



# SUCCESS STORIES



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## RECLAMATION'S S&T PROGRAM

### Using Science to Address Water in the West

The Bureau of Reclamation's Science and Technology (S&T) Program explores innovative ways to increase water management flexibility and reliability in the Western U.S. The program focuses on four main areas: infrastructure reliability, water delivery reliability, water supply technologies, and decision support for water operations. In 2002, the program implemented new business practices, helping to build a better scientific and technological foundation to support Reclamation's mission:

- Developed a Science and Technology Program roadmap to guide research planning and execution by showing how research outputs strategically link to Reclamation's mission outcomes.
- Streamlined our competitive research proposal process to match our research with Reclamation objectives.
- Expanded our steering team membership to involve other water research agencies and stakeholders.
- Strengthened the steering team's role in prioritizing and guiding funding allocations to Reclamation's most critical priorities.
- Improved water resources research coordination with other Federal and non-Federal agencies to more effectively support our unique niche—developing practical, affordable, and innovative solutions for Western water management.

In 2002, we focused on clients and stakeholders to ensure our research outputs are relevant, supported, and used. We held an initial outreach research workshop in July 2002, which was a big success.

## INFRASTRUCTURE RELIABILITY

### Keeping the Lights On and Affordable

The Science and Technology Program's research in 2002 played a key role in keeping a stable and dependable Western power supply. Highlights included:

- A new test system that detects insulation delamination before power outages.
- A new hardware probe to detect faults in stator windings before breakdowns occur. This probe could save more than \$250,000 per year, based on existing failure rates.
- An inexpensive battery system that increases the reliability and life expectancy of back-up power sources. This no-frills system costs only \$50 a cell.
- A rotor-turning gear design which allows workers to safely turn generators and motors during inspections and repairs.
- A tunnel communication radio that enables reliable, clear communications with inspectors and maintenance workers in long water delivery tunnels. The radio improves worker safety and decreases down time needed to inspect and repair tunnels.

*Stabilizing Power Systems.* In 2002, we applied state-of-the-art technology in power system stabilizers to hydroelectric generators at Yellowtail and Alcova Powerplants. The S&T Program collected data to analyze and test these stabilizers to apply them in the future to remote diagnostics, testing, and performance verification. Improving system stability helps reduce the need for more transmission lines and helps avoid regional blackouts and the hundreds of millions of dollars of losses associated with blackouts.

*Supervisory Control and Data Acquisition (SCADA).* SCADA allows operators to control multiple generators and equipment (even remote and unmanned) from a central site. Building these in parts—rather than creating an entire system over again—saves time and provides operating flexibility.

In fiscal year (FY) 2002, S&T completed the Modular SCADA research. Continuing updates are funded by projects. Reclamation's Mid-Pacific and Lower Colorado Regions are using these advanced SCADA concepts. Both regions now employ open access, modular concepts which increase flexibility and facilitate improvements.

The SCADA research in FY 2002 developed configuration methodologies to set up a SCADA system which consists of multiple modules. The research also developed report generation, unit control tools, and powerplant control capabilities that run on a Microsoft operating system. Both regions are retiring their older VMS and UNIX systems. Moving to new systems will cost less and take less time, thanks to the Modular SCADA system. These regions have already saved millions of dollars on developing systems and will continue to save money by sharing these modular concepts.

*Balancing Cell Voltages.* Powerplant batteries are the most critical system in a powerplant and are the sole source of power and control in emergency situations. The S&T Program developed, and is now demonstrating, an electronic circuit to equalize and balance the cell voltages of large, multi-cell batteries used in Reclamation facilities. This process keeps cells at peak performance, extends the useful life of the battery, and signals that the cell is beginning to fail. The cost to monitor a 60-cell battery is estimated to be about \$3,000. Rival systems, presently available, cost over \$10,000.

## INFRASTRUCTURE RELIABILITY

### Self-Cleaning Stilling Basins

Rocks and debris become entrained in continuous forceful flows, damaging stilling basins on many Reclamation and non-Reclamation dams. This damage, called scour, requires expensive, repeated repairs which interrupt water deliveries.

