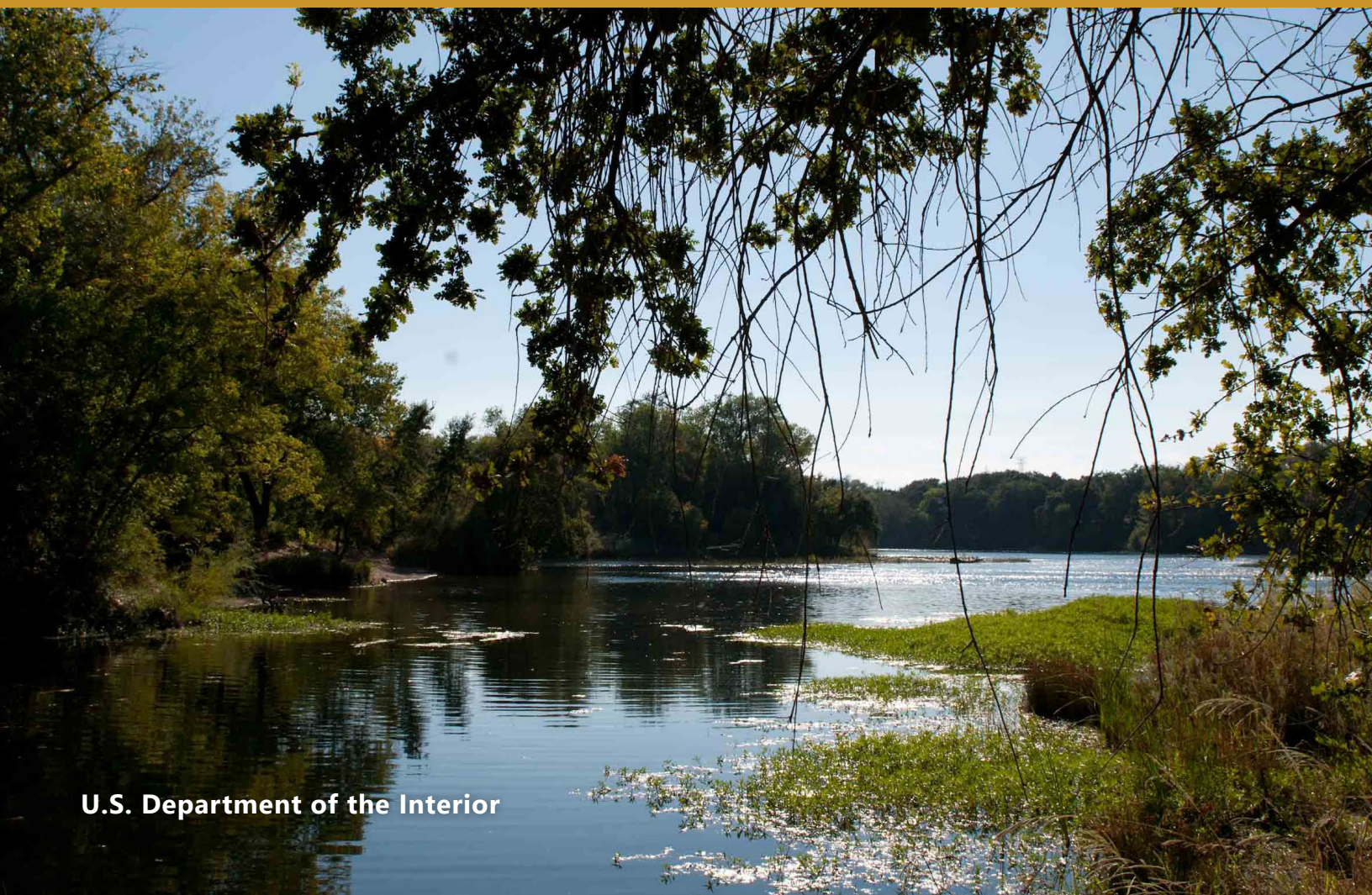
BUREAU OF RECLAMATION

Fall 2023
Issue 261

Water Operations and Maintenance Bulletin

Applied Hydrology



U.S. Department of the Interior

Contents

Mission Statement

This *Water Operations and Maintenance Bulletin* is published quarterly through the Asset Management Division of the Dam Safety and Infrastructure Directorate. It serves as a medium to connect personnel who operate and maintain Bureau of Reclamation water supply systems.

History

The *Water Operations and Maintenance Bulletin* has been published quarterly since 1952. Past issues may be read and downloaded at Water Operations and Maintenance Bulletins, where you can also search the entire *Bulletin* database by subject.

Contact

We welcome suggestions for future issue topics, contributing authors, and comments on the *Bulletin*. Please direct all inquiries to drowateroandm@usbr.gov.

Cover photo: Lower American River, Central Valley, near Sacramento, California.

Editor's Note

One of summer's special traditions at the Denver Federal Center is the Technical Service Center's (TSC) Summer Intern Program. If you're around Building 56 or 67 between May and August, you're likely to see an influx of undergraduate and graduate students. 40-50 interns work in labs and offices, attend site visits to local facilities, network with Bureau of Reclamation (Reclamation) leadership, and complete and present on rigorous summer-long projects. Dam Safety and Infrastructure had three interns this summer, and each of them wrote or contributed to developing this issue's articles.

The TSC's Applied Hydrology Groups wrote two feature articles for this fall issue. The Applied Hydrology overview and American River Basin Study and Willow Creek Flood Hazard Analysis Case Studies highlight innovative research, hydrologic science, and engineering applications within the Water, Environmental, and Ecosystems Division that inform planning and operations modeling. "Application of Geographic Information Systems in Wildland Fire Management" explores intern Karolyn Hilquist's project to map and determine which of Reclamation's assets are most at risk to wildfires. Intern Jonathan Gordon's "Fall Water Conservation Tips" shares best practices for water systems operators as summer ends. And our writer-editor intern, Lydia Ellefsen, conducted a Q&A with Sherri Pucherelli, Biologist and Research Coordinator in the TSC's Ecological Research Laboratory.

In addition to writing and editing, these interns collaborated to determine this issue's focus and design. It has been a pleasure to learn from them and watch their development. Onward!

Darion Mayhorn, P.E.
Supervisor, Operations and Maintenance
Asset Management Division

Andrew Daigle, Ph.D.
Writer-Editor
Dam Safety and Infrastructure

Around O&M

Enterprise Asset Registry

- The Asset Management Division continues to work on integrating the Enterprise Asset Registry, Recommendation Enterprise Management Information System, and Capital Investment and Repair Needs Database. This standardization effort helps position the Enterprise Asset Registry to manage Reclamation's asset information across enterprise systems in a single location.
- The Enterprise Asset Registry is now accessible across Reclamation both geospatially, in feature layers, and in a standardized tabular format to use for big data visualization in applications like Power BI and Tableau.
- The Transmission Asset Class was launched in July with the regional review occurring from July to September 2023. The Recreation Phase 1 and Boat Ramp asset classes have been moved into active management, and the Pumping Plant asset class will be moved to active management by the end of 2023.

