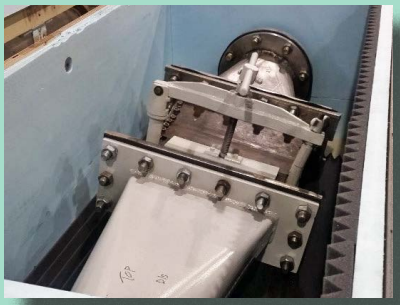
RECLAMATION
Managing Water in the West
Issue No. 246–Summer 2018

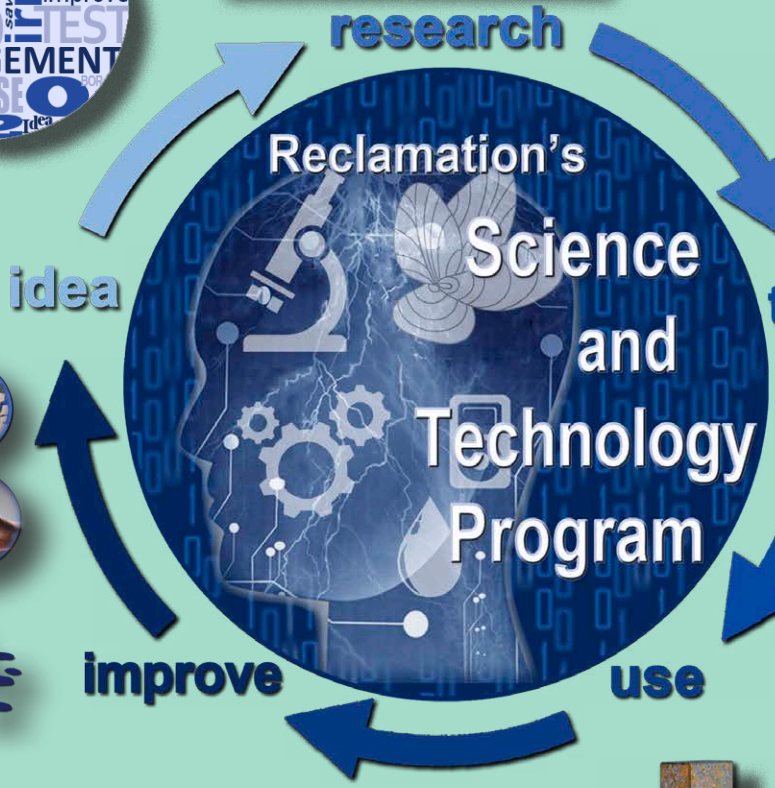
Water Operation and Maintenance Bulletin

Canal Research Workshop
. . .page 15



Will cold spray prevent cavitation?
. . .page 9

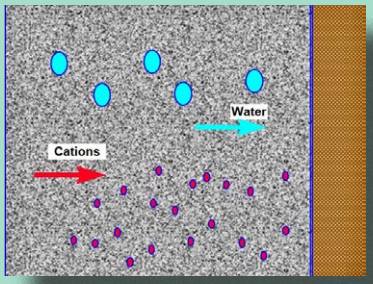
Test wire ropes
. . .page 13



Reclamation's data is expanding
. . .page 12

Use geophysics to quickly find problem spots
. . .page 6

Control seepage with electricity
. . .page 5



Corrosion protection costs
. . .page 10

Also in this Issue:

Issue No. 246–Summer 2018

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Thank you.

On the Covers:

Front: Reclamation's Science and Technology Program.

Back: Partnering with Reclamation's Researchers.

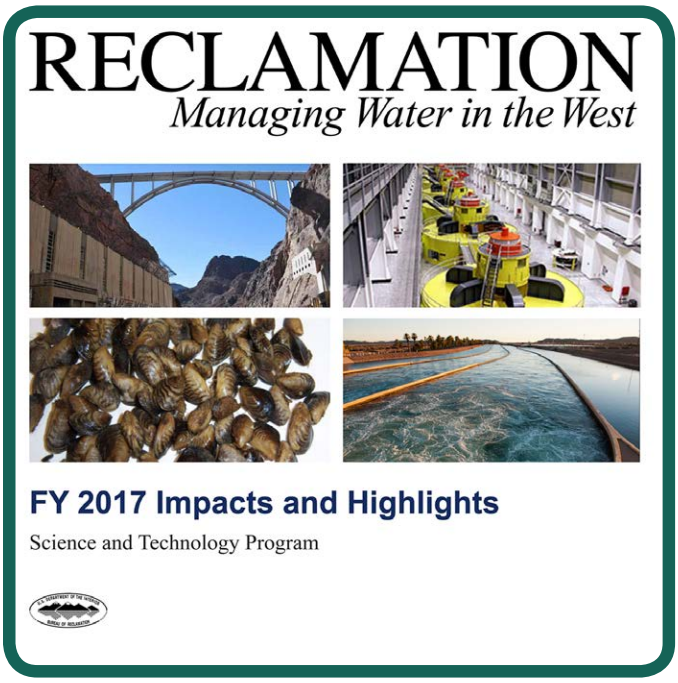
CONTENT

Message from Office of Policy

For this issue of the Water O&M Bulletin, we are focusing on the great work by Reclamation's Science and Technology Program (S&T), managed by the Research and Development Office (R&D). The program is focused on helping find solutions to water O&M issues for Reclamation water and power facility managers and our western customers and stakeholders. Research is primarily through competitive and merit-based applied funding opportunities for Reclamation employees.

R&D Office introduced a new outreach tool in early 2018—the S&T 2017 Program Highlights brochure—which features some high-impact concluding projects from FY17 and is based on R&D's new process for estimating return on research investments. The process was applied to several water infrastructure and power and energy projects, among other research areas. For example, this bulletin discusses several projects:

- The Reclamation Water Information System offers improved efficiency for fulfilling hydrologic data requests within Reclamation: https://water.usbr.gov (see page 12)
- The Electro-Osmotic Pulse Technology controls water seepage through concrete by reversing the movement of water (see page 5)
- Prize Competitions are a unique tool for addressing elusive mission and operations challenges through private sector and "citizen solvers." (see pages 16-19)



Cover of the S&T 2017 Program Highlights brochure.

Currently, S&T funds research in five Research Areas: Water Infrastructure, Environmental Issues in Water Delivery and Management, Power and Energy, Water Operations, and Planning, and Developing Water Supplies. S&T also manages Prize Competitions and Technology Transfer activities.

We invite you to participate. Let us know your ideas and needs by contacting me, your Area Office, or the Research Office directly.