The S&T Program developed a flow deflector that is expected to significantly reduce or eliminate this damage, increasing the reliability and lifespan of many stilling basins. The flow deflector is installed at the end of the stilling basin and alters flow conditions so that the stilling basins are self-cleaning. Reclamation installed this device at Mason Dam in eastern Oregon in October 2002, with testing scheduled for fall 2003.

The S&T Program is partnering with the Baker Valley Irrigation District and the Snake River Area Office to evaluate the field performance of the flow deflector.

## WATER DELIVERY

### Delivering Water While Saving Fish

Innovative fish passages at Reclamation facilities can help promote effective water deliveries by reducing environmental conflicts. S&T Program research has led to many effective fish passes engineered for native fish such as the Colorado razorback suckers, pikeminnow, cui-ui suckers, sturgeon, and other endangered or at-risk species.

In FY 2002, S&T partnered with the Mid-Pacific Region to design a rock fishway that was constructed at Derby Diversion Dam, near Reno, Nevada. Reclamation's first fish pass was constructed on Derby Diversion Dam in about 1913. It was destroyed in a flood a few years

later. The new fishway will help restore access for Lahonton cutthroat trout to spawning areas in the Sierra Mountains, miles upstream of their home in Pyramid Lake. Species recovery is of particular importance to the Pyramid Lake Paiutes Tribe and will reduce the conflicts associated with Reclamation's water delivery operations.



View looking upstream along the Derby Dam rock fishway.

### Irrigation and Chinook Salmon Win

Dam operations can influence the downstream environment for fish, not only on the surface of the water but in the riverbed's intragravel region. The S&T Program is helping to improve the operations of Cle Elum Dam so that operations will not adversely affect Chinook salmon. These salmon lay their eggs in the gravel. The study will help answer vexing questions: does the flow released from a dam influence the flow in the intragravel region; and, if that intragravel flow changes, does it influence the survival of salmon eggs?

The S&T Program is supported by and partnering with Reclamation's Upper Columbia Area Office, Reclamation's Pacific Northwest Region, The Yakama Nation, and the Yakima Joint Irrigation Board. This research will lead to recommendations for dam operations.

## Clearing Clogged Waterways

Aquatic and riparian invasive plants, such as salt cedar, hydrilla, water hyacinth, and salvinia, plague many Western waterways. They spread uncontrollably, clogging Reclamation's water delivery systems and consuming much more water than native vegetation.

Through effective partnership working groups, the S&T Program made strong contributions during FY 2002 to help control invasive species. We advanced and demonstrated integrated control and revegetation technologies along the Rio Grande.

Along the Arkansas River, we released an insect that eats only salt cedar. Expanded demonstration and testing of this biocontrol technology alternative is planned for FY 2003.

The S&T Program also sponsored a research outreach workshop with other agencies, water managers, and stakeholders to better share information, strengthen partnerships, and expand collaboration.

The annual cost of salt cedar invasion in the Western United States:

- 2.5 million acre-feet of water
- \$288 million in lost irrigation water
- \$ 43.5 million in lost power generation along the Colorado River



S&T is assessing promising insect control for salt cedar to lower these costs.

## Recognizing Innovation

In January 2002, the Shasta Temperature Control Device received the National Hydropower Association's Award in the Technological Solutions category. This award is given to projects that demonstrate significant contributions to the hydropower industry in licensing, engineering, construction, hydraulics, dam safety, land use, operations, maintenance, and/or economic use.

The S&T Program has provided innovative solutions for selecting withdrawal temperatures to meet water temperature standards for endangered species below Shasta, Hungry Horse, Flaming Gorge, Folsom, and other Reclamation dams. Without these solutions, project operators had to spill cold water through Shasta Dam's low-level river outlets instead of through the powerplant, costing millions in potential power losses.