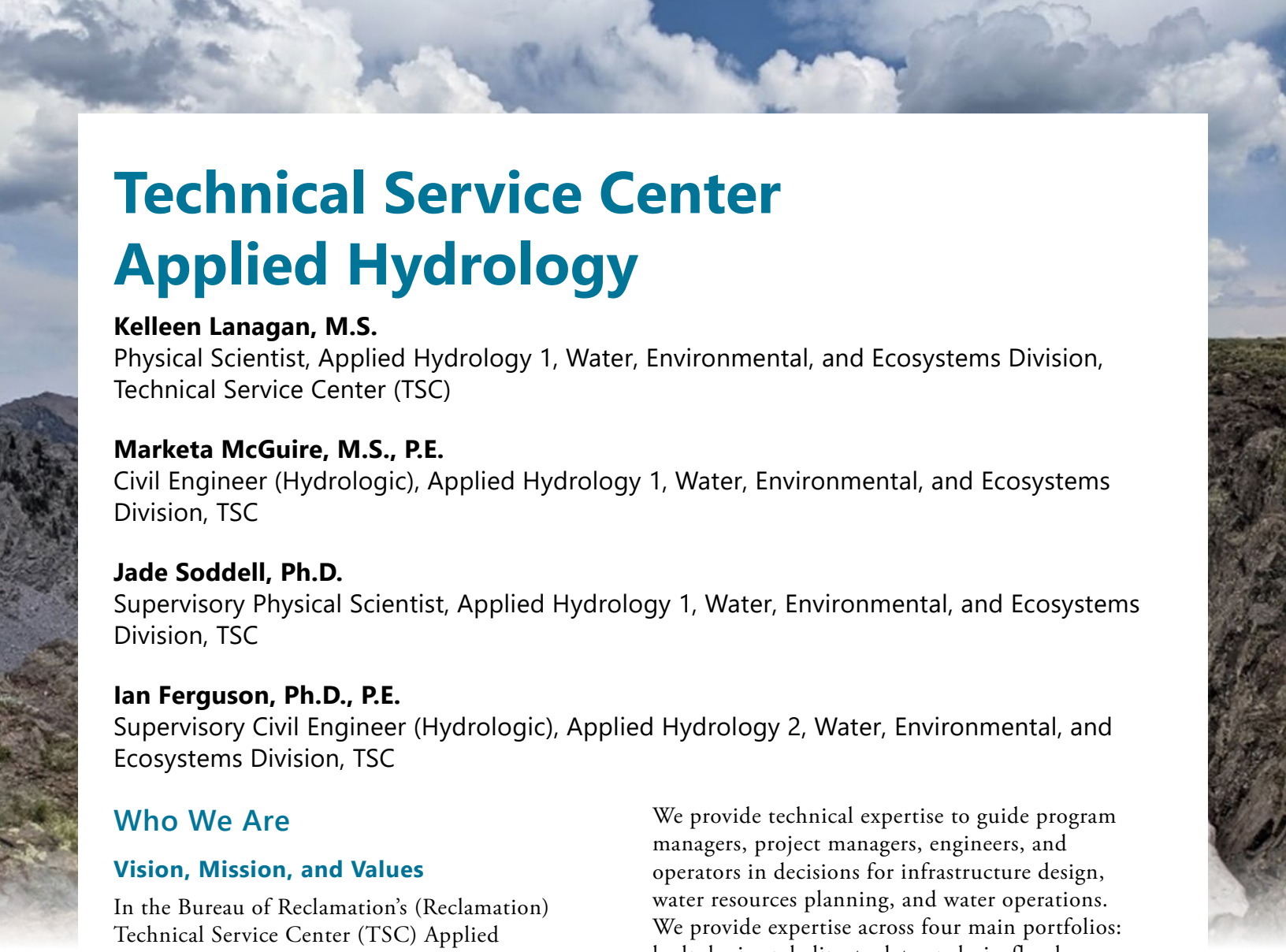
2023 Reservoir Sedimentation Survey Team Workshop

- Representatives from the regions, TSC, and Asset Management Division met August 29-31, 2023, in Grand Junction, Colorado, to discuss implementation of the Reservoir Sedimentation Monitoring section of FAC 02-01. Major workshop goals included strategic planning, a field visit, and discussions about an agency-wide reservoir survey team, among other topics.

Colorado River delta of Lake Powell near Hite Marina.

Water Rights Information Management System (WRIMS)

- The WRIMS Team met with California-Great Basin Region (CGB) water rights subject matter experts August 7-10, 2023, in Sacramento, California, to discuss and upload CGB's water rights inventory.
- The meeting included a walkthrough of WRIMS, the CGB inventory, and the data management processes for validation and verification. The team successfully identified 75 water rights records to upload to WRIMS.



Technical Service Center Applied Hydrology

Kelleen Lanagan, M.S.
Physical Scientist, Applied Hydrology 1, Water, Environmental, and Ecosystems Division, Technical Service Center (TSC)

Marketa McGuire, M.S., P.E.
Civil Engineer (Hydrologic), Applied Hydrology 1, Water, Environmental, and Ecosystems Division, TSC

Jade Soddell, Ph.D.
Supervisory Physical Scientist, Applied Hydrology 1, Water, Environmental, and Ecosystems Division, TSC

Ian Ferguson, Ph.D., P.E.
Supervisory Civil Engineer (Hydrologic), Applied Hydrology 2, Water, Environmental, and Ecosystems Division, TSC

Who We Are

Vision, Mission, and Values

In the Bureau of Reclamation's (Reclamation) Technical Service Center (TSC) Applied Hydrology Groups, our mission is to support environmentally and economically sound water resources infrastructure and operations decisions in the Western United States by advancing hydrologic science and engineering, maintaining and expanding our knowledge and capabilities, adjusting to dynamic challenges, and developing new and innovative methods. In addition to the TSC values of Excellence, Customer Service, Respect, Stewardship, and Innovation, the Applied Hydrology Groups also value Trust and Curiosity. These values guide us in developing new and innovative methods, building relationships among stakeholders and teams of technical experts, and delivering high-quality analyses and products.

Group Capabilities

Our capabilities span a broad spectrum of hydrologic science and engineering applications. We provide technical expertise to guide program managers, project managers, engineers, and operators in decisions for infrastructure design, water resources planning, and water operations. We provide expertise across four main portfolios: hydrologic and climate data analysis, flood hydrology and meteorology, hydrologic modeling, and planning and operations modeling.

Hydrologic and Climate Data Analysis: we leverage a diverse array of data to gain insights into hydrologic and climate variability and trends.

Flood Hydrology and Meteorology: we analyze hydrologic risks and meteorological factors to guide infrastructure design, inform risk analyses, and enhance preparedness and response strategies.

Hydrologic Modeling: we develop and apply numerical models to simulate surface water and groundwater processes, atmospheric processes, evaporation and evapotranspiration (ET), and water quality to inform risk analysis, scenario analysis, and prediction.

Planning and Operations Modeling: we develop and apply rule-based models to simulate reservoir operations, water deliveries, and stream conditions to inform short-term operations and long-term planning and to facilitate collaborative analysis of infrastructure and operating alternatives with partners and stakeholders.

Unique in our Approach

Our work involves statistical analysis of extreme events, modeling of complex physical processes and operating criteria, understanding interactions between natural processes and management actions, and more. In most cases, there are no established standards or guidelines that apply to our work. Instead, we continually adapt and advance established tools and methods and develop new and innovative approaches to address basin- and project-specific challenges. Innovation requires us to maintain and advance our technical capabilities through mentoring and training; to engage with experts from government, industry, and academia; and to spearhead research and development activities to address new and emerging challenges. While we do not make operational, planning, or investment decisions, we strive to provide our partners with the highest-quality studies and analyses as the foundation for water resources design and management in the West.

Our Capabilities in Action

The Applied Hydrology Groups lead a wide range of studies, analyses, and research projects. Below are a few examples:

Infrastructure

Flood hazard analyses are a large component of our overall infrastructure-related workload. With the failure of Teton Dam in the spring of 1976, Reclamation ushered in a new era of understanding and managing risk. On one hand, maximizing water storage is a high priority to ensure reliable water supplies for irrigation, municipal and industrial uses, hydropower generation, and other objectives. On the other hand, ensuring that reservoirs maintain sufficient available storage capacity to attenuate high flows is critical to flood control and dam safety. We analyze meteorology and streamflow characteristics to better understand the mechanisms that drive flood events and quantify their magnitudes and probabilities. These analyses inform infrastructure design and risk analysis of existing infrastructure, as well as development of operating criteria that balance water supply, hydropower, and environmental objectives with flood control and dam safety. For more information about our flood hazard analyses and development of hydrologic loadings, check out TSC Interviews Amanda Stone from the Applied Hydrology Group.

Members of the Klamath Natural Flow Study team at Copco 1 Dam, Klamath River, California (McMillen/Sean Iiams).

Doug Woolridge assessing basin and terrain considerations for the Vallecito Dam Flood Study, La Plata County, Colorado (Reclamation/Amanda Stone).

In addition to flood hazard analysis, we conduct special hydrologic studies to enhance our understanding of how hydrology can influence design considerations (e.g., Design Standards No. 14, Ch. 2: Hydrologic Considerations) and to quantify water supplies and demands for planning and design of structural and non-structural alternatives (e.g., CMP 09-01, CMP 09-02, CMP 09-04, WTR 13-01). As discussed more below, detailed characterization of water supplies and demands is needed to determine the appropriate size for water storage and conveyance facilities and to evaluate the potential performance and reliability of existing and proposed facilities under various operating alternatives. Characterization of interannual variability in water supplies is necessary to evaluate potential performance of existing and proposed infrastructure during periods of high flow as well as drought conditions.

Planning and Operations

Water resources planning and operations require accurate and reliable estimates of water supplies and demands. Water supplies include precipitation, streamflow and reservoir inflows, and recharge and groundwater levels; water demands include demands for irrigation, municipal and industrial uses, and environmental uses such as instream flow requirements and water temperature management. Long-term planning relies on projections of future water supplies and demand over the coming decades and how supplies and demands are likely to vary from season to season and year to year, including potential impacts of climate change, population growth, and other factors. Similarly, short-term operations rely on forecasts of streamflow and reservoir inflows, water demands, and other conditions over the coming days to months to inform water allocations, releases, and diversions.

The Applied Hydrology Groups use a variety of datasets and modeling tools to evaluate and characterize water supplies and demands, as well as other conditions such as water temperature, over a range of timescales to inform planning and operations decisions. We use surface hydrology models (e.g., rainfall-runoff models) to simulate runoff, streamflow, and reservoir inflows, along with recharge and groundwater models to simulate groundwater supplies and groundwater/surface-water interactions. We use ground-based and remote sensing estimates of ET to evaluate historical crop water use and irrigation demands, as well as models to estimate water use and irrigation demands under

projected future conditions. In addition to modeling and analysis of supplies and demands, we use water quality and water temperature models to evaluate and predict water quality parameters in lakes and rivers.

