured from platforms floating on the lake surface. Data on the remaining energy-budget terms, such as the volume and temperature of water inflow to, and outflow from, the lake, are compiled or estimated from other ongoing monitoring programs. The USGS has extensive experience with both methods, but this is the first time both methods are being applied and compared for computing evaporation from a large reservoir.

Study Benefits

There are a number of longer-term benefits that USGS and Reclamation hope to accomplish through this cooperative program:

- Establish a unique long-term record of lake evaporation measurements that will be available to the public, researchers, and stakeholders,
- Improve projections of water availability developed by the Colorado Basin River Forecast Center for Reclamation's 24-Month Study.

In addition, results of the study may contribute to ongoing research of large reservoirs throughout the western U.S. on such topics as:

- Measurement of lake evaporation rates through the use of remote sensing,
- Impacts of climate change to lake evaporation rates, and
- Effects of climate variability on large reservoir heat-storage or heat-budget components.

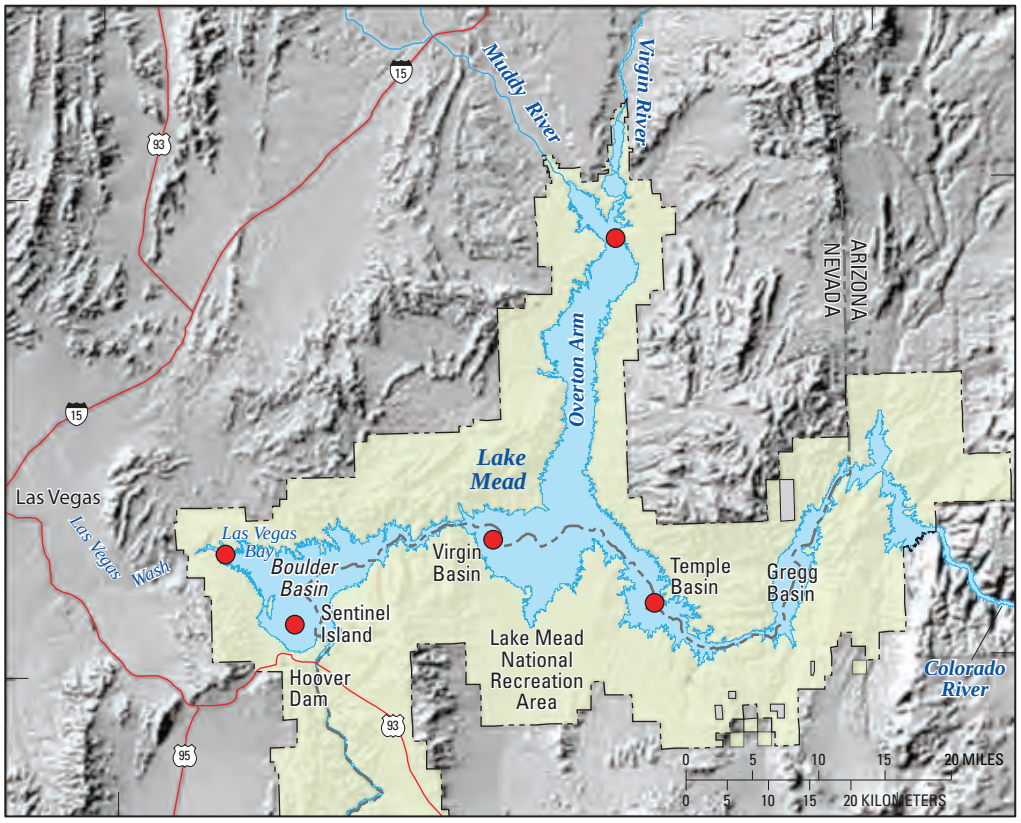
Study results hope to address questions on inter-annual variability in lake evaporation rates that could result from variations in climate conditions, such as net radiation and wind speed. Moreover, long-term studies of evaporation on large reservoirs like Lake Mead could help identify the factors that are most important in controlling evaporation and would further the understanding of lake hydroclimatology.

Lake Mead Monitoring Program, Nevada and Arizona

Continual Depth-Dependent Water-Quality, Acoustic Doppler Current Profile, and Meteorological data collection and analyses.

Project Team: Ron Veley, Mike Moran, and Erin Orozco
Cooperators: National Park Service, Southern Nevada Water Authority, and Clark County Water Reclamation District
Period of project: 2001 - Present

The USGS, in cooperation with the National Park Service, Southern Nevada Water Authority, and Clark County Water Reclamation District is currently collecting continual water-quality, acoustic Doppler current profiles (ADCP), and meteorological data in the Boulder Basin of Lake Mead near Sentinel Island. Data are being collected to better understand spatial and temporal changes in lake water quality and currents, and in atmospheric parameters that influence lake dynamics. Moreover, continual data collected at USGS monitoring stations on the lake help to establish baseline environmental conditions and serve as input and calibration data for ongoing reservoir numerical modeling. Monitoring stations have been rotated over time, with past stations located (1) along the mainstem of the Colorado River in Temple Basin, on the eastern side of the lake, (2) in Virgin Basin, downstream of the confluence of the Colorado River and Virgin River, (3) in Overton Arm below the tributary inflows of the Virgin and Muddy Rivers, and (4) in Las Vegas Bay and below the tributary inflow of Las Vegas Wash. Continual data collected at USGS stations are available online for current and past stations at:
http://nevada.usgs.gov/water/lmqw/map.htm



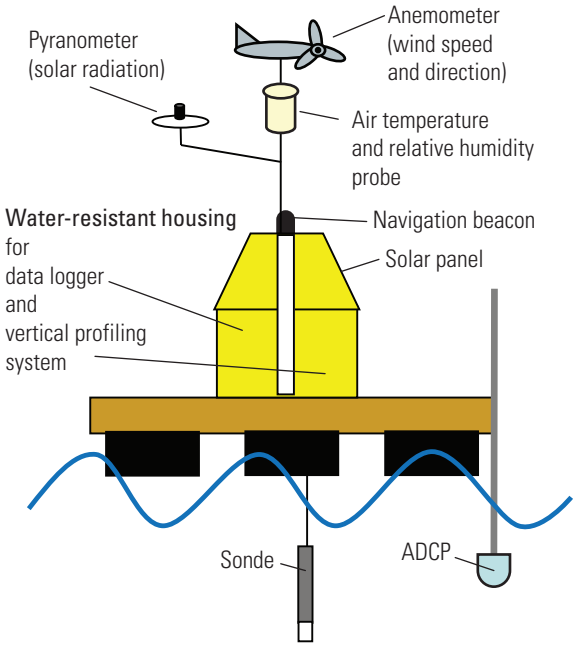
General locations of current and past monitoring stations on Lake Mead.