Chris Vick,
Manager, Asset Management Division, Policy and Administration

Learn More

Science and Technology: www.usbr.gov/research/st

Prize Competitions: www.usbr.gov/research/challenges

Technology Transfer: www.usbr.gov/research/technology_transfer

Recent Research Results:

R&D Knowledge Stream Magazine: www.usbr.gov/research/ks.html

S&T Research Bulletins: www.usbr.gov/research/publications/updates.html

S&T Research Projects: www.usbr.gov/research/projects/index.html

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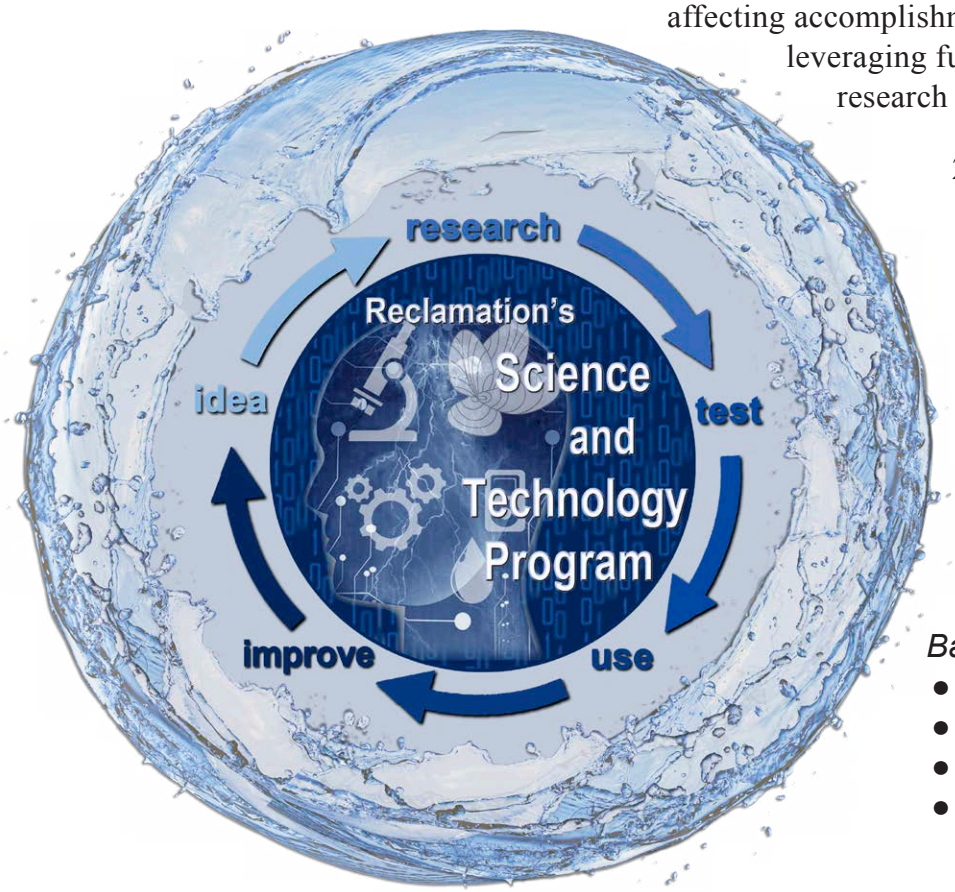
From Research to Impacts

The Science and Technology (S&T) Program is working to advance Reclamation's technical abilities to manage, develop, and protect water and related resources in an environmentally and economically sound manner. Through innovative development, applied, and demonstration research, we are addressing a full range of technical issues that confront Reclamation water and power managers and their project stakeholders. The goals of the Science and Technology Program are to:

1. Develop cost-effective solutions for the technical and scientific problems affecting accomplishment of Reclamation's mission, while leveraging funds with other research entities to advance research in a collaborative manner.



2. Build and strengthen scientific and engineering capacity for Reclamation to advance the most relevant research and demonstration projects for Reclamation.

3. Communicate those solutions to Reclamation offices, other water and power management officials, and the general public to build partnerships with other water and power management agencies and stakeholders.

Basic Program Statistics (FY17)

- 198 projects
- 119 lead researchers
- $11.12 million of funding used
- $11.56 million partner cost share (9 university, 11 local agencies, 3 tribes, 5 states, 12 Federal agencies, and 17 private for profit or non-profit partners)

The S&T Program is trying to tell a better story about completed and ongoing research projects with demonstrated or projected benefits to Reclamation. These research projects have a direct impact on Reclamation's ability to meet core mission needs of water and power delivery. For many of these projects, it was possible to estimate a return on investment to the S&T Program and a benefit cost ratio. Some of the projects highlighted did not undergo an economic evaluation but show significant impacts through the narrative description of impacts. Please see the FY17 S&T Program Impacts and Highlights (www.usbr.gov/research/st/fy17brochure.pdf) document for many of the projects that are leading to a better, faster, and cheaper Reclamation.

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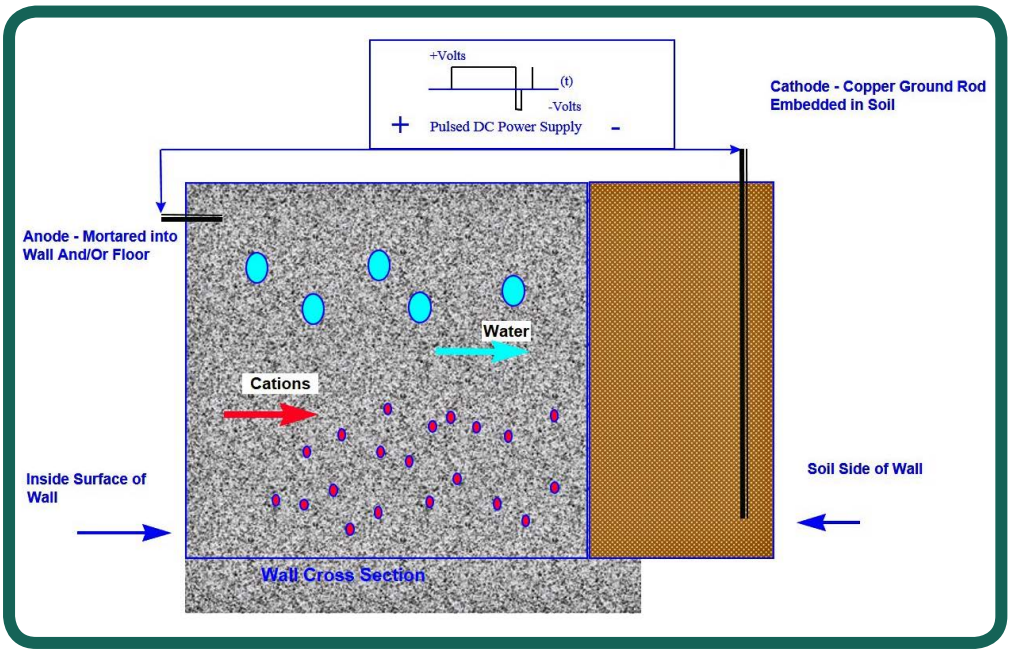
A Shocking Way to Control Leaks through Concrete

Wouldn't it be nice to keep water from seeping through those cracks in your concrete? Water migrating through the concrete causes maintenance problems and expenses. For example, leaks can lead to calcium carbonate deposits that; interfere with gate operations and plug drains, result in standing water in chambers, and cause significant corrosion problems of any metal in contact with the leaking water.