To inform planning and operations decisions, we combine information on water supplies and demands with planning and operations models. Whereas the models used to evaluate water supplies, demands, and quality simulate physical processes such as runoff, recharge, and ET, planning and operations models simulate water management actions such as reservoir storage, water allocations, and reservoir releases and diversions. Planning and operations models represent reservoir operations as a set of logical rules that reflect contractual obligations, regulatory requirements, and operating objectives. Planning models typically simulate water management actions over timescales from years to decades, often at a monthly timestep. In contrast, operations models often simulate water management actions over timescales from one week to one year, often at a daily timestep. Planning models are typically used to inform infrastructure planning and design, whereas operations models inform day-to-day operations.

The Applied Hydrology Groups' technical expertise related to water resources planning and operations is highlighted by our work with the WaterSMART Program. The WaterSMART Program supports a variety of activities where Reclamation works cooperatively with states, tribes, and local entities as they plan for and implement actions to increase water supply through investments to modernize existing infrastructure and avoid potential water conflict. Our contributions to the WaterSMART Program include developing projections of future water supplies and demands, including effects of climate change, population growth, and other factors; analyzing how existing water and power infrastructure will perform under current and projected conditions; and developing and evaluating appropriate adaptation and mitigation strategies to meet current and future demands. Examples of the Applied Hydrology Groups' contributions to WaterSMART include:

- West-Wide Climate and Hydrology Assessment and SECURE Water Act Report to Congress
- Basin Studies such as the Missouri Headwaters Basin Study, American River Basin Study, and others
- Reservoir Operations Pilots in the Klamath River Basin, Salt and Verde River Basins, American River Basin, and others
- Internal Applied Science Tools such as the Snow-Dust-Runoff Decision Support Tool and Estimating Open-Water Evaporation from Elephant Butte Reservoir using the WRF Model

In addition to WaterSMART, the Applied Hydrology Groups provide technical expertise on planning and operations studies across all five Reclamation regions. Additional examples include the Klamath Natural Flow Study, 2021 Consultation on the Coordinated Long-Term Operations of the Central Valley Project and State Water Project, and Pasco Basin Groundwater Management Study.

Research

The Applied Hydrology Groups are frequently tasked with answering questions that push the boundaries of existing datasets, tools, and method where there are no applicable standards or guidelines to guide our analyses. As a result, we frequently lead research projects to advance and expand existing tools and methods and develop new and innovative approaches to address basin- and project-specific challenges. Research projects led by the Applied Hydrology Groups were selected as the Science and Technology Program's Research Project of the Year three years in a row:

- 2020: Development of Web-based Stochastic Storm Transposition Toolkit for Physically-based Rainfall and Flood Hazard Analysis
- 2021: Merging high-resolution airborne snowpack data with existing long-term hydrometeorological observations to improve water supply forecasting
- 2022: Developing process-based and spatially consistent approaches for correcting streamflow biases in watershed hydrology simulations

These projects represent a small sample of the Applied Hydrology Groups' contribution to advancing hydrologic science and engineering in support of Reclamation's mission now and into the future.

Nimbus Dam on the American River near Sacramento, California.

Case Studies in Applied Hydrology: American River Basin Study and Willow Creek Flood Hazard Analysis

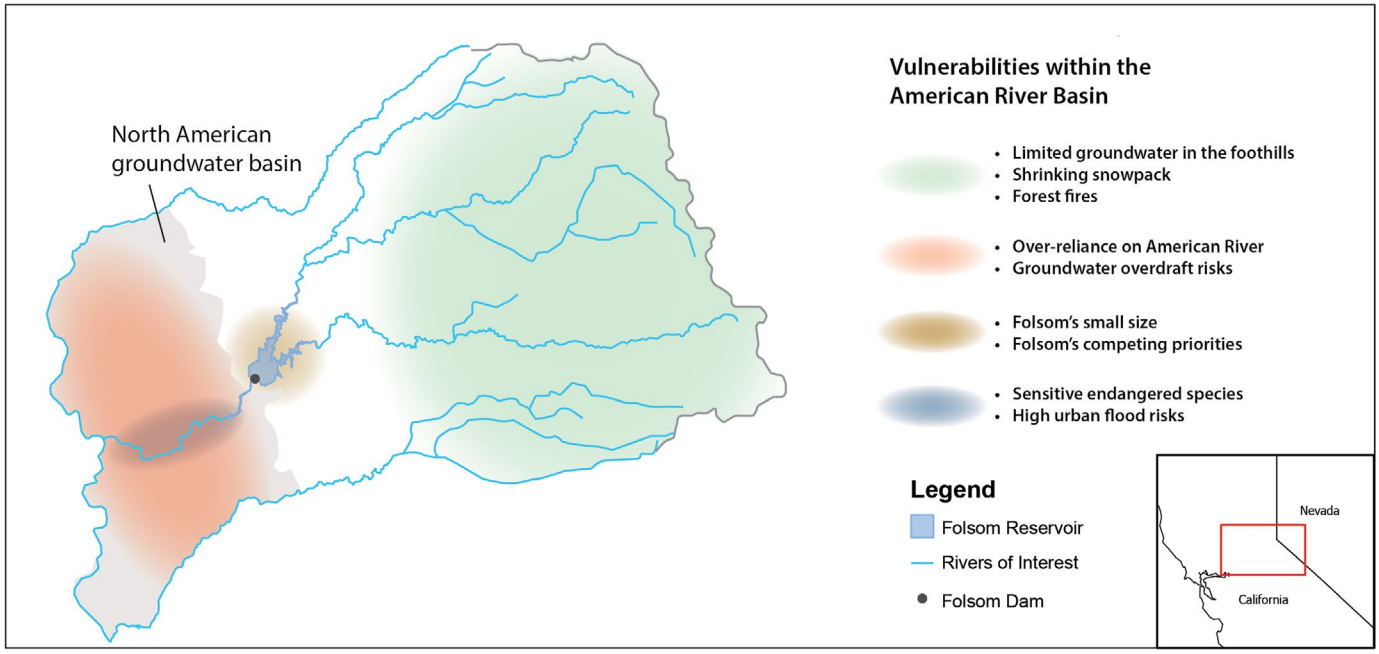
Kelleen Lanagan, M.S.
Physical Scientist, Applied Hydrology 1, Water, Environmental, and Ecosystems Division, Technical Service Center (TSC)

Amanda Stone, M.S., P.E.
Civil Engineer (Hydrologic), Applied Hydrology 2, Water, Environmental, and Ecosystems Division, TSC

Katie Holman, Ph.D.
Meteorologist/Atmospheric Scientist, Applied Hydrology 2, Water, Environmental, and Ecosystems Division, TSC

Jade Soddell, Ph.D.
Supervisory Physical Scientist, Applied Hydrology 1, Water, Environmental, and Ecosystems Division, TSC

Ian Ferguson, Ph.D., P.E.
Supervisory Civil Engineer (Hydrologic), Applied Hydrology 2, Water, Environmental, and Ecosystems Division, TSC



American River Basin regional map of vulnerabilities.

In the Technical Service Center's (TSC) Applied Hydrology Groups, we provide technical expertise across a broad range of hydrologic and meteorological themes. In this article, we present two examples of the work we do to advance our science and engineering in support of our project partners.

Operationalizing Climate Change: the American River Basin Study

The American River flows from the Sierra Nevada Mountains to its confluence with the Sacramento River in the Central Valley near Sacramento, California. Water managers in the American River Basin have experienced a growing imbalance between water supplies and demand due to population growth, economic development, increasing regulatory requirements, and impacts of climate change on water supplies and demands in the basin. The Bureau of Reclamation (Reclamation) collaborated with five state and local partners on the Sacramento and San Joaquin Rivers Basin Study (SCRBS) to evaluate climate change impacts and adaptation actions across the Sacramento River Basin, San Joaquin River Basin, and Tulare Lake Basin. On completion of the SCRBS in 2016, Reclamation subsequently partnered with six water management agencies in the American River Basin on the American River Basin Study (ARBS). The ARBS builds on the SCRBS by developing basin-specific data, tools, analyses, and climate change adaptation strategies for the American River Basin.

Climate Change and Anticipated Impacts

The ARBS developed projections of future water supplies, demands, and system performance for the American River Basin under a range of future climate scenarios. Downscaled climate projections indicate that basin-average annual mean temperature will increase by 4-7 degrees Fahrenheit by the end of the 21st century. While the projections do not show a clear trend future precipitation, hydrologic modeling of future climate scenarios shows a significant shift in the seasonal timing of runoff. Runoff in the basin is linked to snowpack accumulation and melt. As temperature increases, the accumulation season shrinks and snowmelt season begins earlier, resulting in increased runoff during winter and decreased runoff in spring and summer. In addition, rising temperatures are projected to increase evapotranspiration in the basin, which in turn reduces soil moisture and decreases annual runoff.