Objectives

The objectives of the study are to (1) collect continual, depth-dependent measurements of selected water-quality field parameters, hourly averaged ADCP and meteorological data at USGS monitoring stations on Lake Mead, (2) monitor temporal changes in water-quality field parameters measured at each monitoring site, and (3) report near real-time water-quality field-parameter and meteorological data on the internet.

Strategy and Approach

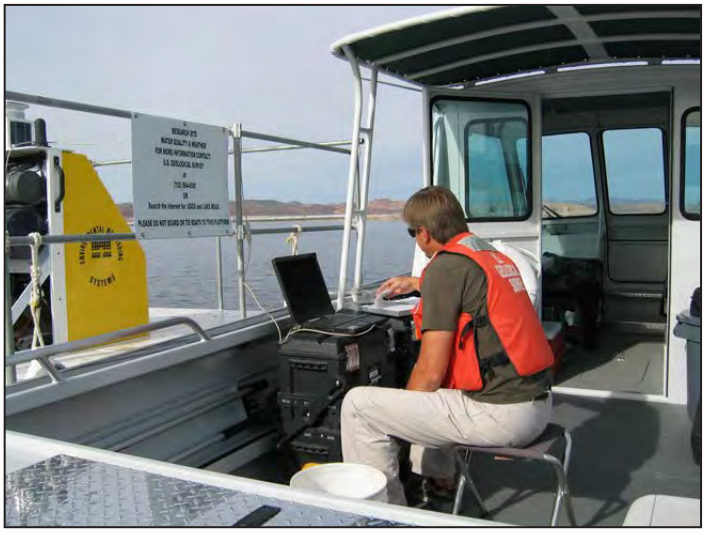
Monitoring stations, housed on floating platforms on Lake Mead, are equipped with a vertical profiling system, a multi-parameter water-quality multiprobe (sonde), a data logger/controller with multiple telemetry options, ADCP and meteorological equipment, a night activated navigation beacon, and power that is supplied by a 12 volt battery/solar panel system. The sonde at each station measures field parameters that include: depth, water temperature, specific conductance, pH, dissolved oxygen, and turbidity. ADCP measure the water velocity and direction of currents over a specified



Left: General schematic diagram of a typical monitoring station. Right: Temple Basin monitoring station.

depth interval. Meteorological equipment measures wind speed and direction, relative humidity, air temperature, solar radiation, and barometric pressure.

The water-quality data are collected every six hours, while the ADCP and meteorological data are collected on an hourly basis. Water-quality and meteorological data are transmitted from the stations to a USGS base station and entered into the USGS National Water Information System database daily. The data are then posted online as near-real-time data. ADCP data are uploaded during routine service trips to the monitoring stations.



ADCP data upload during a routine field visit.

Relevance and Benefits

Continual monitoring of vertical and temporal changes in Lake Mead water quality, lake currents, and meteorological changes provide benefits to ongoing interpretive studies and to programs concerned with natural or anthropogenic change, public education, or recreational activities that have need of near-real time data. Water-quality, ADCP, and meteorological monitoring at Lake Mead are relevant to several USGS Water Resources Discipline (WRD) priorities and Nevada Water Science Center science plan issues. Important WRD goals relevant to this study include (1) providing water-resource information that will be used by multiple agencies for planning and operational purposes and (2) collecting data that will be used to advance the understanding of temporal variations in hydrologic conditions.

Contact Information:

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Hydrogeology of Selected Perennial Hot and Cold Springs in Black Canyon below Hoover Dam, Nevada and Arizona

Delineate and document existing hydrologic conditions at select springs in the Black Canyon area.

Project Team: Leigh Justet, Jon Wilson, Jim Paces, and Sue Beard
Cooperator: National Park Service
Period of project: 2007 - 2010

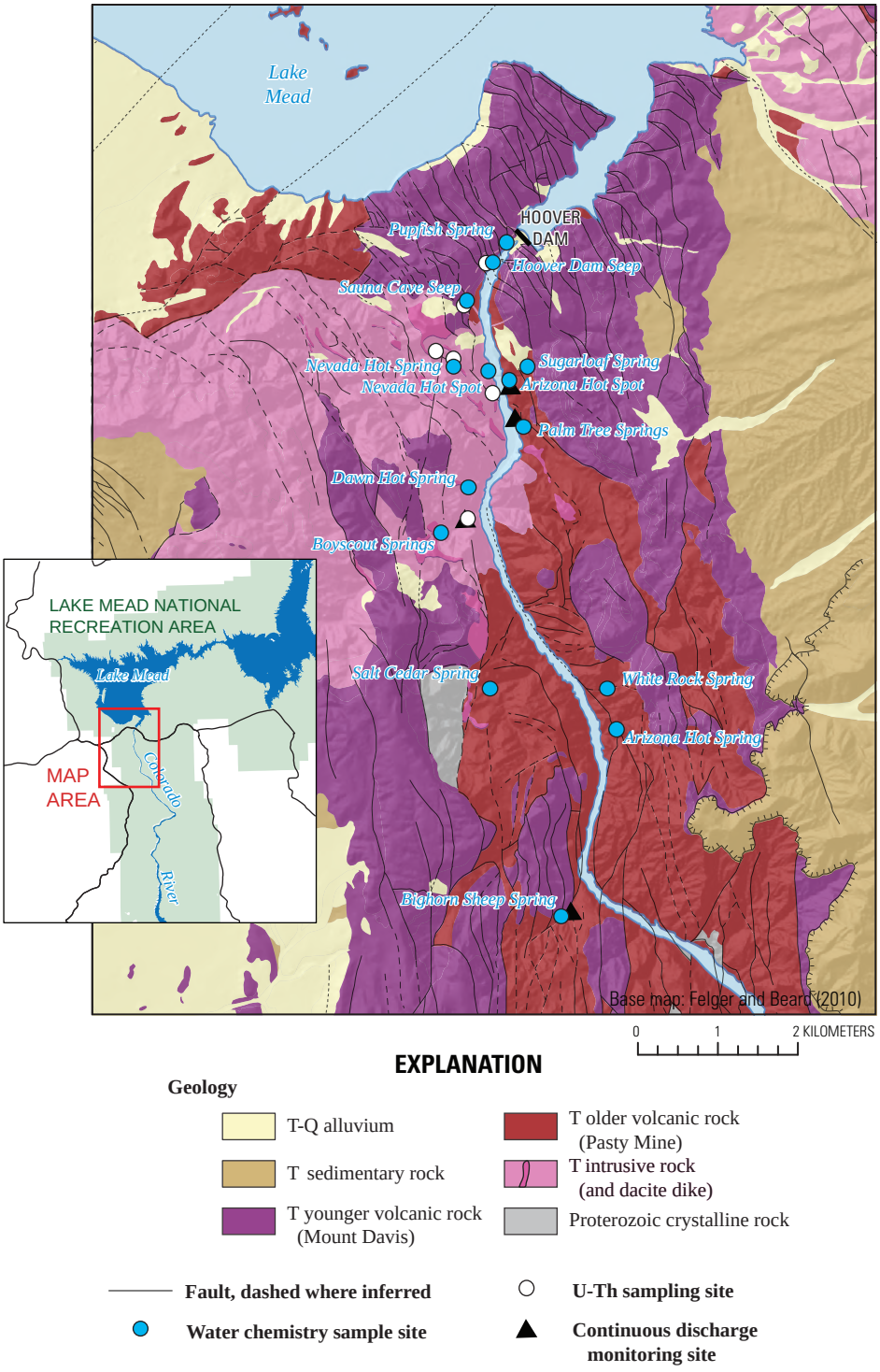
The Springs below Hoover Dam in the Black Canyon of the Colorado River are important hydrologic features of the Lake Mead National Recreation Area. Not only are these springs utilized for recreation, they are unique aquatic, riparian, and phreatophytic ecosystems that support sensitive aquatic species endemic to the Mojave Desert. Rapid population growth in southern Nevada and increased development in Detrital Valley, Arizona, following completion of the Hoover Dam by-pass, will lead to increased demand for water supplies in the area, including ground-water withdrawal. It is unclear how sustained pumping of ground water from these areas may affect aquatic and riparian ecosystems in Black Canyon.