EOP Technology was developed to control water seepage through concrete by reversing the movement of water, so it can dry out concrete vaults and other high-head structures traditionally plagued with water seeping into the concrete cracks. An EOP system consists of three essential parts: (1) anodes, inserted into the concrete wall or floor, (2) cathodes, installed in the soil outside the structure or deep in the concrete wall for thick concrete walls, and (3) an electronic control unit that delivers electric pulses. The pulses of electricity drive water away from the anode, toward the cathode, reversing the direction of water seepage and eventually creating a sort of barrier near the cathodes to prevent water from seeping into the concrete.

Electro-Osmotic Pulse (EOP) technology.



EOP could be a long-term, cost-effective alternative to the trench-and-drain approach to mitigate water-related problems in addition to the cost of continuous grouting. Reclamation has been researching Electro-Osmotic Pulse (EOP) technology to stop water leaks through concrete with several Science and Technology Program research projects. These research projects address:

- Will EOP technology be effective in stopping water leaks through concrete in locations with various crack sizes and under high head?
- How much will EOP decrease the relative humidity of the concrete structure?
- How long will the system last before replacement of the components is required?

You can investigate whether EOP might be right for your concrete structures. EOP is commercially available; please contact Daryl Little.

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New Detective Gadgets for Canal Embankments

Seepage. Animal burrows. Piping. Voids. You know they are out there, just lurking under the surface somewhere along those many long and lonely miles of canal embankments. But where, exactly? And when will they strike—causing embankment breaches, endangering public safety, costing you O&M funds and emergency funds, and hampering your ability to deliver water?

Previous geophysical methods to uncover these hidden menaces, such as electrical resistivity tomography (ERT) profiling surveys and self-potential analysis, took weeks and months to cover a few thousand feet of canal, and required intensive analyses. Using these methods is like building an extensive hydrologic model just to find out if the sky is cloudy now. Moreover, most lengths of canal do not need this intensive analysis—you just need to find out where to focus your detailed investigations.

Reclamation is researching quicker ways to cover thousands of miles of canal rather than thousands of feet to determine vulnerable areas that need a closer look. Combining a suite of technologies (such as ground-based geophysical profiling and airborne and satellite remote sensing data) can help perform rapid reconnaissance for water conveyance losses along canals, and to help infer potential structural integrity issues. A recent Reclamation Science and Technology Program research project, Evaluation and Development of Rapid Geophysical Profiling for Canal Embankment and Levee Health Assessment and Seepage Detection, examined frequency-domain electromagnetic (FEM) and other geophysical

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Sample of EM data along Government Highline Canal embankment, near Grand Junction, Colorado. Red and orange colors near the ends of the image indicate metallic infrastructure (turnouts and bridges) and more subtle light-green anomalies correspond to observed green vegetation and potential seepage areas.

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techniques to develop an effective workflow for combining the results of these technologies and other datasets to identify anomalies that could signal seepage, unauthorized penetrations, or other unhealthy conditions and to weed out false positives (is that a canal conduit or is that seepage?). Reclamation analysts are developing data acquisition workflows and identifying effective ways to use post processing, data analysis, machine learning, and more to interpret this data.

An unmanned aerial vehicle landing after collecting data along the Strawberry Highline Canal near Provo, Utah and a non-magnetic cart used for geophysical profiling along canal embankments.

Two non-magnetic carts used for geophysical profiling with an EM34 system along South Canal near Montrose, Colorado. Here, a tandem cart configuration is required to mount the EM34 transmitter and receiver coils (orange hoops) at a minimum separation of 30 feet. Among other factors, the larger separation of the EM34 system coils results in a greater depth of investigation, compared to smaller and more compact EM systems.

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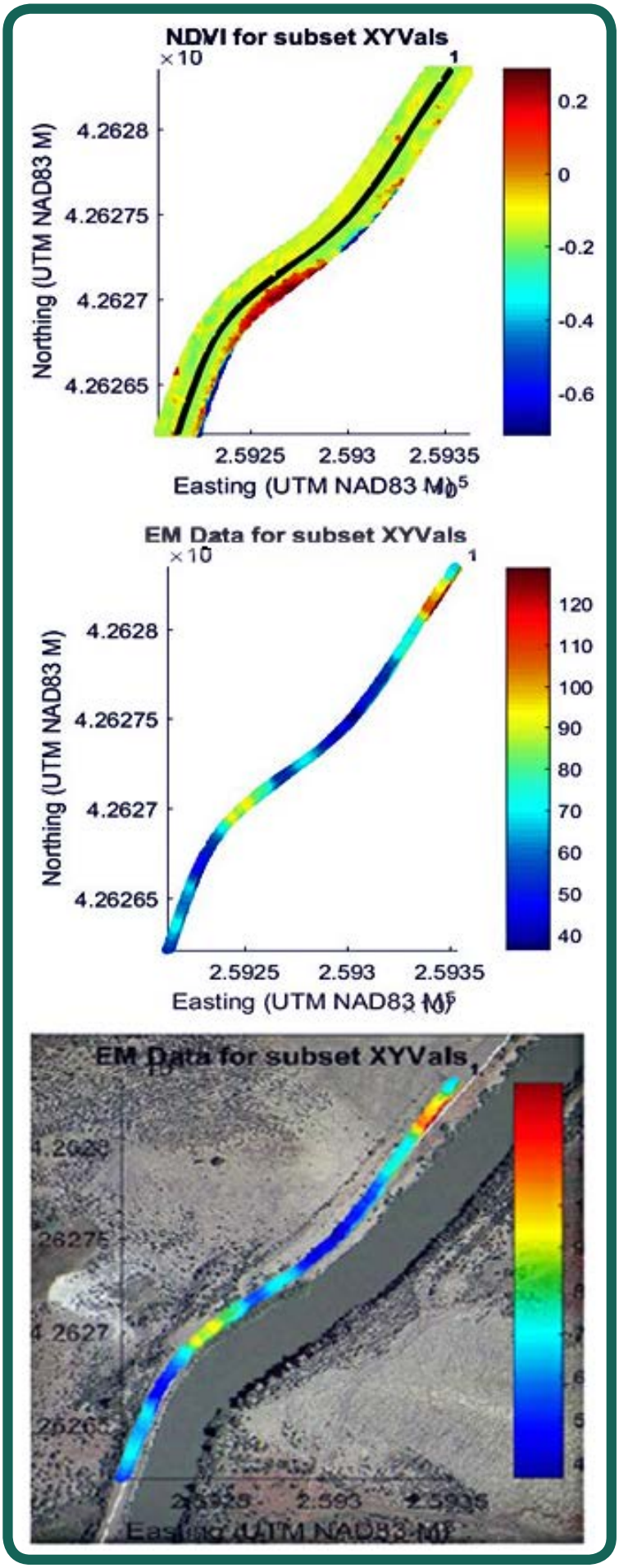

Sample of comparing vegetation with a normalized difference vegetation index (NDVI) and EM data. Using multiple data types helps avoid false positives and false negatives.