These changes in runoff timing and volume will make it more difficult for Reclamation and other water management agencies in the basin to meet competing demands, including storing water for use during the low flow season and droughts, managing flood risk, and protecting freshwater ecosystems. Without adaptation or mitigation actions, impacts would include:

- Reliable Water Supply: Water demand is projected to outpace water supply. To meet

demand, there may be increased groundwater pumping that would affect groundwater sustainability.

- Fish and Wildlife Habitat: The shift in runoff timing and potential lower Folsom Reservoir storage during summer and fall would affect the reservoir's ability to manage flows and water temperatures for fish and wildlife purposes.
- Flood Risk Management: Increased early season runoff could increase flood risk in heavily populated urban areas where more setback levees are not possible.
- Hydropower and Recreation: The shift in runoff timing and volume could result in reduced hydropower and recreation opportunities.

These projected impacts highlight vulnerabilities within the basin, including Folsom Reservoir's relatively small size and competing priorities; sensitive endangered species and high urban risks along the Lower American River; over-reliance on American River water and groundwater overdraft in the lower portion of the basin; and limited groundwater resources, shrinking snowpack, and increasing wildfire risk in the foothills and mountain portions of the basin.

Adaptation Strategies

Adaptation strategies are already underway in the basin to increase agricultural and urban water use efficiency, facilitate water transfers and exchanges, and improve headwaters and forest health. The ARBS developed and evaluated new adaptation strategy portfolios to maintain a balance between supply and demand, including:

- Use of high-elevation, off-stream storage to replace lost storage from reduced snowpack and earlier snowmelt.
- Use of existing diversion facilities along the Sacramento River and exchange of water supply to reduce reliance on Folsom Reservoir and the American River.
- Expanding conjunctive use operations through a federally recognized groundwater bank to augment the regulatory capacity of Folsom Reservoir.

Implementing forecast-informed reservoir operations in combination with flood-managed aquifer recharge and groundwater banking to augment regional water supply and ecosystem benefits.

Gibson Dam overtopping during the June 1964 flood.

Since completing the ARBS in 2022, Reclamation and local water management agencies continue to collaborate on planning and evaluation of strategies to meet current and future water demands. These efforts will shape water infrastructure and operations in the basin into the future. Learn more about the collaborative work being done on the American River in the American River Basin Study.

Dam Safety: Willow Creek Flood Hazard Analysis

In June 1964, the Sun River Basin in Montana saw its largest flood event in recorded history. During this event, Gibson Dam overtopped as water filled the reservoir and cascaded over the concrete structure. Additionally, Willow Creek Dam, an earthen dam located approximately 16 miles east of Gibson Dam on a tributary of the Sun River, activated its emergency spillway. This flood exceeded the original inflow design floods developed for both facilities.

Overtopping can cause dam failure and hazards for people and property downstream. About 30% of dam failures in the United States can be attributed to overtopping events. For about 20 hours in 1964, Gibson Dam was overtopping the concrete parapet by about 3 feet but did not fail. This extraordinary flood event highlighted the need to better understand flood hazard and erosion potential at dams in the Sun River Basin. Since then, the region has experienced several large rainfall events during the month of June, when streamflow is high from snowmelt and reservoirs are filling rapidly, though none of the large rainfall and resulting flow events have exceeded the magnitude of the 1964 flood.

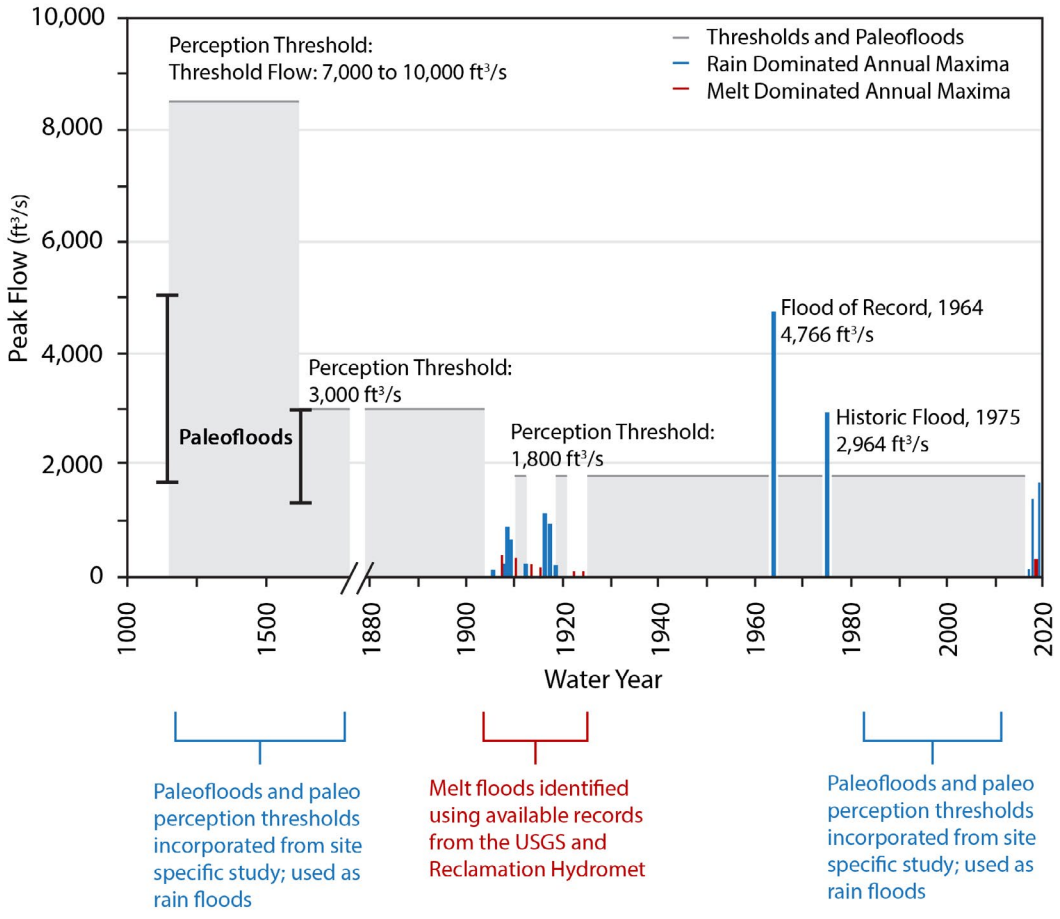
Safety of Dams

TSC Applied Hydrology Groups recently analyzed flood hazards for Willow Creek and Gibson Dams to address a Safety of Dams recommendation in which there was a call to update the flood frequency analysis (FFA) for Willow Creek Dam. FFA is used to support quantitative risk computations, where risk for a certain failure mode can be defined as the probability of a hydrologic load (e.g., peak water surface elevation) times the probability of failure given the load times the consequences of failure given the load. Previous analyses at Willow Creek Dam were high-level and based on a very short streamflow gage record and therefore had very low confidence in estimates.

Steps to Analyze Flood Frequency

Improving confidence and reducing uncertainty in estimating rare floods requires leveraging multiple datasets and methods. Flood frequency analysis requires robust streamflow data. Due to the lack of high-quality inflow records at Willow Creek Dam, the study scope was expanded to include Gibson Dam, which had a much longer and more robust streamflow record and still experienced the same large rain events as Willow Creek. This allowed us to leverage the data-rich Gibson Dam region to improve our analyses at Willow Creek.

In the Sun River Basin, floods are driven by two primary mechanisms: spring snowmelt and rain on snow events. For basins with multiple mechanisms, the best practice is to analyze them individually and then mathematically combine the results to get a total estimate of the flood hazard for the basin. Methods included development of paleoflood bounds, statistical analysis of streamflow records, and rainfall-runoff modeling. Paleoflood bound development is led by scientists in the TSC's Seismology and Geomorphology Group.



Peak flows identified by streamflow records and paleoflood bounds.

Caroline Ubing and Kyra Hewett surveying stream channel upstream of Willow Creek Reservoir, Montana, to support flood hazard study (Reclamation/Amanda Stone).

Development and use of paleoflood information is critical for understanding very infrequent events required for dam safety decision-making, as streamflow records are limited to 100 years of record at best. A paleoflood study typically includes soil stratigraphy, radiocarbon aging of samples, and 2D hydraulic modeling to pair those ages with flows. Multiple locations are analyzed, and paleofloods and non-exceedance bounds are developed to support a statistical analysis of flows in the basin.

Paleoflood information is combined with streamflow records to extend the observational record beyond what is available solely with streamflow observations, as illustrated above. A statistical analysis can then be conducted using this information to fit a distribution to represent flood magnitudes, associated probabilities, and uncertainties.