Objectives

The objectives of the proposed study are to: (1) document existing hydrologic conditions at select springs in the Black Canyon area and compare current spring discharge with records of discharge prior to impoundment of Lake Mead;
(2) examine the hydrogeologic conditions that result in the discharge of hot and cold springs in close proximity to one another in Black Canyon; and
(3) delineate potential source areas and flow paths of water discharging at the hot and cold springs in Black Canyon.

Strategy and Approach

Geochemical, hydrologic, and geologic data will be collected to help character-



Geologic map of Black Canyon study area showing sample locations.

Photos of hydrogeologic reconnaissance at various hot and cold springs in Boy Scout Canyon, below Hoover Dam, Nevada.

ize the ground-water system in the Black Canyon area. Major element, trace element, stable oxygen isotopes ($\delta^{18}O$), deuterium (δD), strontium isotopes ($^{87}Sr/^{86}Sr$), uranium isotopes ($^{234}U/^{238}U$), and nutrient concentrations will be determined for water and rock samples from springs in Black Canyon and springs and wells in nearby areas. These data will be used to document seasonal or longer-term variability in water chemistry, characterize water quality conditions, and delineate ground-water sources. Because of the possible hydraulic connection between water impounded in Lake Mead and discharge at Black Canyon springs, records of paleodischarge from tufa or siliceous sinter mounds at several springs will be dated using U-series or radiocarbon methods and analyzed for $\delta^{18}O$, $^{87}Sr/^{86}Sr$, and $^{234}U/^{238}U$. New and existing discharge, water-level, and water-chemistry data collected by land-management agencies, other entities, and this study will be compiled, reconciled, reviewed for quality assurance/quality control purposes, and entered into the publicly accessible USGS National Water Information System. Geologic mapping and kinematic analysis of structures associated with the co-located, hot and cold springs in Black Canyon will be used to evaluate the geologic controls on flow paths.

Five geologic cross-sections will be constructed, including sections roughly east-west from Eldorado to Detrital Valley and NW-SE, north-south, and NE-SW from Las Vegas Valley and Muddy Mountains to Black Canyon.

Relevance and Benefits

Evaluating the quantity, quality, and source of springs within Black Canyon below Hoover Dam will provide water-resource information that can be used by National Park Service scientists and natural-resource managers, as well as representatives of other government entities and local water development interests. Results from this study will help the USGS meet its mission of providing reliable, impartial information useful for water management in a high-growth region and will address a USGS science strategy priority to understand ecosystems and predict ecosystem change.

For additional information contact:

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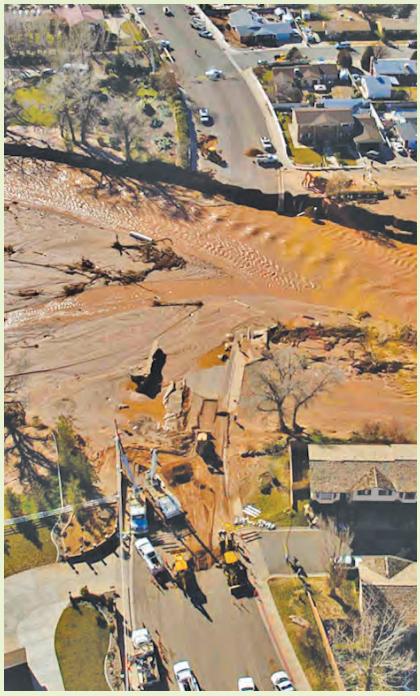
Utah Water Resources Programs, U.S. Geological Survey
http://ut.water.usgs.gov

U.S. Geological Survey Utah Water Science Center

The U.S. Geological Survey (USGS), a bureau of the U.S. Department of the Interior, serves the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life. The USGS has become a world leader in the natural sciences thanks to our scientific excellence and responsiveness to society's needs.



As the Nation's largest water, earth, and biological science and civilian mapping agency, the USGS provides scientific understanding about natural resource conditions, issues, and problems. The diversity of our scientific expertise enables us to carry out large-scale, multi-disciplinary investigations and provide impartial scientific information to resource managers, planners, and other customers.

USGS Utah Water Science is one of 48 Water Science Centers within the USGS. The Water Science Center's mission is to collect, analyze, and disseminate the impartial hydrologic data and information needed to wisely manage water resources for the people of the United States and the State of Utah. Center'scientists conduct investigations on the quantity and quality of Utah's water-related resources and provide science support for Federal, State and local cooperators. Many USGS Utah Water Science Center programs are conducted as part of the USGS Cooperative Water Program. This program supplies approximately 1.5 million dollars of direct science support annually to water-related projects in Utah, frequently through coop-erative arrangements with state and local natural resource agencies. The USGS Utah Water Science Center web site (ut.water.usgs.gov) provides on-line access to our data and includes real-time stream-flow information and historic streamflow data for over 650 sites across the state of Utah.

U.S. Geological Survey Offices in Utah

Data Collection

The U.S. Geological Survey has been collecting stream-flow, water quality and ground water information in Utah since the late 1800's. The USGS currently operates over 150 streamgages, measures nearly 1,000 wells annually. The information is used by government agencies, water users, and the general public to make informed decisions on water related activities and to observe long term trends. Information from both the hundreds of current and thousands of historic sites are available through an interactive map based Web interface (http://wdr.water.usgs.gov/nwisgmap/index.html).

Utah Water Science Center Programs and Activities

Use of Groundwater Models for Water-Resources Management

As demands for water resources in Utah grow, many communities are developing groundwater to meet these needs. Groundwater-flow models are important tools for understanding groundwater conditions and are widely used in the management of groundwater resources. New groundwater-flow models have been developed by the USGS in cooperation with federal, state, and local partners to simulate groundwater flow in the eastern Great Basin and northern Utah Valley, to manage aquifer recharge in Washington County, and to assess groundwater and surface-water relations in the Uinta River. In each case the model integrates data for analysis of the groundwater-flow system and is used to test the conceptual understanding of the groundwater-flow system and to make predictive simulations to assess the effects of groundwater development.

