State of the Infrastructure

A Joint Report by the Bureau of Reclamation and the U.S. Army Corps of Engineers

US Army Corps of Engineers ®

BUREAU OF RECLAMATION

December 2019

On the cover and this page: the Joint Federal Project at Folsom Dam (photographs: Reclamation, December 2016).

The U.S. Army Corps of Engineers (Army Corps) and the Bureau of Reclamation (Reclamation) collaborated on a critical infrastructure project to construct the Folsom Dam auxiliary spillway, also known as the Joint Federal Project. Reclamation and the Army Corps, along with other cooperating agencies, formed an unprecedented partnership to address dam safety issues associated with extreme floods and to provide enhanced flood risk reduction for the Sacramento area – one of the most at-risk communities in the Nation. The auxiliary spillway was constructed adjacent to Folsom's main concrete dam, 23 miles northeast of Sacramento. It includes a 1,100-foot-long approach channel beginning in Folsom Reservoir, a concrete control structure with six bulkheads and six radial gates, a 3,100-foot-long auxiliary spillway chute, and a stilling basin that acts as an energy dissipation structure as water discharges and enters the American River. With the ability to operate the new spillway, large floods can be better managed by safely releasing more water from Folsom Reservoir earlier in a storm through both the spillway gates on Folsom Dam and the new control structure's radial gates, thereby reducing hydrologic risk and leaving more storage capacity in the reservoir.

Executive Statement

The Army Corps and Reclamation have a long history of collaboration in evaluating, constructing, operating, and maintaining water infrastructure projects, in addition to sharing management responsibilities at major facilities. Reclamation and the Army Corps Civil Works Program receive funding through annual Energy and Water Development Act appropriations, supplemental appropriations, and from non-Federal cost-sharing partners and other receipts. In an ongoing effort to return the highest overall value to the Nation from available funds, the Army Corps and Reclamation seek opportunities to work with their partners to develop planning study solutions in a timely and cost-effective manner, to manage the cost, schedule, and scope of ongoing construction projects, and to use risk analysis to prioritize capital investment and maintenance needs.

The Army Corps and Reclamation are committed to working with Tribal Governments, other Federal agencies, states, local governments, the private sector, and the public to manage, maintain, and enhance infrastructure. This report provides a high-level overview of the infrastructure asset portfolio and related asset management practices, collaboration efforts, and future strategies. Additional detail can be found on the respective agency websites. Our work is part of the broader effort at all levels of government to manage the Nation's water resources in a responsible manner.

US Army Corps of Engineers ®

James Dalton
Director of Civil Works
U.S. Army Corps of Engineers

The mission of the U.S. Army Corps of Engineers is to provide engineering services in collaboration with our partners to achieve technically thorough, environmentally sustainable, and economically-driven solutions to our nation's water resource needs.

BUREAU OF RECLAMATION

Brenda Burman
Commissioner
Bureau of Reclamation

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Water-Related Infrastructure

Decades of Federal investment have yielded a robust national portfolio of water-related infrastructure, which represents a diverse and vast inventory of mission-critical, legacy, and strategically-developed assets for the benefit of the American people.

This enormous physical infrastructure is one of our Nation's most valuable assets, providing ongoing power generation, water supply, navigation, flood risk reduction, recreation, and other benefits. The importance, extent, and impacts of water-related infrastructure managed and maintained by the Army Corps and Reclamation are large and broad, impacting the Nation's economy daily.

The agencies will continue to efficiently manage funds and will pursue opportunities to respond to evolving influences on water-related infrastructure, such as infrastructure that is reaching or, in some cases, exceeding its design life, resulting in continuing and increasing needs for maintenance, repair, and replacement projects. Many Army Corps and Reclamation dams are more than 50 years old and most were built well before modern state-of-the-art design and construction practices were in use.