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Reclamation is working with three area offices (Provo Area Office: Strawberry Highline Canal; Lahontan Basin Area Office: Truckee Canal; and Grand Junction Area Office: South Canal and Government Highline Canal) to research the most effective way to identify locations along these canal embankments that look suspicious and warrant detailed investigations to determine if there are risks to public safety, operations, or canal failure. This technology demonstration will enable Reclamation to offer rapid reconnaissance services for other operating districts. Data results would be available within a month after testing.

Next steps in the research are to incorporate even more data types, explore more advanced remote sensing techniques, and extend follow-up analyses. If you are interested in getting a quick check up for your operating entity, give us a call.

For more information contact:

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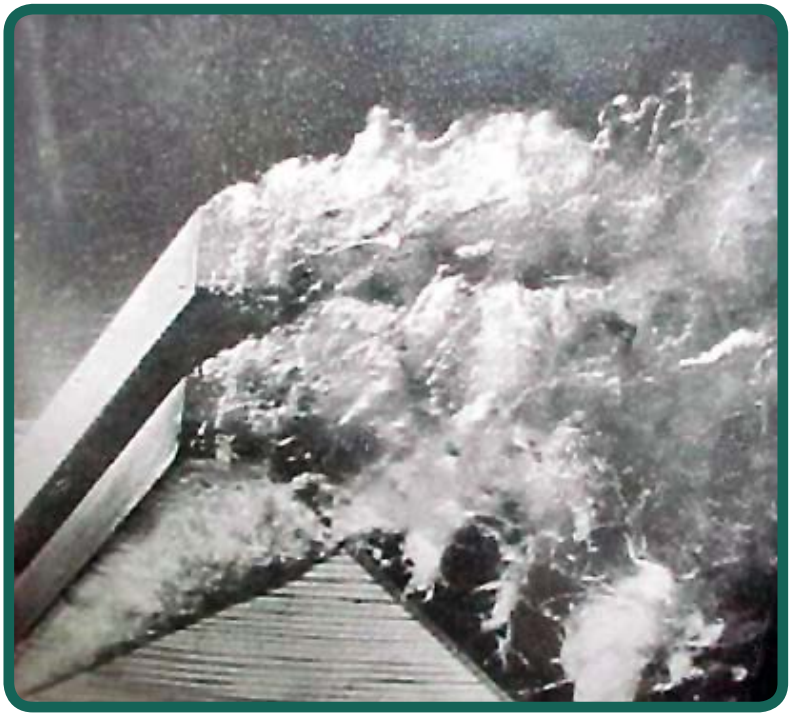
Could You Spray Your Cavitation Problems Away?

Who would ever have thought that tiny bubbles could pose such problems for metal and concrete? Yet cavitation damage occurs when small vapor bubbles formed in low-pressure zones collapse when encountering higher pressure downstream. Over time, the damage accumulates and creates high cost maintenance issues.

Repairing cavitation damage on metals has traditionally used stainless steel weld overlays and ceramic polymer systems. However, both of these techniques have health and safety issues that require special environmental controls and personal protective equipment during the repair process. Also, these methods can change the profile of the blade over time, reducing the efficiency of the machine. We need new ways to repair cavitation that is cheaper and can last longer.

Cavitation tester in the lab.

A current Science and Technology Research Project, Evaluation of Field Repairable Materials and Techniques for Cavitation Damage is examining whether cold-spray techniques offer better resistance to cavitation while offering a better, safer alternative to current stainless steel welding techniques. In this technique, particles are accelerated to very high speeds. The idea is that the particles will impact the steel material (or substrate) with a high enough kinetic energy to mechanically bond to it. It essentially forms a mechanically bonded coating of metal particles. Cold spray doesn't require the high heat that welding needs and thus avoids changing crystalline microstructure and the mechanical properties of the metal. Moreover, the repair is less porous than traditional repair methods, so there are fewer micro-pockets where bubbles can implode, thus reducing the places where cavitation can occur. In theory, this could increase the service life of the repair and maintain machine efficiency over the lifetime of the equipment.



Vapor bubbles causing cavitation.

Reclamation researchers, in collaboration with Pacific Northwest National Labs (PNNL), are testing cold spray applied samples in the lab through 2018 and 2019. If we see promising results, Reclamation plans to demonstrate this technology at a test location in the future. So keep in touch and let's find out if cold sprays can conquer cavitation someday.

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Consider the Corrosion Protection Costs over a Lifetime

Gates are the control center of any canal system and need to be protected from corrosion. You need coatings and cathodic protection, but how much will this cost? And what is the price over the lifetime of the equipment? What is the most cost-effective coatings maintenance and corrosion controls strategy for your penstocks and gates?

An ongoing Science and Technology Program research project, Cost of Corrosion Control for Reclamation Penstocks and Gates, developed a framework to analyze life-cycle costs to compare costs for competing corrosion protection approaches. This analysis is particularly suitable for determining whether it is economically worthwhile to pay a higher initial cost and save future costs in lower maintenance, repair, or replacement needs.

This analysis is the foundation for building a spreadsheet tool designed to accommodate the considerations needed for determining costs over a gate's lifetime. Reclamation's Technical Service Center is working on applying this spreadsheet for case studies and using it to generate better guidelines.

Corrosion control alternatives have costs in multiple years over the life-cycle of the alternative—both the initial cost of the method and then operations, maintenance, and replacement costs. Timing of costs differs across corrosion control alternatives, and the spreadsheet tool accounts for future costs so you can make equal comparisons. This tool uses present values, which are the current equivalent of costs that will be paid in the future.

This spreadsheet offers several output options to help decision makers in selecting coating systems. Cost estimates rely on assumptions, so a sensitivity analysis is also provided to demonstrate the effect of modifying assumptions such as coating service life (will this last 19 years or 35 years or 51 years?) and the discount rate (what is the present value of costs that occur at different points in the future—what if the inflation rate is 2% or 4%?).