Great Salt Lake Science

Despite the ecological and economic importance of Great Salt Lake, little is known about current and historic mercury input and biogeochemical cycling. The Utah Department of Environmental Quality, Utah Department of Natural Resources, and the USGS initiated studies to investigate the amount of mercury entering the lake from surface and atmospheric sources. In addition to mercury, the USGS is also studying the sources, fate, and transport of other trace elements and nutrients and the ecological effects of these elements. As part of these studies, hydrodynamic models of selected parts of the lake have been constructed to simulate flow including bi-directional density-driven flow and the transport of solutes in the lake and adjoining wetland ecosystems.

Salinity in the Colorado River Basin

The Upper Colorado River Basin discharges more than 6 million tons of dissolved solids annually. The Bureau of Reclamation has estimated the economic damages related to salinity in the basin to be in excess of 330 million dollars annually. The USGS has recently developed a statistical model for the basin which is providing Colorado River Basin Salinity Control Program managers and others with estimates of salinity loads and sources, and enabling them to make informed decisions about the most cost-effective use of salinity control program funds and mitigation projects.

Water in the Great Basin

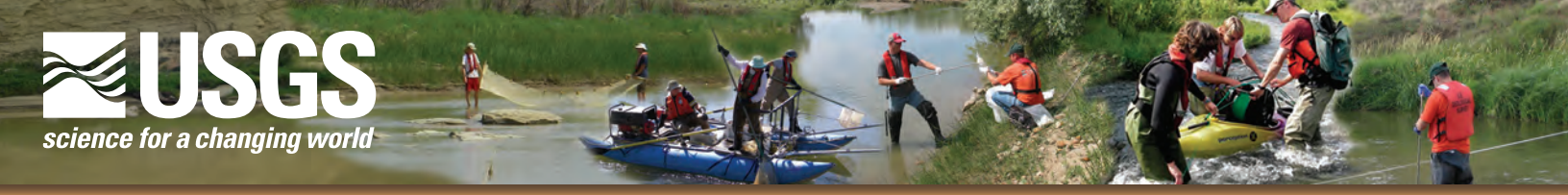
The eastern Great Basin Carbonate Province, located primarily in western Utah and eastern Nevada is undergoing unprecedented population growth. As part of the USGS National Water Availability Program, the Great Basin Carbonate and Alluvial Aquifer System study is quantifying current groundwater resources, evaluating how those resources have changed over time, and developing tools to assess system responses to stresses from future human uses and climate variability. An integrated assessment of hydrology and geology has resulted in a new conceptual understanding of water movement within this complex system.

Other USGS Studies and Activities in Utah

The USGS conducts studies, and monitors and models water resources to provide science support and understanding for management of these resources by federal, state, and local agencies. Examples include:

- Great Basin groundwater model
- Mapping land disturbance associated with oil and gas development
- Mercury remediation in Newcastle Reservoir
- Groundwater/surface-water interaction in the Uinta River
- Managed aquifer recharge at Sand Hollow Reservoir
- Aquatic ecology of streams in the southwestern United States
- Hydrodynamic modeling of the Jordan River
- Selenium fate and transport in the Great Salt Lake
- Uranium contamination adjacent to a uranium mill site
- Groundwater and salinity discharge to the Colorado River
- Source and travel time of water discharged to large springs
- Great Salt Lake Basins National Water Quality Assessment
- Assessment of the groundwater in Rush Valley
- Water use in Utah

For additional information, please contact the Utah Water Science Center at (801) 908-5000 or visit http://ut.water.usgs.gov



Wyoming Water Resources Programs, U.S. Geological Survey
http://wy.water.usgs.gov

Mission of the U.S. Geological Survey

The U.S. Geological Survey (USGS) provides the Nation with reliable, impartial information to describe and understand the Earth. This information is used to:

- Minimize loss of life and property;
- Manage water, biological, energy, and mineral resources;
- Enhance and protect the quality of life; and
- Contribute to wise economic and physical development

U.S. Geological Survey Offices in Wyoming

Water-Resources Programs at the Wyoming Water Science Center

The U.S. Geological Survey has been providing information about the distribution, availability, and quality of water in Wyoming since 1890. Our mission is to collect high-quality hydrologic data and conduct objective, scientifically-sound hydrologic investigations. Over time, the focus of our work has evolved to meet the changing needs of those who use our information, but our mission has not changed.

The bulk of the Wyoming Water Science Center's work is driven by State needs: The Cooperative Water Program provides the authority and funding to partner with State and local agencies for up to 50 percent of qualifying project costs; the Cost-Share program allows us to partner with Department of Interior agencies managing lands within Wyoming. We also receive appropriated funding for our contributions to USGS national programs such as the National Streamflow Information Program (NSIP) and the National Water Quality Assessment Program (NAWQA). For examples of center activities please see the reverse side.

Funding Breakdown for the Wyoming Water Science Center

Partnerships with State and Local Agencies $2,007,241:

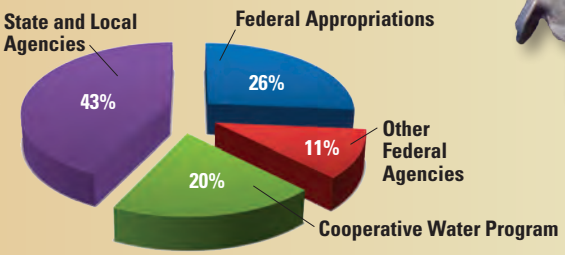
City of Gillette
City of Sheridan
Jackson Hole Airport
Colorado University
Montana Department of Environmental Quality
Teton Conservation District
Wyoming Department of Agriculture
Wyoming Department of Environmental Quality
Wyoming State Engineer
Wyoming State Geological Survey

Federal Appropriations $1,238,307

Partnerships with Other Federal Agencies $521,702:

Bureau of Land Management
Bureau of Indian Affairs
Bureau of Reclamation
National Park Service
U.S. Army Corps of Engineers

Cooperative water program $928,308



Wyoming Water Science Center Programs and Activities

Data Collection Network

The U.S. Geological Survey currently operates hundreds of data collection sites in Wyoming for acquiring information on surface-water, groundwater, water-quality, and precipitation. Sites with satellite telemetry provide real-time data via GOES satellites and downlinks, which enables the posting of data to the Web for public dissemination. We recently added a Google-Map based Web page to deliver map-based current surface-water resources conditions in Wyoming.

Hydrologic data collected by the USGS are published in annual hydrologic data reports for Wyoming, or in interpretive reports. Most of the data are also available on the Web through the USGS National Water Information System NWISWeb server.