Rainfall-based methods can be used to further improve confidence of the flood frequency estimates. This typically involves a robust analysis of extreme precipitation events in the region and development of a precipitation-frequency curve by atmospheric scientists in the Applied Hydrology Groups. This information is then used to force rainfall-runoff models to simulate large flows in the basin. Simulated streamflows further contribute to the statistical streamflow analysis, allowing the analyst to estimate even lower probability floods. In this case, a stochastic rainfall-runoff model was developed to simulate tens of thousands of theoretical floods across the Gibson Basin. Further, the calibration information from Gibson Basin was used to inform a rainfall runoff model specific to the Willow Creek Basin, where there was insufficient high-quality data to develop and calibrate a model individually.

Decision-Making Support

Results from this analysis were used to develop inflow hydrographs and associated probabilities for both Gibson and Willow Creek Dams. Willow Creek hydrographs representing both snowmelt runoff and rain-driven runoff for a range of probabilities were routed through Willow Creek Reservoir to determine probability of overtopping. Hydraulic engineers from the TSC's Sedimentation and River Hydraulics Group completed 2D modeling of the spillway during these simulated events to better understand the magnitude of potential spillway erosion. This information is being used to inform both interim risk reduction measures as well as to develop corrective action alternatives.

This study addressed several technical challenges to improve confidence in flood frequency estimates at Willow Creek Dam to support ongoing decisions. Major challenges include the relatively high probability of large flood events, the mixed population nature of the floods, the limited nature of data specific to the basin of interest, and the high chance of spillway activation and erosion at this facility.

One issue this study did not address relates to climate change. There is ongoing work within the Applied Hydrology Groups to understand climate change impacts on dam safety decision-making and how to understand those impacts from scales ranging west-wide for screening purposes down to the basin-specific level for risk analysis and decision support at individual facilities.

Application of Geographic Information Systems in Wildland Fire Management

Karolyn Hilquist
Intern, Land Resources Branch, Asset Management Division, Dam Safety and Infrastructure

The Bureau of Reclamation (Reclamation) has jurisdiction over approximately six million acres of burnable land that contains critical infrastructure, such as dams and hydropower facilities, and water bodies. Currently, there is no method to assess the risks of wildfire to assets or to distribute or prioritize associated funding for fuels reduction treatments. Taking action to protect and lessen the impact of wildfire through fuels reduction will help reduce the severity of wildfires and help prevent more significant damage to Reclamation's land, infrastructure, and watersheds. A wildfire risk assessment has recently been created to determine which of Reclamation's assets are most at risk to wildfires.

By having methods to determine where fuels reduction is needed for wildfires, Reclamation will be able to provide funding more efficiently and effectively where it is needed most to protect its assets. Wildfire risk reduction and wildfire resilience improvements are extremely relevant to Reclamation as drought continues to impact the Western United States. This geographic information systems (GIS) assessment tool creates a baseline model to spatially measure wildfire risk to Reclamation's land, infrastructure, and waterbodies. Better understanding the wildfire risk of all of its individual assets will help Reclamation prepare for and respond to the unpredictable nature of wildland fire.

Moderately burned area from Saddle Mountain Fire that had higher percentage of sagebrush cover (Reclamation/Danielle Blevins).

Saddle Mountain Fire

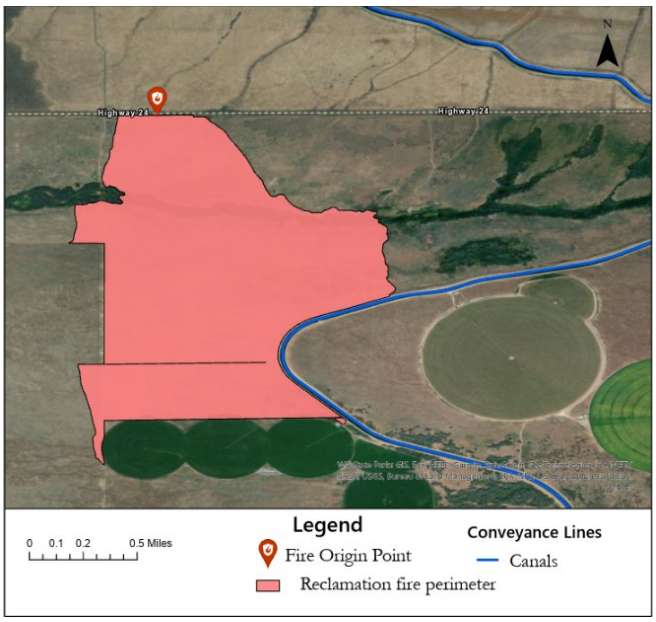
On June 6, 2023, the Saddle Mountain Fire started along the south side of Highway 24, southwest of Othello, Washington. The fire's origin, within the Columbia Cascades Area Office boundaries, was at a semitrailer, likely resulting from tire issues. The wildfire spread south and burned a total of 619 acres, 569 of those being Reclamation jurisdictional acres. The fire burned right up and along the Wahluke Branch Canal, which is part of the Columbia Basin Project System. It damaged an operations and maintenance road, knocking power out and making the road difficult to drive on. Since the fire burned along a Reclamation canal, we can use the wildfire risk assessment tool to see the potential wildfire hazard for the asset.

Methodology

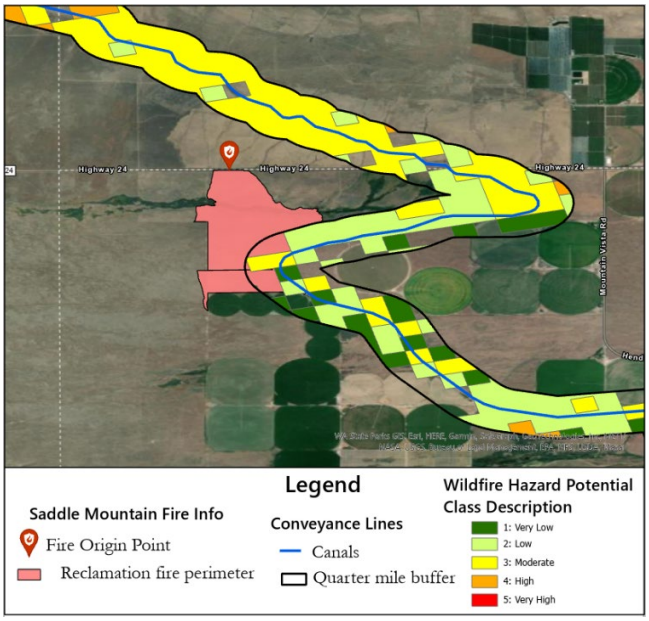
To create the wildfire risk assessment, data was collected from Reclamation's Enterprise Asset Registry, which contains layers for multiple types of assets: dams, hydropower, pumping plants, urban canals, conveyance lines, levees, offices, recreation sites and management areas, and reservoirs. To determine the wildfire risk, the wildfire hazard potential (WHP) data for the United States was chosen from the U.S. Department of Agriculture Forest Service. The WHP data set incorporates vegetation and wildland fuels data from LANDFIRE 2014, as well as annual burn probability and fire intensity or flame lengths that were generated using the large fire simulation system (FSim) to create five class descriptions of wildfire hazard: very low, low, moderate, high, and very high.

Using the application ArcGIS Pro, the analysis was conducted by creating buffers around all the assets. Since many of Reclamation's assets are right next to water, the pixel they intersected with was sometimes a water pixel. By adding a one-mile buffer around points and polygons and a quarter mile around line data, an average wildfire hazard potential was calculated using the pixel values between one and five within the buffered zone.

Using the wildfire risk assessment tool on the Wahluke Branch Canal, its average wildfire hazard potential from the quarter-mile buffer is 2.22, which is a moderate wildfire hazard. The map shows that the buffered zone includes a mix of pixels from very low to high wildfire hazard potential, which is where the moderate average comes from.



Screen capture of the Saddle Mountain Fire in relation to the nearby Reclamation canal asset.



Screen capture of Wildfire Risk Assessment analysis on the Wahluke Branch Canal.