Grand Coulee Dam, Washington (photograph: Reclamation, June 2011)

US Army Corps of Engineers ®

The U.S. Army Corps of Engineers' & the Bureau of Reclamation's Combined

BUREAU OF RECLAMATION

WATER-RELATED INFRASTRUCTURE

1,200+ Dams

5,000+ Recreation Areas

153 Hydroelectric Powerplants

Powering

10 Million Homes

150 Million acre-feet

Serves ▸ **130 Million People**

1 ACRE-FOOT OF WATER STORAGE

10 Million Acres

Tens of Thousands of Miles of Canals

25,000 Miles of Navigable Waterways

Reliable Systems

Dams

Dams are major components of a comprehensive strategy to address water resource challenges posed by drought, flooding, depleted aquifers, environmental needs, energy demands, and population increase and movement in the United States. The Army Corps and Reclamation evaluate the condition of dams, dikes, and levees, and monitor the performance of facilities to manage the risks posed to the public due to these facilities. This is done through common Federal public protection guidelines which provide a framework for managing risk for life loss, economic, cultural, and environmental consequences. The guidelines also help maintain the ability of dams and related facilities to provide reliable water, power, and flood risk management benefits.

One of the Army Corps' primary missions is flood risk management and reducing risk from flood events. Reclamation's dams also provide flood control benefits in many cases, but the agency's mission is focused on water storage to irrigate farms and ranches, supply drinking water, enhance fish and wildlife habitats, and create public recreational opportunities. Dams managed by both the Army Corps and Reclamation provide water for generating a major portion of the United States' hydroelectric power.

Strengths

- Systematic and rigorous inspection and maintenance programs assure the continued provision of benefits from the Army Corps' 716 dams and Reclamation's 491 dams.
- State-of-the art dam safety programs use risk-informed evaluations to identify, analyze, and address hazards. These programs assure that the safety and welfare of the public is prioritized and reduce risks to property and the environment.
- Both the Army Corps and Reclamation have developed programs to reduce the required Federal investment for many projects by accounting for cost sharing with stakeholders in Federal dam projects, as directed by Congress.
- Reclamation has new authority to consider title transfers that can reduce the Federal inventory and focus resources on assets having national significance and benefit.

J. Strom Thurmond Dam and Lake. The lake is the third-largest artificial lake east of the Mississippi River, behind Kentucky Lake on the Tennessee River and Lake Marion on the Santee River. Clarks Hills, South Carolina. Completed in 1952 (photograph: Army Corps, November 2011).

Challenges

- Some Army Corps and Reclamation dams operate at reduced capacity for flood storage, water supply, recreation, and other purposes because of measures implemented to address safety challenges informed by state-of-the-art design and construction standards. Most Army Corps and Reclamation dams were built 50 or more years ago.
- Water storage capacity in some reservoirs has decreased due to sediment accumulation, requiring evaluation of sediment removal and management options to reduce risk to water supply, power generation, and other uses.
- Competing infrastructure demands require balancing of water supply, flood risk management, agricultural demand versus municipal and industrial needs, urban encroachment, and storm magnitudes and frequencies.
- Dam safety repairs are sometimes needed in areas of dense population.
- Innovative investment decisions are needed to improve the technical capabilities and financial capacities of non-Federal operating entities responsible for operations and maintenance of Federal facilities.

Reliable Systems

Hydropower Facilities

The Army Corps is the largest producer of hydroelectric power in the United States and owns 75 hydropower facilities with a total generating capacity of approximately 24,000 megawatts. Reclamation is the second largest producer of hydroelectric power in the Nation and owns 78 facilities; Reclamation directly operates and maintains 53 of these facilities, which have a total generating capacity of approximately 15,000 megawatts. Reclamation and Army Corps facilities generate more than 100 million megawatt-hours of electricity each year, the equivalent annual demand of more than 10 million U.S. homes.

John Keys Pumping Plant, Grand Coulee Dam, Grand Coulee, Washington. Construction 1967-1974 (photograph: Reclamation, October 2019).