Jackson Hole Airport Groundwater Study

In 2008 the U.S. Geological Survey, in cooperation with the Jackson Hole Airport Board of Directors and Teton Conservation District, began a study designed to characterize the alluvial aquifer at the Jackson Hole Airport. The purpose of this study is to determine the direction of groundwater flow, calculate hydraulic gradients, and characterize groundwater quality both upgradient and downgradient of airport activities and facilities that could affect shallow groundwater quality.

Assessment of Aquatic Communities in Northeastern Wyoming and Southeastern Montana

The Powder River Structural Basin (PRB) in northeastern Wyoming and southeastern Montana is an important source of energy resources for the United States. Resources developed from the basin include coal, oil, uranium, conventional natural gas, and within the last decade coal-bed natural gas (CBNG) which often is referred to as coal-bed methane. As of 2008, about 20,000 CBNG wells had been drilled in northeastern Wyoming (Wyoming Oil and Gas Conservation Commission, 2010). An estimated 50,000 to 60,000 CBNG wells could be drilled and put into production in the PRB by 2012. Throughout the PRB large volumes of groundwater are removed from coal-bed aquifers and discharged on the surface in order to recover CBNG. This groundwater, which can be slightly to moderately saline, is discharged to perennial, intermittent and ephemeral streams as well as to surface impoundments. It is currently unknown what potential impacts these discharges will have on aquatic communities (fish, macroinvertebrates, and algae) and their habitats.

Wyoming Landscape Conservation Initiative

The Wyoming Landscape Conservation Initiative (WLCI) is a multi-partner, long-term, science-based program to assess, monitor, and enhance aquatic and terrestrial habitats at a landscape scale in southwest Wyoming. The Wyoming Water Science Center conducts several projects in the WLCI footprint in cooperation with local, State, and other Federal agencies.

Other Projects in Wyoming

The Wyoming Water Science Center conducts hydrologic projects that address a wide variety of water-resources issues, including water supply, ground-water contamination, nutrient loading in streams, effects of land use on water quality, and basic hydrologic data collection. Projects include:

- Aquatic Community Assessment
- Antarctica Streamgaging
- Characterization of Fish Creek
- Coupled Real-time Streambank Piezometer and Gaging Station
- Development of Regional Curves Relating Bankfull-Channel Geometry and Discharge to Drainage Area for Hydrophysiographic Regions in Wyoming
- Drought Watch
- Jackson Hole Airport Groundwater Study
- Pesticide Monitoring
- Wyoming Groundwater-Quality Monitoring Network
- Water Use in Wyoming
- Yellowstone River Basin National Water Quality Assessment

For additional information, please contact David Mott at (307) 775-9162 (dmott@usgs.gov) or visit http://wy.water.usgs.gov

USGS science for a changing world

Prepared in cooperation with the Wyoming Department of Environmental Quality

Wyoming Groundwater-Quality Monitoring Network

Introduction

A wide variety of human activities have the potential to contaminate groundwater. In addition, naturally occurring constituents can limit the suitability of groundwater for some uses. The State of Wyoming has established rules and programs to evaluate and protect groundwater quality based on existing and potential uses. The Wyoming Groundwater-Quality Monitoring Network (WGQMN) is a cooperative program between the U.S. Geological Survey (USGS) and the Wyoming Department of Environmental Quality (WDEQ) and was implemented in 2009 to evaluate the water-quality characteristics of the State's groundwater. Representatives from USGS, WDEQ, U.S. Environmental Protection Agency (USEPA), Wyoming Water Development Office, Wyoming State Geological Survey, and Wyoming State Engineer's Office formed a steering committee, which meets periodically to evaluate progress and consider modifications to strengthen program objectives. The purpose of this fact sheet is to describe the WGQMN design and objectives, field procedures, and water-quality analyses. USGS groundwater activities in the Greater Green River Basin also are described.

Network Design and Objectives

The WGQMN is designed to include wells that are in priority areas where groundwater has been identified as an important source of drinking water to public and private water supplies, is susceptible to contamination, and is overlain by one or multiple land-use activities that could negatively affect groundwater resources (Bedessem and others, 2003) (fig. 1, table 1). The State identified 33 priority areas and grouped them together by major basin for implementation purposes (table 1). Groundwater-quality samples will be collected from 20 to 30 wells within each priority area. Wells to be selected for sampling will be completed in Quaternary-age unconsolidated aquifers and shallow (less than 500 feet deep) bedrock aquifers. Data collection and reporting activities by the USGS as part of the WGQMN will include the following:

- Measurement of the water level in each well;
- Collection of groundwater samples from each well to be analyzed for a wide variety of natural and human-made constituents;
- Analysis of select samples for constituents such as stable isotopes to help determine recharge characteristics of the groundwater;
- Reporting of analytical results through a publicly available USGS water-quality Web site (*http://waterdata.usgs.gov/wy/nwis/qw/*); and
- Periodic summaries of groundwater data in published USGS Fact Sheets and Scientific Investigations Reports.

Field Procedures

Site selection, field measurements, and water-quality sampling procedures are performed in accordance with approved methods in the USGS National Field Manual for the Collection of Water-Quality Data (U.S. Geological Survey, variously dated). Prior to sampling, the depth to water in the well is measured to the nearest 0.01 foot, if possible. If a pump is not permanently installed in the well, a submersible pump is used for purging and sampling. Field properties (temperature, pH, oxidation-reduction potential, specific conductance, dissolved oxygen, and turbidity) are measured and recorded regularly during purging. Each well is purged by removing a minimum of three casing volumes of standing water. After purging, samples are collected when field properties have stabilized. Sample-collection connections are made at the wellhead or other sampling point to allow the use of a mobile water-quality laboratory to process the samples (figs. 2 and 3). Samples are preserved and containerized on site, according to individual analytical method requirements.

Details about the site and well are useful for interpreting analytical results. Field documentation includes groundwater-quality notes, which are used to record information about sampling conditions, analytical laboratories, calibration, well condition, water-level measurements, well purging and associated stability measurements, and quality-control samples. Analytical services request forms are used to record the USGS site identification number, sample date and time, requested laboratory schedules and codes, and types of bottles and their treatments. Photographs are used to document the well condition and surrounding land uses.