Reclamation Wildfire Risk Assessment Dashboard

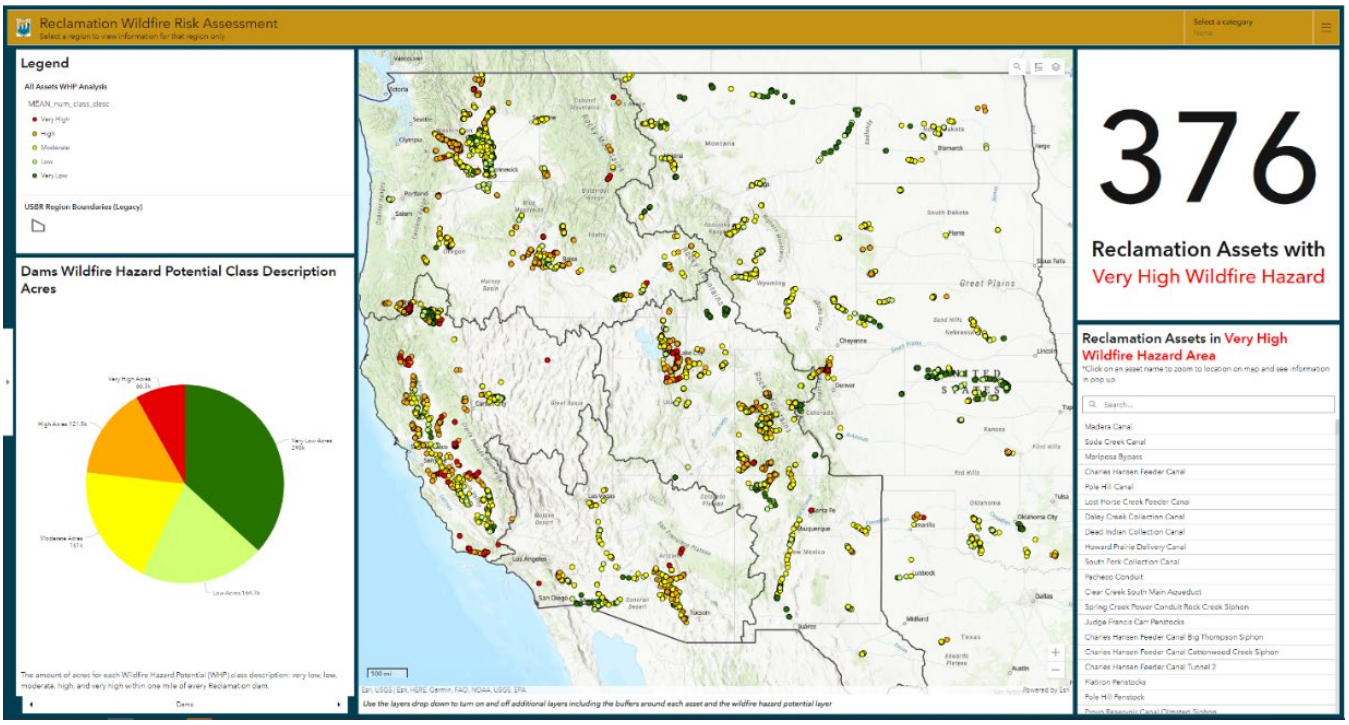
The interactive Wildfire Risk Assessment Dashboard produces a visual snapshot of the level of potential risk that wildfire poses to Reclamation lands, infrastructure, and waterbodies. By taking the average wildfire hazard potential of almost every asset class, the data was converted into points and merged into one large dataset to display on the dashboard. The dashboard allows users to interact

with the map by zooming in and out and clicking on points to view information on asset class, asset name, and locational information. Additionally, at the top of the dashboard, a category can be selected to filter the map, pie chart, total assets with very high wildfire hazard, and list data to one region.

The dashboard will be shared across Reclamation's regions for Wildland Fire Management (WFM) Program coordinators to identify assets most at risk and use that information to address and reduce risk by prioritizing fuels treatments. As a result, fuels reductions can be conducted in areas that are identified as very high wildfire hazard to help protect those assets from the damage and dangers of wildfire. Additionally, by using the layer of the buffers around the assets, some directions around an asset could have more wildfire risk than other directions. This data can help regions determine exactly where the most beneficial locations will be to plan fuels treatments.

Future Direction

The project began at the end of May 2023 and will be continued into the fall to further the development and scope of the wildfire risk assessment tool by incorporating Reclamation land boundary data from the Enterprise Asset Registry and working towards a way to collaboratively quantify the importance of assets (e.g., the difference between a hydropower facility and a recreation site). As shown in the situation at Wahluke Branch Canal, wildfires can happen anywhere. To be prepared, Reclamation must effectively and efficiently use available funding to help reduce the impact of wildfires through WFM plans and wildfire reduction improvements. By adding an importance variable, the wildfire risk assessment tool will be streamlined to further help Reclamation prioritize funding and ensure effective operations and stewardship of Reclamation land, infrastructure, and waterbodies.



Screen capture of Wildfire Risk Assessment Dashboard.

Fall Water Conservation Tips for Water Systems Operators in the Western United States

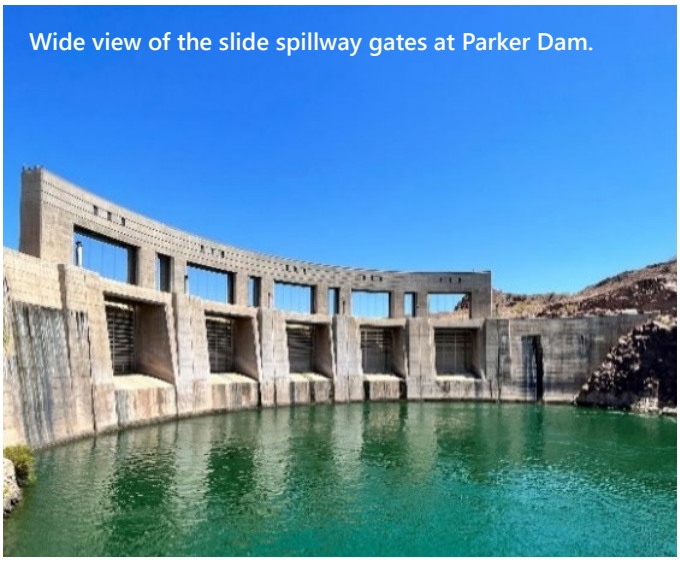
Jonathan Gordon
Intern, Operations and Maintenance Branch, Asset Management Division,
Dam Safety and Infrastructure

As the fall season arrives, water conservation becomes increasingly critical for the Bureau of Reclamation (Reclamation). Responsible for managing water resources across the western United States, Reclamation aims to maintain reliable water supply and hydropower for the 17 western states by using water conservation techniques and practices. To achieve this goal, it is essential for water system operators to implement effective water conservation strategies during the autumn months.

Jonathan Gordon, a Summer 2023 intern working within the Asset Management Division (AMD), Dam Safety and Infrastructure, examined parts of Reclamation's infrastructure with the goal of gaining a greater understanding of Reclamation's operations and maintenance (O&M) needs and responsibilities. In particular, Gordon visited Parker Dam in western Arizona for an Annual Site Inspection under Dustin Johnson in the Examination of Existing Structures/ Safety of Dams Group of the Lower Colorado Basin Regional Office. Gordon also traveled to the Klamath Project in southwest Oregon for an Urban Canal Inspection with Nick Casamatta, Conveyance O&M Program Manager in AMD. Both are older assets within Reclamation, with Parker Dam having finished construction in 1938 and the Klamath Project first delivering water in 1907. This article presents various fall seasonal water conservation tips and guidelines tailored to the needs of managing partners and operators, inspectors, and staff across Reclamation. This analysis draws primarily from inspectors and operators at Parker Dam, the Klamath Project, and the O&M Branch.