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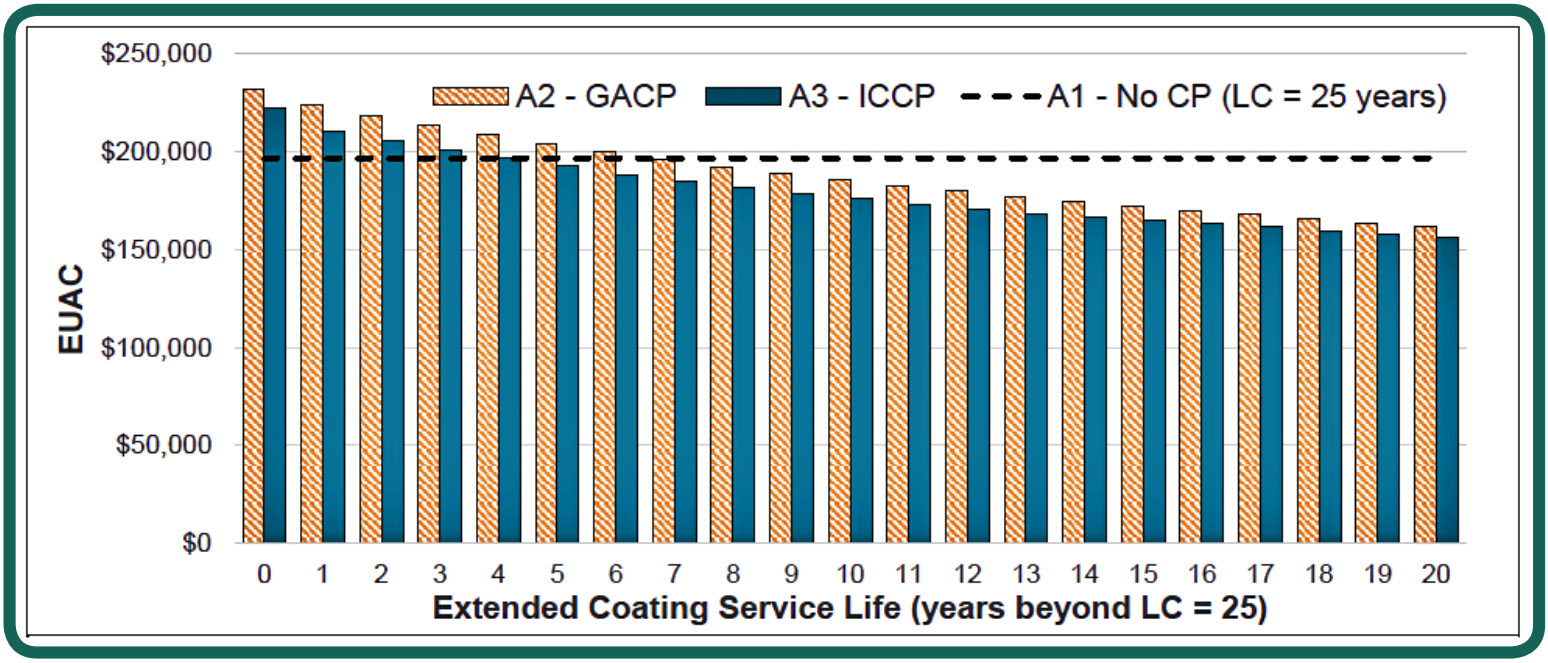
For example, the case study at Parker Dam compared costs for a galvanic anode cathodic protection (GACP) system with an impressed current cathodic protection (ICCP) system for four penstock gates that allow the intake structures to the powerplant to be closed during unit outages. Researchers used the spreadsheet to manipulate possible outcomes for real-world variables, including coating life-cycle and maintenance. The figure shows the equivalent uniform annual cost (EUAC) for each cathodic protection option as well as without cathodic protection. The break-even point for GACP and ICCP is 8 and 5 years of extended coating service life, respectively. This indicates that although GACP and ICCP have more up-front costs, there is a net cost-savings because they are able to extend the coating service life.



CP break-even analysis calculated for 4 penstock gates at a discount rate of 2.875%.

The spreadsheet is a powerful tool to aid facility owners in determining the most economical course of action. Reclamation researchers presented this analysis and case studies at NACE International 2017. If you are interested in working with the Technical Service Center to conduct a similar case study, please contact us.

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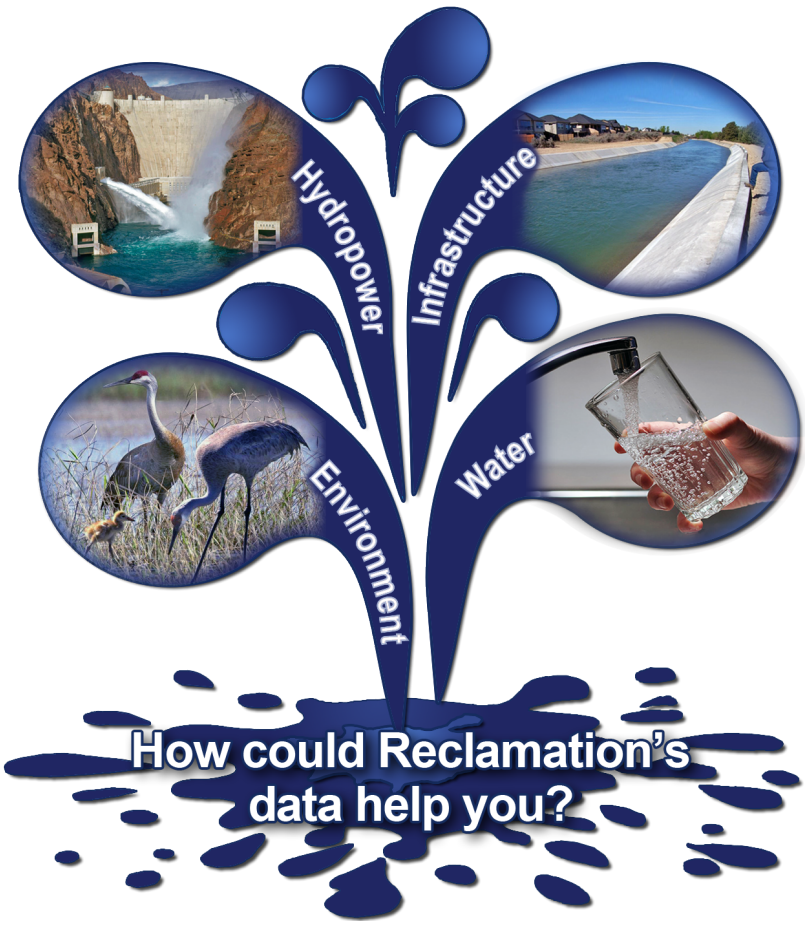
Data You Can Use

The Reclamation Water Information System (RWIS)

Did you know that right now, you can go to water.usbr.gov and get a pretty good idea about the water resources in your area or across Reclamation? The Reclamation Water Information System (RWIS) shares lots of data, from weather data to canal levels to reservoir storage and elevation, in a variety of common formats. With RWIS, you can view interactive plots, download data, automate data retrieval through an API, and more.