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U.S. Geological Survey

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April 2011

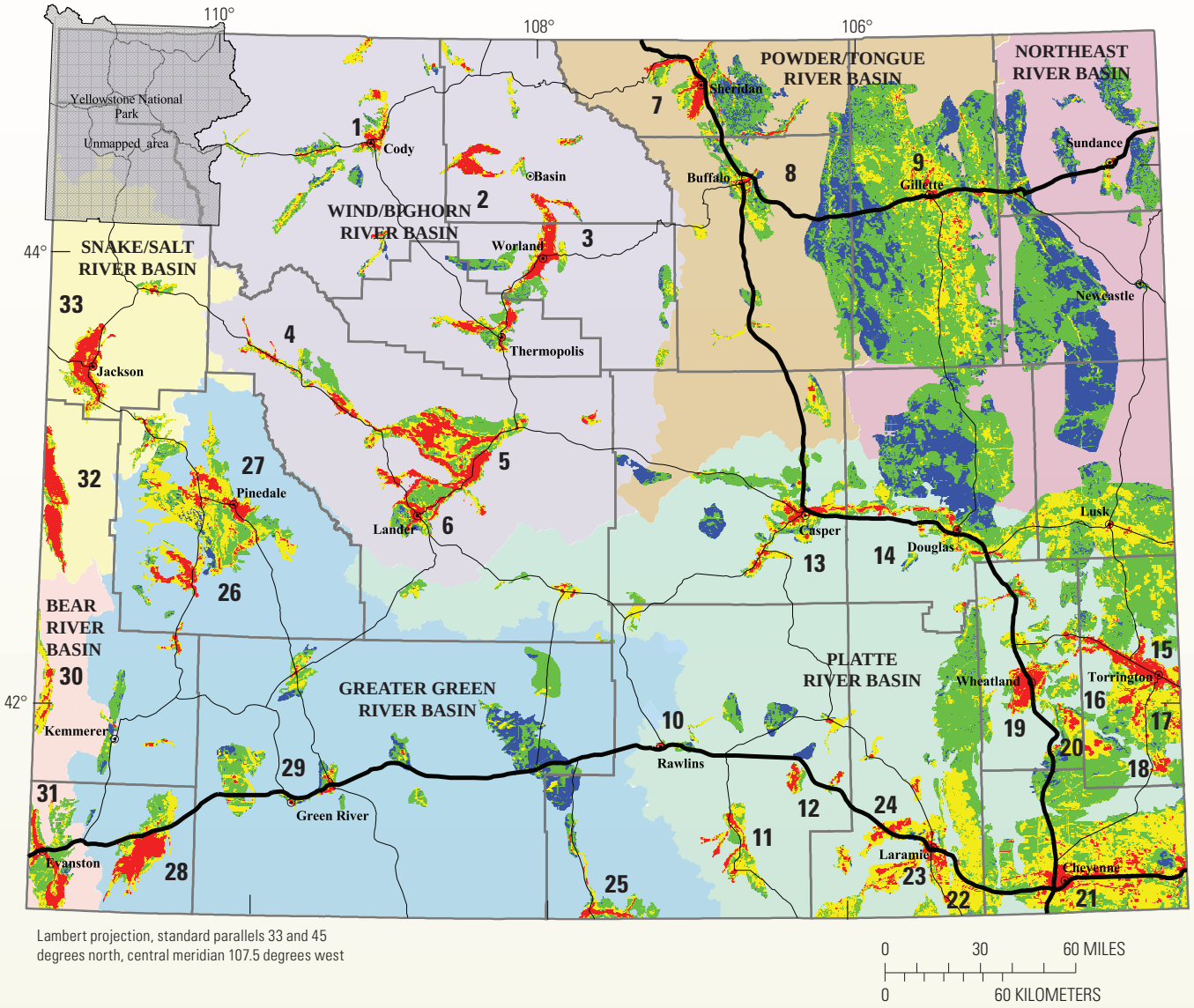

Figure 1. Groundwater with the highest priority for sampling is shown as red and yellow (modified from Bedessem and others, 2003).

EXPLANATION

Aquifer Prioritization for Ambient Groundwater Monitoring

Aquifer prioritization

- Low
- Low–moderate
- Moderate–high
- High
- No data

15 Map number (see table 1) for moderate–high and high priority areas

Produced by the University of Wyoming Geographic Information Science Center and the Department of Civil and Architectural Engineering at the University of Wyoming, in cooperation with the Wyoming Department of Environmental Quality Water Quality Division, the Wyoming State Geological Survey, the U.S. Geological Survey, and the University of Wyoming Department of Geology and Geophysics.

UNIVERSITY OF WYOMING

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Distributed by the Wyoming Geographic Information Science Center (WyGISC). For information call (307)766-2532 or e-mail info@wygisc.uwyo.edu.

Table 1. Priority areas identified for inclusion in the Wyoming Groundwater-Quality Monitoring Network.

Site number (fig. 1)	Priority area	Basin	Site number (fig. 1)	Priority area	Basin
1	Cody/Wapiti	Wind/Bighorn	18	LaGrange/Hawk Springs	Platte
2	Emblem	Wind/Bighorn	19	Wheatland	Platte
3	Thermopolis/Big Horn River/Worland	Wind/Bighorn	20	Slater/Chugwater	Platte
4	Dubois/Crowheart	Wind/Bighorn	21	Cheyenne	Platte
5	Riverton/Wind River	Wind/Bighorn	22	Laramie/Tie Siding	Platte
6	Lander/Hudson	Wind/Bighorn	23	Laramie River	Platte
7	Sheridan/Dayton	Powder/Tongue	24	Little Laramie River	Platte
8	Buffalo	Powder/Tongue	25	Baggs	Greater Green
9	Gillette/Rozet	Powder/Tongue	26	Big Piney/Marbleton	Greater Green
10	Rawlins	Platte	27	Pinedale/Boulder/Daniel	Greater Green
11	Saratoga	Platte	28	Mountain View	Greater Green
12	Elk Mountain	Platte	29	Rock Springs	Greater Green
13	Casper/Evansville/Alcova	Platte	30	Cokeville	Bear
14	Glenrock/Douglas/Orin	Platte	31	Evanston	Bear
15	Torrington	Platte	32	Star Valley	Snake/Salt
16	Yoder/Veteran	Platte	33	Jackson/Teton Village	Snake/Salt
17	Huntley and by border	Platte			

Figure 2. Mobile water-quality laboratory used for the collection of samples from groundwater wells.

Figure 3. Wellhead connections for groundwater sampling that lead to the mobile water-quality laboratory and discharge line.

Water-Quality Analyses

Groundwater samples are analyzed for major ions, trace elements, nutrients, and volatile organic compounds at the USEPA Region 8 Laboratory in Denver, Colo., and for total dissolved solids, dissolved organic carbon, and stable isotopes at various USGS laboratories. Coliform bacteria (total coliform and *E. coli*) colony counts and alkalinity values are determined in the field. Select samples also may be analyzed for wastewater compounds, radionuclides (tritium, gross-alpha and gross-beta radioactivity, and radon-222), total petroleum hydrocarbons (diesel-range and gasoline-range organics), dissolved hydrocarbon gases, and biological activity reaction tests.

USGS Groundwater Activities in the Greater Green River Basin

Although the WGQMN scope is Statewide, water-quality sampling will be implemented by basin. Sampling by the USGS began in December 2009 in five priority areas within the Greater Green River Basin. The WGQMN in the Greater Green River Basin builds on existing USGS projects in the basin such as the Wyoming Landscape Conservation Initiative, not only to leverage limited resources, but also to improve the understanding of groundwater. A recently completed summary of physical and chemical characteristics of groundwater resources (Clarey and others, 2010) and an ongoing project by Bowen and others (2010) were used to select wells to be sampled in unconsolidated and bedrock aquifers within the priority areas for the Greater Green River Basin. Selection of basins for future sampling will be conducted in consultation with the WDEQ and will be based on groundwater management needs of the State.