Monitor Water Levels and Usage

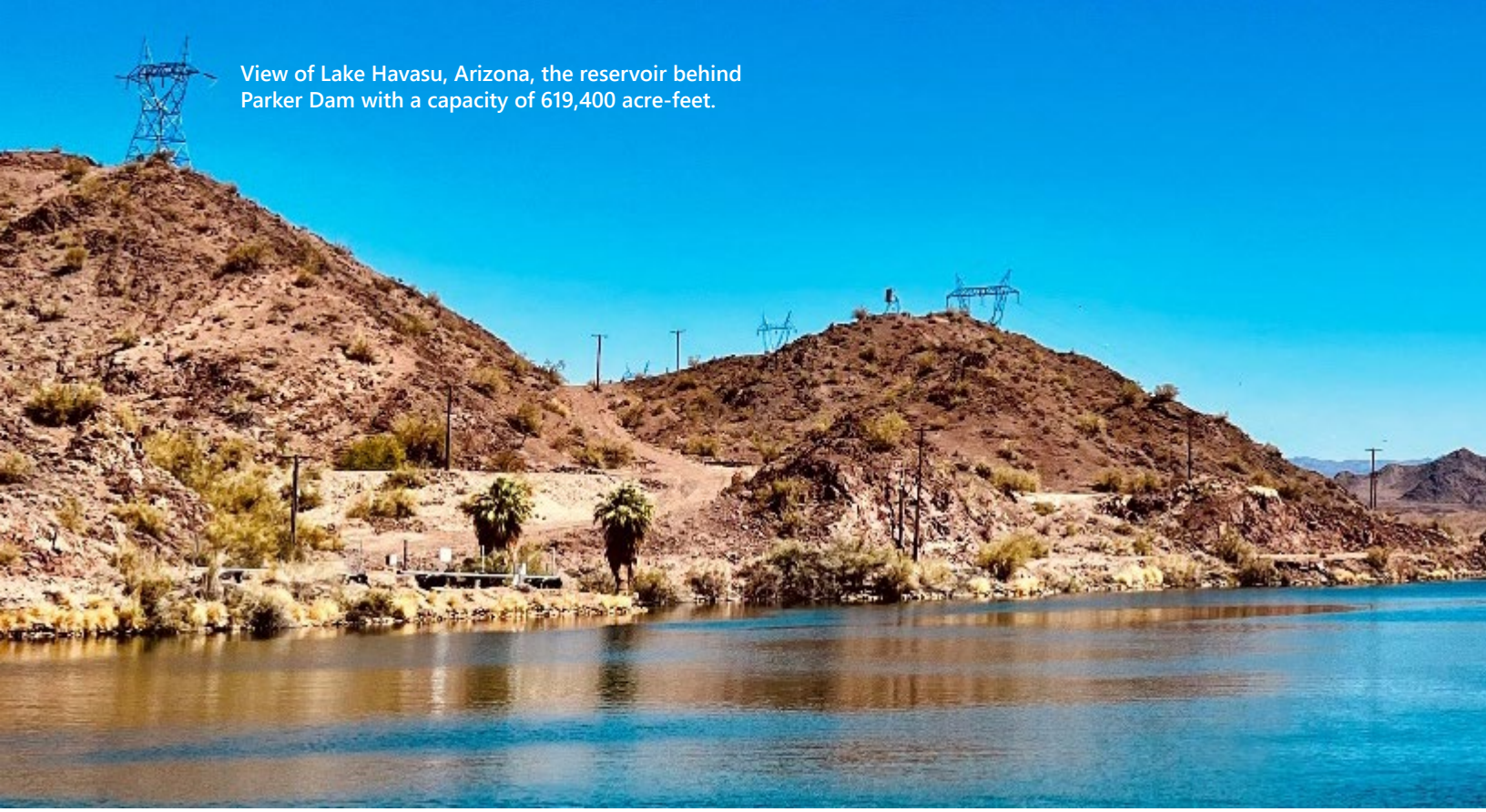
One of the fundamental aspects of water conservation is monitoring water levels and usage. Regular assessments help identify areas of concern and opportunities, allowing for prompt action to mitigate water wastage and ensure efficient use. By closely monitoring reservoir levels and use patterns, dam operators can implement timely water release strategies, safeguarding the dam's structural integrity and downstream water supply.



Wide view of the slide spillway gates at Parker Dam.

Increase Water-Efficient Landscaping

Water suppliers can promote water-saving landscaping. However, it is important to note the risk of unregulated vegetation around infrastructure. While vegetation offers ecological benefits, it



View of Lake Havasu, Arizona, the reservoir behind Parker Dam with a capacity of 619,400 acre-feet.

can pose challenges with asset maintenance and structural integrity. For example, the Klamath Project's canals have little-to-no concrete lining. The canal deals with regular vegetation along the embankment, which can contribute to seepage and erosion via root penetration. Due to the project's age and surrounding development, O&M staff conduct frequent maintenance and monitoring along the canal.

As fall brings cooler temperatures, facility operators should consider implementing these water-efficient techniques:

- Use native plants that require minimal watering and are well-suited to the local climate.
- Apply mulch to retain soil moisture and reduce evaporation.
- Utilize low-water plants and smart irrigation systems to conserve water, reduce maintenance costs, and enhance landscape sustainability.

Encourage Public Awareness and Education

Public engagement and awareness are crucial components of any successful water conservation strategy. When the public is aware of the importance of water conservation, they are more likely to adopt everyday water-saving practices. Engaging with schools and community groups can help instill a culture of responsible water usage that will benefit the environment in the long term. Collaborating with communities and organizations helps promote the importance of water conservation through workshops, seminars, and outreach programs about water-saving techniques that are prudent during the fall.

Implement Seasonal Watering Schedules

Adjusting watering schedules in response to seasonal changes is an effective way to conserve water. As the fall season brings cooler weather and reduced evaporation rates, encourage users to decrease the frequency and duration of irrigation. Water operators can develop watering schedules tailored to the needs of different ecosystems. This approach reduces waste and protects supply for more critical time periods.

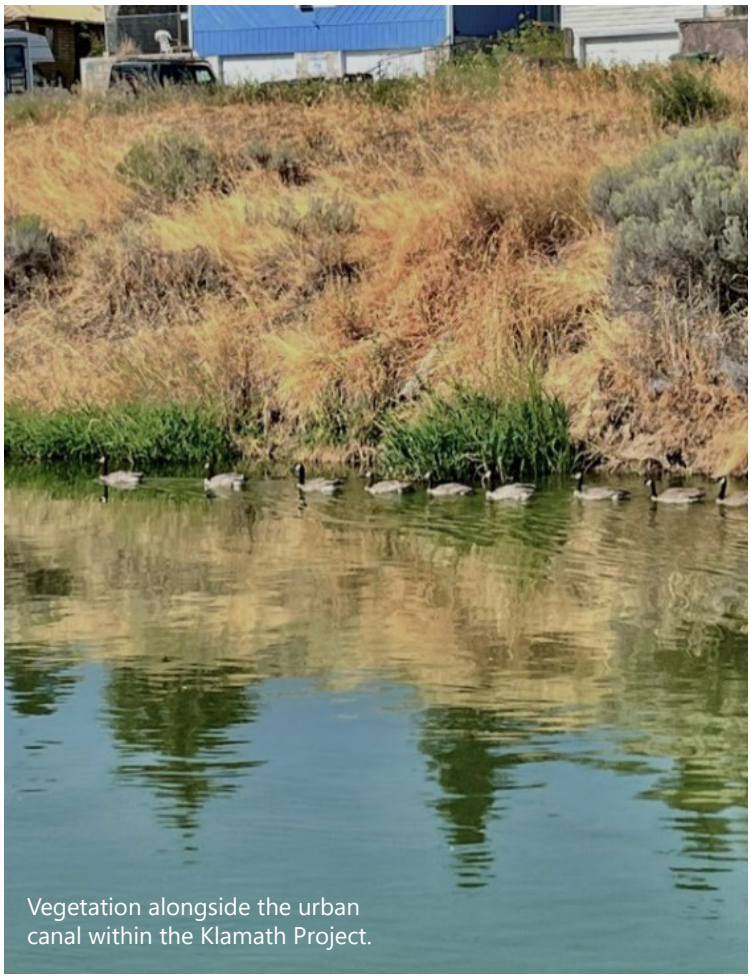
Adopt Water-Saving Technologies

Advancements in water-saving technologies present valuable opportunities to optimize water usage. Implementing state-of-the-art irrigation systems with smart sensors and automated controls can minimize water waste and enhance overall water management efficiency. Learning from the success at Parker Dam, where automated water monitoring systems are installed, operators can extend such technologies to other water infrastructure projects. The systems

used at Parker Dam offer real-time data, enabling proactive responses to changing water conditions and supporting a consistent water supply. Klamath Project irrigators are also moving towards automated control systems, including with funding from a recent WaterSMART grant.

Invest in Water Infrastructure Upgrades

To maintain a resilient water supply system, it's prudent to invest in regular maintenance and improvement of water infrastructure. Fall offers a window for conducting inspections and necessary repairs before winter. Likewise, water suppliers should prioritize critical upgrades that address water leakage, evaporation losses, and inefficiencies in water conveyance systems. Adopting these water conservation tips can lead to significant improvements in water management efficiency during the fall. By leveraging insights from Parker Dam and the Klamath Project, water suppliers and users can develop innovative strategies for water operations. Effective water conservation not only protects natural ecosystems but also strengthens resilience in the face of changing environmental conditions.



Vegetation alongside the urban canal within the Klamath Project.

Sherri Pucherelli, biologist in Reclamation's Ecological Research Laboratory.

Q&A
Sherri Pucherelli

Biologist and Research Coordinator, Ecological Research Laboratory, Hydraulic Investigations and Laboratory Services Group, Engineering and Laboratory Services Division, Technical Service Center

Sherri Pucherelli is a biologist in the Ecological Research Lab in the Hydraulic Investigations and Laboratory Services Group, Engineering and Laboratory Services Division, housed in the Bureau of Reclamation's (Reclamation) Technical Service Center (TSC). She is also the Invasive Species Research Coordinator for the Reclamation Science and Technology (S&T) Program. She spoke with us about the lab's work with its detection and monitoring program, research on invasive mussels, innovative technologies being advanced at the lab, and the importance of being open-minded to new experiences.

Can you provide a high-level summary of your work before and since joining Reclamation, and what made you want to work for Reclamation?

While completing my undergraduate biology degree at Western Colorado University, I had the opportunity to intern with the USDA Forest Service and Reclamation. During these internships, I worked on invasive species and entomology projects that inspired me to pursue a master's degree on those topics. I learned about Reclamation's internship program and its biology-focused projects from my dad, who worked at the TSC.

I received a master's degree from Colorado State University in bio-agricultural sciences and pest management, with a focus in entomology. My thesis focused on invasive Russian wheat aphids. I wanted to pursue a career with Reclamation because my internship experience was very positive and because of the wide range of projects in which the agency was involved. Fortunately, I was hired on as a contractor and eventually became a permanent employee with Reclamation.