And RWIS is just the first step. It is leading the way to the Reclamation Information Sharing Environment (RISE), which will get even more of Reclamation's data to you. RISE will be a system for aggregating, storing, managing, and publishing a variety of data and information to support Reclamation's mission. RISE will evolve from and absorb the existing RWIS pilot system to become a mature, sustainable application. RISE will:

- **Expand data offerings** to include:
  - ❖ A broader range of water data, as well as environmental data (e.g. biological and water quality data), hydropower data, and infrastructure/assets data (e.g. facilities and lands)
  - ❖ Additional time steps for time series data (e.g. hourly, 15-minute, monthly, annual) as well as geospatial data and binary data (e.g. documents, multimedia, and file archives)
- **Support data access** and use for internal and external users, including Reclamation staff, partners from Federal, State, and local agencies, and stakeholders such as water and power users, researchers, media outlets, and the general public
- **Standardize and centralize Reclamation's data** publication to provide access to Reclamation's mission-related data in a single portal in common, machine-readable formats
- **Coordinate** with other data management efforts

We'd like to know what you think—what data would be useful for your operations?

RISE/RWIS Team Contact:

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Learn the Ropes—Without Destroying Them

Wire ropes should be replaced every 15 to 20 years. But how do you know exactly when to replace them? Traditional testing methods destroy a portion of the rope, and only view a portion of that rope, which can mean that you are replacing the entire rope before you need to—or worse, that the portion you tested was fine, but other portions were not ok, which can leave you hanging by a rusted thread.

Non-destructive testing (NDT) for wire ropes tests in-service ropes without permanently damaging them. NDT can help determine when to remove wire ropes from commission and decrease the frequency of possible unnecessary replacements, significantly decreasing costs over time. NDT testing is a valuable accompaniment to visual inspection to gauge the condition of the interior, non-visible regions of a wire hoist rope.

A recent Science and Technology Program research project, Extending the Useful Service Life of Wire Hoist Ropes using Nondestructive Testing compared electromagnetic NDT testing with conventional destructive testing on wire ropes at Shasta Dam to determine the effectiveness of NDT testing. Insights gained include:

- Use an NDT testing technique along with visual inspection to gauge the condition of the interior, non-visible regions of the wire rope.
- Conduct the NDT on full length ropes, not on small sections, to gauge its entire condition.
- Use magnetic NDT testing at regular intervals, starting at the beginning of a rope's life.

You can investigate whether using NDT might be effective for your wire ropes inspections. Contact the Technical Service Center with questions about this technique.

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Unmanned Aircraft Systems

Unmanned Aircraft Systems (UAS), or commonly called drones, seem to be as ubiquitous as many other new technology devices in society today. Many already know of someone who has a UAS, or maybe a child, friend, or spouse that wants one as a gift. Using a UAS beyond a recreational hobby is becoming big business, and applications throughout the commercial and public sector are becoming much more common. Relatively recent guidance by the Federal Aviation Administration (FAA) means that these tools are considered aircraft and must be operated in accordance with FAA regulations.

UAS Airframe 3DR Solo. Photograph by Jakeb Prickett, Reclamation's TSC.

On the surface, there appears to be a huge potential benefit for using UAS to obtain data not easily gathered in other ways or to reduce potential safety hazards of data collection currently performed manually. Reclamation's Science and Technology (S&T) Program has funded several efforts in recent years to demonstrate the effectiveness of UAS. These technologies, like other initiatives supporting Reclamation's mission, are another tool in Reclamation's toolbox.

One such project is the UAS Data Collection at Reclamation Sites (Principal Investigator Matthew Klein, Technical Service Center). This research project is providing comparable data to demonstrate whether using UAS for data collection is cheaper than traditional Reclamation methods. This project unites three distinct technical services at Reclamation's Technical Service Center (TSC) that promise to reap large benefits with UAS technologies: facility condition assessments, geologic mapping and investigation, and geographic information system (GIS)/remote sensing. As a result of this project, there are now six carded U.S. Department of the Interior (DOI) UAS pilots and three approved airframes at the TSC.

An important aspect of UAS work is to ensure all proper procedures and policies are followed, and that Reclamation's National and Regional Aviation Managers are aware of and approve the work. Depending on the complexity of the project and the plan for execution, DOI's Office of Aviation Services may also need to approve the project. These approvals must occur if the work is performed by Reclamation, or by a contractor.

Reclamation's TSC and several of its regions are building capacity to support UAS missions, which will allow Reclamation staff to use these services quickly and efficiently. Reclamation's UAS work is coordinated with Reclamation's Security, Safety, and Law Enforcement Office. The National and Regional Aviation Managers should also be consulted about any UAS-related work to ensure that, if the proposal is funded, the proper approvals can be acquired to proceed with the proposed work.

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Connections

Technical Transfer

Implement Ideas

Got a problem you need to solve? Got an idea that would help others? Then work with Reclamation's Technology Transfer program in the Research and Development Office to move from an idea or a need into an on-the-ground solution.

Technology Transfer enables Federal agencies, the private sector, and other non-Federal entities to join forces. We can use various types of agreements to test materials, allow researchers to use our facilities, develop and commercialize Reclamation's technology, or partner to discover and develop new technologies.

For more information contact:

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Canal Research Workshops

Help Gather Ideas

Reclamation's Science and Technology (S&T) Program organized a Canal Research Workshop last year to help coordinate efforts to address pressing problems. Last year's workshop identified several actions for improving the projects' outcomes and dissemination of results. Activities to watch out for include an annual project briefing meeting, results reported in Water O&M Bulletin and FO&M Workshop, and more partnering via demonstration or implementation on canal test sites.

This summer's S&T Canal Research Workshop will be in early June 2018. The event includes active research project and prize competition briefings as well as updating the canal research roadmap to indicate new or resolved priority research needs. If you have any pressing needs or ideas that you would like to be brought up in that workshop, please contact Bobbi Jo Merten.