Over the past century, Federal hydropower generated at Reclamation projects has enabled the conveyance of water across the arid western U.S. In addition, power that is surplus to project requirements is marketed by Department of Energy Power Marketing Administrations. Surplus power has provided Reclamation a steady source of funding for project repayment and investment. Reliable, low-cost hydropower generated at Reclamation and Army Corps projects has provided tremendous value to the Nation, including spurring the development of the western United States through the provision of reliable electric power to rural communities as well as supporting western interconnected grid reliability.

Strengths

- Hydropower is a source of clean and renewable energy.
- Systematic Power Review programs provide audit-like evaluations of the status of power programs relative to policy requirements.
- The Army Corps and Reclamation conduct regular condition assessments to strategically plan capital investments at hydropower facilities.
- Army Corps and Reclamation power is to be generated in a safe, reliable, and cost-effective manner. To that end, both programs seek out efficiencies while protecting against threats such as cyber and other attacks.
- Reclamation and Army Corps hydropower programs support domestic energy security initiatives by optimizing existing hydropower resources and facilitating the development of untapped resource potential through collaborative regulatory reform, operational and technological innovation, and stakeholder outreach. Collectively, these activities add to the value and revenue realized from existing public infrastructure.
- Additional hydropower can be developed by non-Federal entities at non-powered Reclamation and Army Corps assets via Federal Energy Regulatory Commission licensing or Reclamation Lease of Power Privilege authorizations, dependent upon the nature of the underlying Federal asset.

Challenges

- Recapitalizing Federal hydropower assets is difficult when energy prices are low, requiring an investment strategy that balances trade-offs among performance, reliability, and increased energy costs.
- Hydropower must remain competitive and derive maximum value in an evolving energy market, one marked by low energy prices and availability of other energy generation resources.
- Competing water demands require a balance among hydroelectric power generation and flood risk management, water supply, ecosystem restoration, and species enhancement activities.

Reliable Systems

Navigation – Ports, Locks, and Dredging

The Army Corps' primary navigation responsibility is to provide safe, reliable, efficient, effective, and environmentally sustainable waterborne transportation systems for the movement of commerce, national security needs, and recreation. The Army Corps operates and maintains 25,000 miles of navigable waterways, channels and harbors, including 239 lock chambers at 193 sites and 1,067 coastal, Great Lakes, and inland harbors that directly serve 40 states. Coastal channels and inland and intracoastal waterways maintained by the Army Corps support the Nation's economy and security and contribute to state and local government economic development.

A six barge tow tied off on the downstream side of Markland Lock & Dam's 600-foot lock on the Ohio River, 531.5 river miles below Pittsburgh. Towboats push up to 15 barges when navigating the inland waterway system, but a lock can accommodate only six to nine barges at a time. One barge has the capacity to safely transport 1,500 tons of products (photograph: Army Corps, November 2009).

Strengths

- The U.S. marine transportation industry supports approximately $2 trillion in commerce annually. Army Corps maintenance dredging avoided at least $1 billion in additional shipping costs in coastal channels in 2017.
- The Army Corps dredges over 210 million cubic yards of material each year to keep the Nation's waterways navigable. Much of the dredged material is reused beneficially for environmental restoration projects including the creation and restoration of wetlands and other valuable habitat.
- More than 48 percent of consumer goods bought by Americans passes through harbors maintained by the Army Corps.
- The Nation's harbors, channels, and waterways handle almost 2.4 billion tons of commerce annually. Approximately 600 million tons of cargo or 15 percent of domestic freight moves on inland waterways: 52 percent of the Nation's grains, 22 percent of domestic petroleum/products, and 20 percent of coal used for electricity.