References Cited

Bedessem, M.E., Casey, Brenda, Frederick, Kevin, and Nibbelink, Nathan, 2003, Phase I: Aquifer prioritization, Final report: Prepared for the Wyoming Department of Environmental Quality by the University of Wyoming Department of Civil and Architectural Engineering, Laramie, Wyo., variously paged.

Bowen, Z.H., Aldridge, C.L., Anderson, P.J., Assal, T.J., Biewick, L.R.H., Blecker, S.W., Bristol, S., Carr, N.B., Chalfoun, A.D., Chong, G.W., Diffendorfer, J.E., Fedy, B.C., Garman, S.L., Germaine, S., Grauch, R.I., Holloway, J., Homer, C., Kauffman, M.J., Keinath, D., Latysh, N., Manier, D., McDougal, R.R., Melcher, C.P., Miller, K.A., Montag, J., Nutt, C.J., Potter, C.J., Sawyer, H., Schell, S., Shafer, S.L., Smith, D.B., Stillings, L.L., Tuttle, M., and Wilson, A.B., 2010, U.S. Geological Survey Science for the Wyoming Landscape Conservation Initiative—2009 Annual Report: U.S. Geological Survey Open-File Report 2010–1231, 106 p., accessed March 7, 2011, at *http://pubs.usgs.gov/of/2010/1231/*.

Clarey, K.E., Bartos, Timothy, Copeland, David, Hallberg, L.L., Clark, M.L., and Thompson, M.L., 2010, Available groundwater determination, Technical memorandum, Green River Basin Water Plan II—Groundwater study Level I (2007–2009): Prepared for the Wyoming Water Development Commission by the Wyoming State Geological Survey, Laramie, Wyo., variously paged, accessed March 7, 2011, at *http://waterplan.state.wy.us/plan/green/2010/finalrept/gw-tpage_preface.pdf*.

U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1–A9, available online at *http://pubs.water.usgs.gov/twri9A*.

For More Information

Visit the USGS Wyoming Water Science Center Web site at: *http://wy.water.usgs.gov/projects/gw_monitoring/index.htm*, or contact:

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This fact sheet is available at *http://pubs.usgs.gov/fs/2011/3041* or from U.S. Geological Survey, Information Services, Box 25286, Denver Federal Center, Denver, CO 80225.

Water Use Data Exchange

Overall Goals:

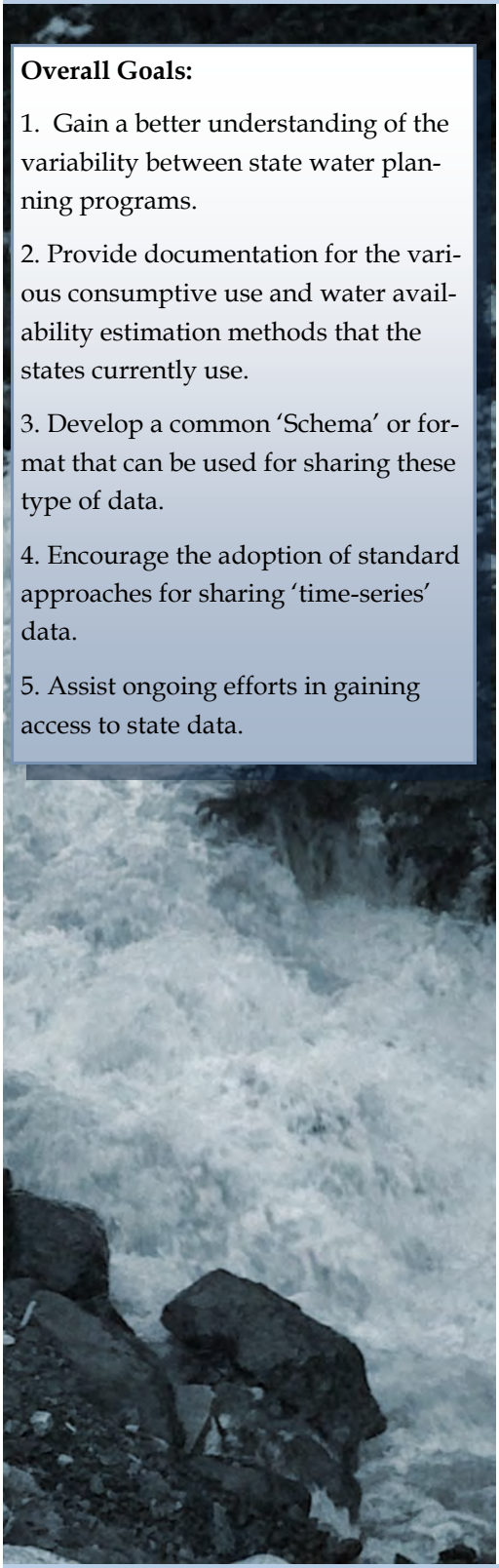
1. Gain a better understanding of the variability between state water planning programs.

2. Provide documentation for the various consumptive use and water availability estimation methods that the states currently use.

3. Develop a common 'Schema' or format that can be used for sharing these type of data.

4. Encourage the adoption of standard approaches for sharing 'time-series' data.

5. Assist ongoing efforts in gaining access to state data.



What is the Water Use Data Exchange?

The Water Use Data Exchange is a project that will focus on better enabling the western states to share water use, water allocation, and water planning data with one another and with the Federal Government. It will also seek to improve the sharing of Federal data that supports state water planning efforts.

The Water Use Data Exchange is a collaborative effort between the Western States Water Council (WSWC), the Western States Federal Agency Support Team (WestFAST), the Western Governors' Association (WGA), and the Department of Energy Labs.

These data are important for a number of applications. Some examples include, but are certainly not limited to:

1. State and Regional Water Planning
2. Local Development Planning
3. Siting of Power Production Facilities
4. Enabling a Better Understanding of the Link Between Water Quantity and Water Quality

How does this project relate to other national efforts?

This effort is in direct support of a Department of Energy study that is evaluating water availability for energy production in the West. Another national effort, the Water Census, which is led by the U.S. Geological Survey (USGS) is also looking for ways to better understand water use, and to answer the question of: "Is there enough water to meet human and ecological needs now, and into the future?" . The Water Use Data Exchange will support both of these efforts by laying the groundwork for exchanging the core data that support these studies.

For both of these studies, one of the first steps is to get access to the raw data. Currently that process if manual. Additionally, the data are difficult to compare across states, or even across basins. This project will begin the process of improving the interoperability of these disparate data sources by first evaluating the differences, documenting the various methodologies, and then making recommendations for common data exchange formats and piloting that exchange with some of the western states.