A unique selective withdrawal system, designed using knowledge gained through the S&T Program, now provides the required water temperature for endangered salmon while making releases through the powerplant to fully use generating capacity. The device is also used to manage turbidity levels in the Sacramento River and allows Reclamation to fulfill contractual obligations for both water delivery and power generation.



Shasta Dam.

## WATER SUPPLIES

### New Water from Desalination Research

Reclamation's desalination research program worked with private sector, non-governmental entities, municipalities, and other Federal laboratories to develop a desalination research roadmap in 2002. The roadmap will help guide, prioritize, and coordinate desalination research by Reclamation and others.

Researchers developed many innovations, including a high pressure seawater pump that reduces energy consumption and dramatically improves seawater desalination. The S&T Program partnered with the desalination research program and:

- Enhanced Central Arizona Project (CAP) water supplies. Research determined that slow sand filtration (SSF) can reduce costs of new CAP water treatment plants by an amazing 75 percent. A combination of SSF and reverse osmosis (RO) can reduce desalting costs for surface waters by a breakthrough 20 percent.

Reclamation's Phoenix Area Office and local municipal water providers are working to further demonstrate and prove these technologies. As SSF is inexpensive, partners are focusing on treatment and direct delivery as the most promising alternative for using their CAP water allocation.

- Worked with the Phoenix Area Office to treat tertiary treated waste water on the Tonto Indian Reservation. This project demonstrated treating this source with microfiltration and reverse osmosis. The results showed that the town can safely inject the treated water into their drinking water aquifer.
- Developed a Water Treatment Process Cost Estimation (WTCost) as a common

reference point for comparing desalination costs. The S&T Program worked with the private sector to commercialize a Reclamation innovation, WATER, a water treatment estimation routine for costs based on current economic indices, water analysis, and capacity. WTCost estimates process parameters and cost for conventional and membrane water treatment processes. This is the first model to be based on industry needs, a standardized calculation process, and Reclamation's algorithms. The American Desalting Association verified its accuracy. Reclamation managers can now make justifiable decisions about advanced water treatment alternatives based on costs.

- Showed that chloramination can work for the Mni Wiconi Water Treatment Plant. When the full distribution system is complete, water from this plant will travel through over 1,000 miles of pipe before reaching the last customer up to 1 month after leaving the plant. Multiple re-injection systems would be needed to maintain free chlorine residual for disinfection. The extra chlorine would form disinfection byproducts known to cause cancer, foul taste, and odor problems.

To avoid problems, S&T evaluated chloramines for disinfection at the Mni Wiconi Treatment Plant in Pierre, South Dakota, rather than chlorine. Chloramine is formed when ammonia and chlorine are mixed. Chloramine acts at a slower rate and so provides free chlorine residual longer than chlorine. As a result of this study, the design and construction of an ammonia injection system to provide chloramination disinfection is now underway at Mni Wiconi and shown to be reliable and effective for other similar applications.

## DECISION SUPPORT

### Making Informed Decisions Faster

By improving reservoir and river system operation modeling, the S&T Program helps ensure that not a single drop of water is wasted. Many of the models we helped develop are now standard tools for many Western river systems. For example, daily Middle-Rio Grande riparian and crop consumptive use forecasts now help Reclamation to do its best to provide water for farmers and fish.

S&T research develops the necessary new capabilities in river models to address new issues in water quality, hydropower, irrigation, and more. Adaptations made to models in one river basin can then be used in other river basins. Research advances in 2002 included:

- Deployed the Stochastic Hydrology Package (SAMS) on the Snake River basin to provide a dataset for long-term planning studies in Reclamation's Pacific Northwest Region. Using this dataset to help manage water resources is expected to save thousands of acre-feet of water.
- Improved streamflow forecasts from the Advanced Hydrologic Prediction Services (AHPS) products at many locations within the Upper Missouri Basin. We worked with the National Weather Service Missouri Basin River Forecast Center and water operations managers to provide more timely and accurate streamflow forecasts. Bimonthly forecasts and improved headwater analysis enhance the ability of Reclamation water managers to optimally manage supplies. Similar studies on a single basin during the spring runoff have shown potential savings of \$3 million in hydropower generation and irrigation deliveries from improved streamflow forecasts.
- Improved the evapo-transpiration (ET) Toolbox demand forecasts. Water managers

use these data to determine irrigation demands, which helps manage water with extreme drought conditions and competing demands for Endangered Species Act (ESA) minimum flows in the Middle Rio Grand and Yakima Basins. This improved model was used in Federal District Courts to show Reclamation is using the best available science to protect the silvery minnow, an ESA listed species.