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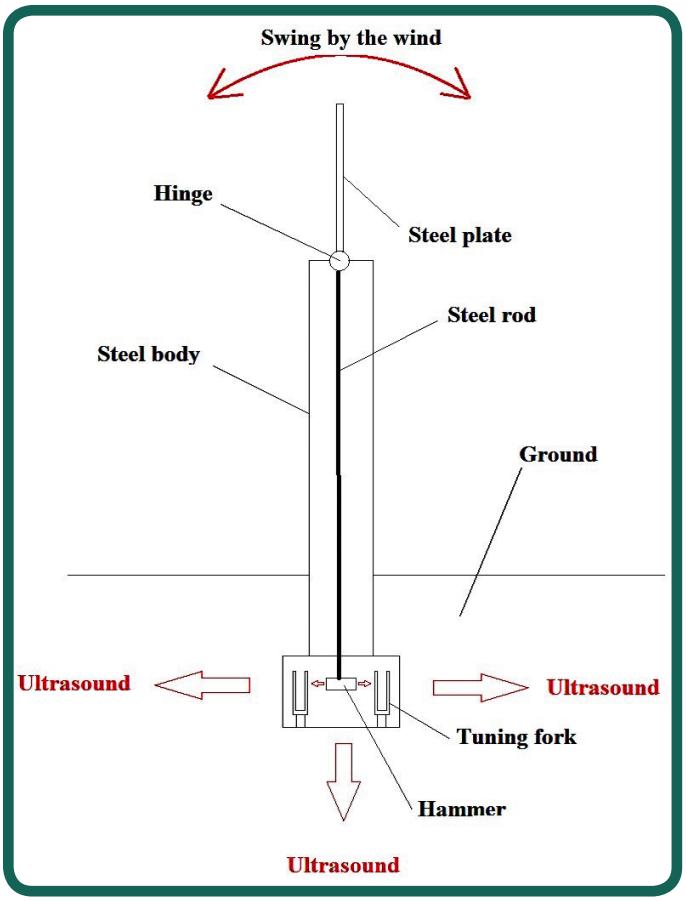
Connections (continued)

Prize Competitions

Reclamation's Research & Development (R&D) Office formed the Water Prize Competition Center in 2014 to seek innovative means of solving its complex and "elusive" research problems. Reclamation began launching prize competitions early in 2015 under the prize competition authority provided under the America COMPETES Reauthorization Act of 2010, as amended (15 USC 3719). Reclamation works with Challenge.gov and outside vendors to promote and host online prize competitions. These problem-solving events use crowdsourcing techniques and cash awards or meritorious recognition to invite the public's help to solve perplexing mission-centric problems. To date, Reclamation has launched over 12 successful competitions in the theme areas of Water Availability, Infrastructure Sustainability, and Environmental Compliance. Completed O&M-related competitions include those addressing rodent burrows, internal erosion, and corrosion of steel structures. The winning solutions for Rodent Burrows and Internal Erosion are listed below. A competition to improve methods to detect leaks and flaws in pipelines is underway and a Stage 2 competition to "reduce to practice" ideas for improved corrosion is planned.



Simple Machine for Subsurface Acoustic Deterrent.

Rodent Burrows

Most canal embankment breaches are attributed to rodents. We need cost effective, feasible, scalable and long-term solutions to prevent rodents from burrowing into earthen embankments, thereby preventing seepage paths through those embankments from developing. Winning solutions used current technologies in new ways:

- **Sound or scent deterrents**. *Predators and Hydro-Seeded Plant Deterrents* has a plan to provide habitats for native species (such as owls) that will prey on the rodent and to grow plants or herbs that deter rodents with taste, smell, or toxicity. *Simple Machine for Subsurface Acoustic Deterrent* is a mechanical, wind-powered ultrasound generation machine that emits high frequency sound to scare rodents away from embankments and deter any burrowing. While rodents habituate to constant noise, this sound source is as intermittent as the wind, simple to install, and needs no or low maintenance.

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- **Barriers.** *Subsurface Cut-Off Wall Barrier Using Hydro-Excavation* uses an underground barrier of "Concrete Cloth" in a narrow trench cut with a vacuum excavation rig.

- **Embankment armoring.** *Surface Geotextile with Embedded Steel Wool* uses a prickly stainless steel mesh that prevents rodents from burrowing in earthen embankments while still allowing plant growth.

- **Bait and trap.** *Robotic Smart Trap* is a solar-powered, autonomous robot that functions as an electric trap for gophers in burrows on embankments. This is programed to locate burrows, identify species, and dispose of the problem-causing species.

Internal Erosion

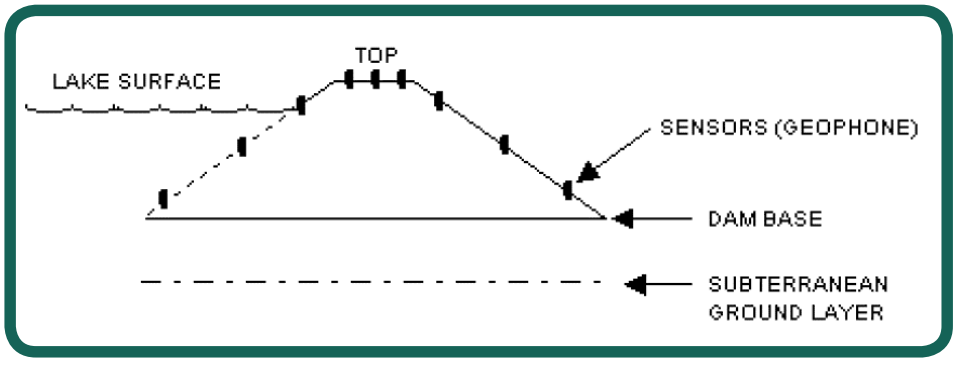
Internal erosion mechanisms involve soil moving to an exit point. If soil movement can be detected and localized inside the structure in the early stages of erosion, flaws could be mitigated and failures prevented. While inspection and condition assessment programs are effective ways to protect the public and property, these current methods are resource intensive and cannot reliably detect internal erosion early in the process. Internal erosion can take place over a long time, but often remains invisible (inside or below the structure) until serious damage occurs, placing lives, property, and water delivery at risk.

Five solutions hold some promise for either direct or indirect application to seepage/erosion characterization (or could possibly solve other challenges not related to seepage/erosion).

1. *Robot Enabled Underwater Flowmeter* would use a flow-meter on an underwater remotely operated vehicle (ROV) or unmanned aerial vehicle, which could map the unknown inflow-zones of known seepage problems.

2. *Phased Array Seismic Tomographic Anomaly Imaging* proposes a permanent seismic monitoring system, using geophones and an impact hammer.

3. *Brine Seepage Tracer* would conduct repeated tracer testing/ monitoring during brine injection upstream. The solution inspired ideas about different tracers (such as deionized water, organics in solution with a ceramic sensor, and passive pulsing).