Who have been your mentors? What have you learned from them?

Reclamation didn't have a formal mentor program like they do now. I was a mentor to one of the newer employees recently, which was awesome. I wish that opportunity would have been available for me when I started. There are few biologists at the TSC, so our group is close, and we mentor and help each other.

When I first started, Mark Nelson and Denise Hosler taught me about developing research studies and how to effectively conduct field work. They provided a lot of guidance about working with clients and effective communication, especially when handling sensitive data.

How would you describe your role and responsibilities in the Ecological Research Lab?

Over the past decade, the lab's primary focus has been on invasive quagga and zebra mussel early detection, monitoring, and research. I am the invasive species research coordinator for the S&T Program, so part of my role is coordinating invasive mussel research. I also write and review proposals and conduct my own research. Most of my projects involve field work in the Lower Colorado Basin Region because of the quagga mussel infestation

Mussel early detection samples settling in Imhoff cones in the Ecological Research Lab.

Quagga mussel shells in a strainer at Hoover Dam.

Mussel fouling on a fixed wheel gate at Glen Canyon Dam.

in the Lower Colorado River and reservoirs. I also participate in a variety of invasive mussel working groups, such as the Western Regional Panel on Aquatic Nuisance Species and the Invasive Mussel Collaborative. We participate in many working groups to make sure our lab's efforts and research are aligning with needs and other efforts across the United States.

How do sampling processes work at the lab?

The Ecological Research Lab analyzes approximately 1,500 invasive mussel early detection and monitoring samples every year. Many of the samples are collected by Reclamation employees, but we also receive samples from managing partners, such as states or other Federal agencies. Samples are collected with a plankton tow net, which allows collection of veligers, the mussel larval stage. The water samples are preserved with ethanol and Tris buffer to preserve the tissue, DNA, and shell.

Samples are sent to our lab within 24 hours of collection and stored in the refrigerator to prevent degradation. Samples are settled on Imhoff cones for 24 hours, which allows the veligers to settle to the bottom of the sample, and then we only need to analyze the heaviest 15 milliliters of the sample. Samples are analyzed under the microscope to identify the microscopic veligers, and certain priority samples are further analyzed for the presence of mussel DNA.

What are the biggest challenges with detecting and monitoring invasive species?

It is a challenge to monitor all of Reclamation's water bodies and to collect enough samples for detection. That's why we also do a lot of research on the collection and analysis of environmental DNA (eDNA), which is another method that can be used to detect the presence of invasive species.

How does your work intersect with operations and maintenance (O&M) of facilities?

Invasive mussels cause significant O&M issues at hydropower plants. They can attach to any submerged equipment, including the inside of pipes, and they can prevent operation and flow of water. The shell debris can also accumulate inside of strainers and other locations, requiring removal. A lot of our research projects have focused on development and testing of control methods to prevent mussel fouling at hydropower plants. The impact of mussel fouling is site-specific and additional research is needed to find a variety of suitable treatments.

The mussel early detection effort can also help facilities avoid significant mussel-related O&M issues. If a mussel is detected early in the establishment of the population, it provides the facility three to five years to implement control methods so mussels don't become a huge issue.

Collection of mussel larvae with a plankton tow net at Lake Mead.

Can you share a success story about a project? How did it positively impact facilities' O&M?

We received funding from the S&T Program to investigate ultraviolet (UV) light for the prevention of mussel attachment in generator cooling systems. The treatment was found to successfully reduce mussel settlement and has been implemented at a variety of hydropower plants, including Parker Dam at Lake Havasu. In the past, Parker Dam would have to pull out equipment and remove mussels frequently because they would get overheating alarms. Since they installed the UV treatment, they have not had issues with mussels. Unfortunately, UV light technology is only suited for certain locations, so we continue to research and try to find other methods for hydropower plants.

What is some of the more unique work being done at the lab?

Once mussels become established in a large water body, you can't get rid of them with currently available treatments. We are pursuing some innovative biological control methods that have the potential to address this problem. Genetic biological control is a new area of study, especially for mussels, and Reclamation has made significant contributions by sequencing the quagga mussel genome.

The genome opened research paths for us and others to pursue mussel genetic control. The genome is currently assisting a research team that is pursuing a genetic biocontrol project that was initiated by a Reclamation Prize Competition. We also started an international invasive mussel genetic biocontrol working group to share information and move the science forward.

We are also working with a contractor to identify a more traditional biocontrol agent. The team is looking for parasites of closely related mussel species in their native range. The idea is to identify a parasite that might be able to kill quagga and zebra mussels. The team has established a laboratory in Montenegro and is doing trans-infection studies to see if parasites can infect and kill quagga and zebra mussels.

Our lab also has the capability to analyze environmental samples by metabarcoding. This is a technique that can be utilized to detect the DNA of many target species of interest, and it can be useful for a variety of environmental monitoring studies.

What is often misunderstood about studying invasive species?

Invasive species are so widespread, so many people think there's nothing we can really do. But we know of many cases where investing in prevention, detection, and research has made it possible to reduce the impacts. Monitoring seems challenging because you can't monitor every water body, but in the case of mussels, early detection can allow for quick containment with the implementation of watercraft inspection and decontamination programs. Significant advances in science and integrated pest management programs have resulted in the eradication of invasive species in certain areas.

What advice can you share for those just starting careers in Reclamation?

Be open to participating in a variety of different projects, even if something seems outside of your interest. When I started, I did a lot of field work. I don't always love being out in the field, but getting out there helped me expand my understanding of Reclamation and helped me connect with folks and develop relationships that have helped me as my career has progressed.

Edited and condensed by:

Lydia Ellefsen
Writer-Editor Intern, Budget and Administrative Services Office, Dam Safety and Infrastructure

Updates & Due Dates

Solar Over Canals (Section 50232 of the Inflation Reduction Act)

The Bureau of Reclamation (Reclamation) is utilizing a merit-based, internal formulation process to identify pilot projects to place solar panels over canals associated with Reclamation projects.

- An Internal Call for Proposals was distributed on July 28, 2023, with responses due by October 30, 2023.
- It is anticipated that cooperative agreements will be awarded to selected transferred works operators by September 2024.

Future Operations and Maintenance (O&M) Trainings

Water Management Workshop (WMW)

- The 2024 WMW will be Tuesday, February 13, through Thursday, February 15, in Denver, CO.
- This training is tailored for supervisors, managers, water masters, and others responsible for the O&M of water systems.

Review of Operation and Maintenance (RO&M) Workshop

- The 2024 RO&M Workshop will be Tuesday, April 9, through Thursday, April 11, in Sacramento, CA.
- This training is intended for Reclamation O&M personnel who are responsible for inspecting Reclamation dams and associated facilities.

More detailed information on both workshops will be forthcoming in the winter and spring *Bulletins*.

Aging Infrastructure Account

Pub. L. 116-260 added a new subsection to Pub. L. 111-11 (43 USC 510b(d)), creating the Aging Infrastructure Account (AIA) "to provide funds to and provide for the extended repayment of funds by" eligible applicants. Eligible applicants are transferred works operating entities and project beneficiaries responsible for reimbursable Operation, Maintenance, and Replacement costs. Once the applications are approved by the Secretary and reported to Congress, applicants may enter repayment contracts to receive aging infrastructure funding allocations to complete extraordinary maintenance (XM) work on Reclamation-owned assets.

Benefits

Congress appropriated $3.2 billion to the AIA to be made available through the application process over a 5-year period. $680 million will be made available in the fiscal year (FY) 2024 application cycle. This unprecedented investment of Federal funding is an opportunity for operators to apply for funds for aging infrastructure and extended repayment when there are few alternative sources of funding.

Key Dates

The FY 2024 application period opens October 2, 2023, and closes on December 1, 2023. Please work with a Reclamation regional representative to apply.

For future application planning, the fourth application period, for FY 2025, is anticipated to open summer 2024. More information will follow from the Asset Management Division in spring 2024.

TSC Summer Intern Poster Symposium, Denver, Colorado, July 2023.

Summer 2024 Technical Service Center (TSC) Internships

Our three TSC summer interns made invaluable contributions to this issue, writing two articles, conducting the Q&A, and determining its overall focus. Here's additional information on the TSC Summer Intern Program:

Each summer, Reclamation's TSC seeks motivated, hard-working, resourceful individuals for its Summer Intern Program. Candidates must be enrolled in an undergraduate or graduate program in engineering or related science fields. Limited spots may be available for other disciplines.

The program typically includes:

- an 11-week summer internship
- weekly professional development series
- field trips to local Reclamation facilities
- capstone poster or webinar symposium
- networking activities

Interns are matched to groups and projects based on current workload and the intern's field of study. While most positions are within the TSC, other groups and directorates may also host interns. Additional information and a link to the 2024 TSC Intern Application can be found at www.usbr.gov/tsc/interns/interns.html.