- Demonstrated an improved RiverWare-based salinity model on the Colorado River. This model will allow managers and technical specialists to accurately assess impacts of operational policies on Reclamation's ability to meet salinity constraints.
- Partnered with the Lahonton Basin Area Office technical experts to develop necessary new capabilities in RiverWare and deploy it on the Truckee River. This is a complex modeling system which integrates surface runoff, environmental factors, total maximum daily loads for listed and endangered species, municipal and tribal water needs, and irrigation needs. The model will help implement the Truckee River Operating Agreement, which symbolizes the consensus of basin stakeholders on this politically sensitive river and reservoir system's operations.

The Truckee River Operational Forecast Model is successfully providing information needed to determine reservoir releases to improve water temperatures for Lahonton cutthroat trout and cui-ui. This model allows Truckee River managers, partners, and stakeholders to evaluate operational scenarios that will deliver water in the basin to benefit listed and endangered fish and is expected to result in significant savings of water in this water-short basin.

- Collaborated with the U.S. Army Corps of Engineers and the University of Colorado Center for Advanced Decision Support for Water and Environmental Systems to create a personal computer version of RiverWare. The software now allows many more managers and technical specialists throughout Reclamation and many of its stakeholder organizations to use RiverWare. This saves Reclamation from the necessity of using complex and expensive UNIX work stations.

### **How Much Flood Storage Do I Need?**

Keeping flood storage open in reservoirs when it is not needed takes away from active reservoir storage and limits Reclamation's water operation's flexibility. Knowing more about flood volumes helps ensure safer and more efficient flood storage allocation.

In FY 2002, the S&T Program worked with a private sector consultant and the U.S. Army Corps of Engineers to develop a basic stochastic flood model that will help estimate probabilistic flood volumes with more confidence. The model can produce more reliable reservoir operation scenarios. This could enable a portion of existing flood control space to be safely reallocated to active water supply storage. We have also written a technical manual on how to run the model.

This model allows Reclamation managers to modify flood control operations in reservoirs and could free additional space for conservation storage and increased water supplies.

Activities for FY 2003 include integrating Geographic Information Systems (GIS) technology and demonstrations. For example, at Folsom Dam, this model will help develop operating criteria to maximize flood benefits.

### **What's My Sediment Load?**

Very fine sediments can carry pollutants into reservoirs, which may cause water quality concerns. Many reservoirs are getting old, and sediment buildup behind dams can cost a great deal to remove, affect downstream fish, and infiltrate water intake structures. This is a primary concern in Reclamation facilities as the Environmental Protection Agency is working on total maximum daily load criteria for sediment and the pollutants that may adsorb to sediment. Reclamation managers may need to calculate the sediment load for cohesive materials both upstream and downstream of their facilities. Most literature and research now revolves around sand and coarse sediments, which do not carry the pollutants. More research is needed for efficient water operations and decision support.

The S&T Program began a partnered study with the Environmental Protection Agency in FY 1999 to develop a Generalized Sediment Transport Model for Alluvial River Simulation (GSTARS 1-D). This model will be able to track fine sediment carried through canal and river systems. Researchers are currently testing the model on the San Luis Canal near Coalinga, California. The ephemeral stream, Arroyo Pasajero, drains directly into the California Aqueduct. The stream contains extremely high concentrations of suspended sediment and water quality constituents such as total dissolved solids. The model is assessing the value of a new gated structure to help remove polluted waters when flood waters enter the aqueduct from the arroyo.