How will the Exchange Work?

The exchange will rely upon a web-services-based approach allowing each of the states to maintain their current data systems as they currently exist, with their data mapped to a standard format. Using automated processes, these data would be published over the web using eXtensible Markup Language (XML) and will be discoverable via a common catalog that is maintained at the WSWC.

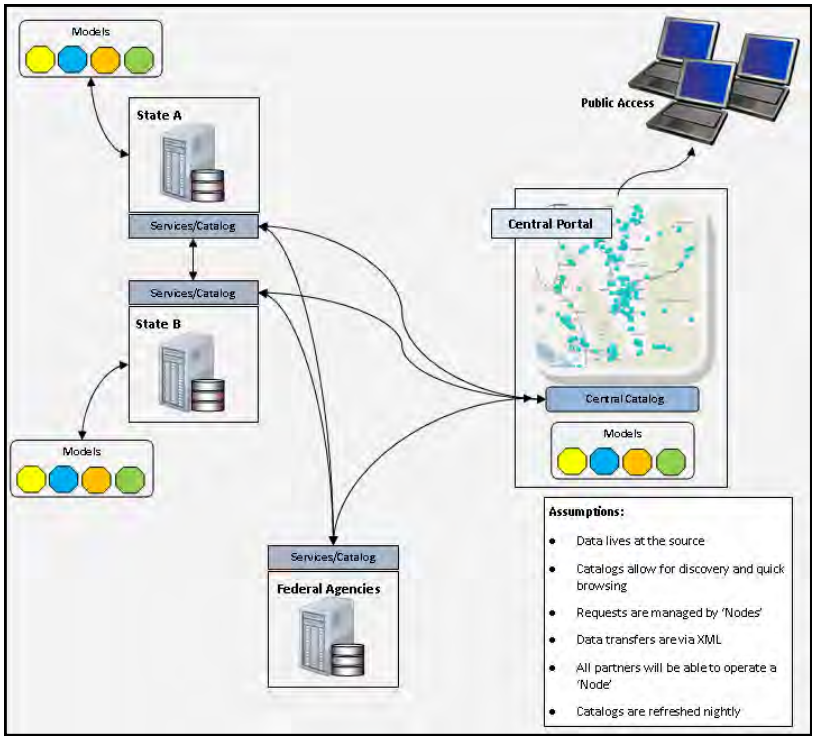


Figure 1. Conceptual Design

Who's Participating in This Effort?

The Water Resources Committee under the WSWC has commissioned its Water Information and Data Subcommittee to lead this effort. The subcommittee has also commissioned four workgroups to begin scoping out and designing the exchange. The workgroups currently consist of representatives from state and federal agencies, and currently include representatives from:

-Nebraska	-Texas	-NASA
-Oklahoma	-Wyoming	-Reclamation
-Oregon	-BLM	-USGS

Want to Be Involved?

If you're interested in participating in this effort, please contact the WestFAST Federal Liaison (Dwane Young) at:

Phone: 801-685-2555
Email: dayoung@wswc.utah.gov

Western States Water Council
5296 South Commerce Drive, Suite 202
Murray, UT 84107
801-685-2555
http://www.westgov.org/wswc/

For more information on the Water Use Data Exchange, see: http://www.westgov.org/wswc/wateruse/

WestFAST on the Web: http://www.westgov.org/wswc/WestFAST.htm

Western States Federal Agency Support Team (WestFAST)

The Western States Federal Agency Support Team (WestFAST) is a collaboration between 11 Federal agencies with water management responsibilities in the West (Environmental Protection Agency, National Oceanic Atmospheric Administration, Bureau of Reclamation, Bureau of Land Management, , U.S. Geological Survey, U.S. Fish and Wildlife Service, U.S. Forest Service, Natural Resources Conservation Service, U.S. Army Corps of Engineers, U.S. Department of Energy, and National Aeronautics and Space Administration). WestFAST was established to support the Western States Water Council (WSWC), and the Western Governors Association in coordinating Federal efforts regarding water resources.

WestFAST began as an agreement between nine federal agencies in 2008. In 2010, that number grew to eleven when the Department of Energy (DOE) and National Aeronautics and Space Administration (NASA) joined the WestFAST team. These eleven federal agencies form a dynamic, flexible team that provides the opportunity for interaction initiated by WSWC, individual states, or the federal government. These agencies have also continued to support a federal liaison stationed in the WSWC's office responsible for coordinating efforts among the agencies with the WSWC. The WestFAST collaboration has provided excellent opportunities for cross-agency discussions and leveraging of shared knowledge. In 2010 WestFAST developed the *WestFAST Agencies Water-Climate Change Program Inventory Report*, which provided an overview of WestFAST agency efforts in regard to climate change, continued to support the National Integrated Drought Information System (NIDIS), provided support to the Landscape Conservation Cooperatives (LCCs), and began discussion on forming a 'WestFAST-type' organization for the State of Kansas.

The federal agencies that make up WestFAST all have unique roles within western water management. WestFAST provides a means for those agencies to collaborate in a way that they may not otherwise be able. The WestFAST team stresses collaboration in the following areas:

1. Climate Change
2. Water Availability, Water Use, and Water Reuse
3. Water Quality

By identifying ways that the federal agencies can collaborate in these areas, WestFAST will not only mimic the WSWC's goals and the WGA's goals, but will also help promote the individual agency goals.

The WestFAST chair is Jean Thomas (USFS); the vice-chair is Michael Fallon (USACE). Dwane Young is the Federal Liaison to the WSWC.

Colorado River Water Science Stakeholders' Roundtable

Useful Website Addresses

Interstate Council on Water Policy (ICWP) - http://www.icwp.org

Western States Federal Agency Support Team (WestFAST) – http://www.westgov.org/wswc/WestFAST.htm

Western States Water Council - http://www.westgov.org/wswc/

USGS – National Programs

- Cooperative Water Program (CWP) - http://water.usgs.gov/coop/
- National Streamflow Information Program (NSIP) - http://water.usgs.gov/nsip/
- Office of Surface Water – http://water.usgs.gov/osw
- Office of Groundwater – http://water.usgs.gov/ogw
- Office of Water Quality – http://water.usgs.gov/owq
- Water Use - http://water.usgs.gov/watuse/
- Water Census - http://water.usgs.gov/wsi/index.html

USGS – Water Science Centers in the Colorado River Basin

- Arizona – http://az.water.usgs.gov/
- California – http://ca.water.usgs.gov
- Colorado – http://co.water.usgs.gov
- New Mexico – http://nm.water.usgs.gov
- Nevada – http://nv.water.usgs.gov
- Utah – http://ut.water.usgs.gov
- Wyoming – http://wy.water.usgs.gov

Federal Advisory Committee on Water Information
http://acwi.gov/

US Department of the Interior
http://www.doi.gov/bureaus.html

Colorado River Basin States

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