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Connections (continued)

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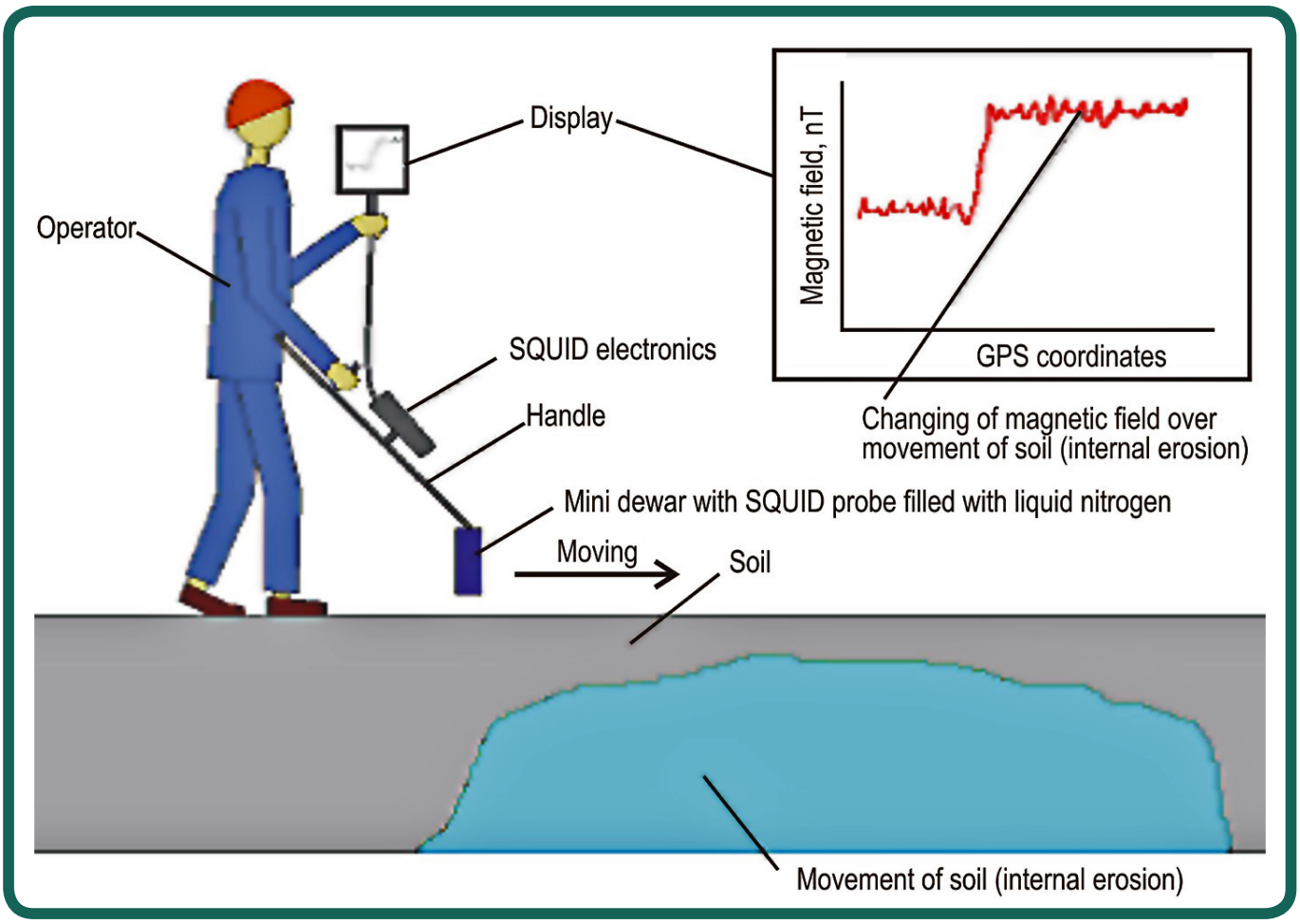

4. *Superconducting Quantum Interference Device (SQUID)* would use repeated/time-lapse SQUID magnetometer mapping. This untested approach could meet all requirements, but it may not be able to detect internal erosion before it manifests at the ground surface. And it is a passive technique, with no permanent installation. The technology is vulnerable to external noise sources and may be expensive, but costs may come down over time. A UAV based platform could be used for this technology.

5. *Shear-Wave Reflection Seismic Imaging* Repeated shear wave reflection imaging, a standard geophysical application for void detection, could be used for large dams.

Corrosion

The cost of maintenance and replacement of existing corrosion control systems has increased greatly in recent decades due to increasing health, safety, and environmental concerns associated with coatings that have performed well in the past as well as the decreased life cycles of commercially available alternative

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coatings. New long-term solutions to protect steel structures in water immersion service will help to reduce the high cost incurred to keep steel infrastructure reliable and functional.

Reclamation is partnering with the U.S. Army Corps of Engineers, U.S. Navy Facilities Engineering Command, and National Institute of Standards and Technology, in a prize competition seeking ideas for long-term corrosion protection for large, hydraulic steel structures beyond the protection provided by available coatings and cathodic protection.

We are completing Stage 1, which sought new or improved concepts. This will gear up to Stage 2, which will ask for technology and demonstrations of proof-of-concept data in both the lab and the field.

Leaks and Flaws in Large Buried Pipeline

Currently, no practical method exists to detect leaks and flaws in large diameter, operational pipelines. For example, leaks in pipes delivering treated drinking water result in billions of gallons of water lost annually—an amount that could fill more than three million Olympic-size swimming pools. Detecting leaks and flaws early is the key to solving this problem and preventing the loss of valuable and scarce water resources. This prize competition will consist of two stages. Stage one is a theoretical challenge that requires a written proposal. Reclamation is making a total prize purse of $75,000 available, to be divided by up to five winners. If successful, stage two is planned to provide proof-of-concept in a laboratory-scale demonstration. This competition was open in April and May, and proposals are being looked at. We'll keep you informed of potential solutions.

Reclamation is partnering with the San Diego County Water Authority, Southern Nevada Water Authority, and Isle Utilities for this competition.

www.usbr.gov/research/challenges/leakypipes.html.

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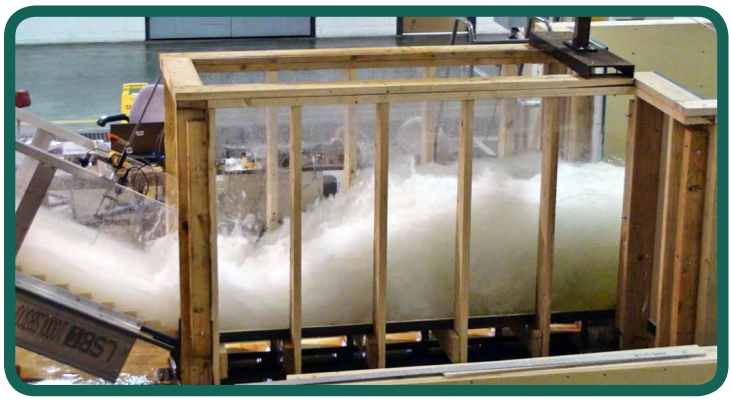
RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

Get with Reclamation's Researchers

Reclamation's researchers explore ideas that could help you:

- **Save water**
- **Prevent seepage, corrosion, cavitation, or other problems**
- **Repair machinery, concrete, metal, etc. more effectively**



Got a Test Spot?

Partner with Reclamation to test these ideas in the field.

Got an Idea?

Suggest solutions for Reclamation to partner with.

Got a Problem?

Work with Reclamation to determine potential solutions you can try in the field.