Challenges

- Many U.S. coastal ports have limited ability to accept post-Panamax cargo vessels which drive international commerce.
- Many inland locks lack the capacity or redundancy for optimal industry barge traffic configuration.
- Continued focus is needed toward operating and maintaining the Nation's harbors, channels, waterways, and infrastructure by using asset management principles that target the greatest economic, environmental, and public safety returns to the Nation, and to reduce unscheduled lock and dam outages.
- An estimated 657 million tons of cargo could potentially be disrupted annually without regular maintenance dredging of major waterways.
- The cost of dredging has increased 12 percent in the last 10 years (adjusted for inflation); this is coupled with ongoing sediment accumulation in coastal navigation channels.
- Intermodal transportation needs require extensive coordination with other agencies and entities.

The Army Corps Vicksburg District's Mat Sinking Unit places articulated concrete mat on the west side of the Mississippi River near Newellton in Tensas Parish, Louisiana at Mile 413.5. This maintenance is done to preserve the Mississippi River's navigation channel, as well as to prevent erosion of levees and other critical flood control structures. The Mississippi Valley Division's Regional Channel Improvement Program completes revetment maintenance annually on critical portions of a 1,000-mile reach of the Mississippi River from Cairo, Illinois, to Head of Passes, Louisiana (photograph: Army Corps, January 2018).

Reliable Systems

Canals and Pipelines

Potholes Canal, Columbia Basin Project, Washington (photograph: Reclamation, September 2018).

Reclamation water conveyance facilities include approximately 8,000 miles of main line canals. Most are open channel and many are lined. Additionally, Reclamation owns inverted siphons and pressurized pipelines used for the conveyance of irrigation water to irrigation districts or water districts for direct delivery. Reclamation's water conveyance systems range in age from over 100 years old to newly-constructed.

Strengths

- Reclamation conveyance facilities are inspected every three to six years, with the more frequent inspections focusing on canals in urban areas. These inspection programs are designed to ensure safe and reliable operation and to maximize cost-effectiveness by targeting priority maintenance and rehabilitation efforts.
- Nearly 90 percent of Reclamation conveyance facilities are transferred works, where operations, maintenance, and replacement are funded and executed by a non-Federal partner. Reclamation coordinates with the operating partners on inspections for these facilities.
- Specialized inspections are conducted for inaccessible features and specific asset types such as prestressed concrete cylinder pipe (PCCP). Risk analyses and planning scenarios inform proactive management actions.
- Implementation of Reclamation's new title transfer authority under Public Law 116-9 will streamline the process for water users to take title to canals and other water-related facilities, where appropriate. This will allow Reclamation to focus its operation and maintenance efforts on priority assets while providing water users with more flexibility to meet local or regional needs through operational changes.

Challenges

- Over 1,000 miles of Reclamation's canal sections are classified as urbanized. Reclamation is in the second phase of a Bureau-wide canal condition analysis, an ongoing process using monitoring to prioritize action and enable informed decision making. Targeted risk reduction and investment will be required over the long term to maintain safe and reliable operations.
- Managing Reclamation's inventory of large diameter PCCP requires continued investment. This inventory has been in service for 25 to 60 years with over 40 installations totaling approximately 140 miles of pipe. Corrosion of this material has led to recent sudden failures. Reclamation is taking proactive measures to assess the condition of its full inventory of PCCP through electromagnetic inspection from inside the pipe, conducting associated risk analyses, and conducting planning scenarios for anticipated repairs and replacements.

Reliable Systems

Recreation Facilities

The range of recreation infrastructure includes boat launches, marinas, campground facilities, roads, parking lots, and numerous buildings and structures that require routine inspection, maintenance, repairs, and replacements. These assets provide safe access to recreation for hundreds of millions of visitors without impacting the dynamic multiple missions of the agencies' water-related infrastructure.

The Army Corps is one of the leading Federal providers of outdoor recreation with 270 million visits at more than 400 lake and river projects in 42 states. The Army Corps and non-Federal entities manage 4,865 developed recreation areas on more than 12 million acres.

Reclamation manages almost 8 million acres of land and water, most of which is available for public outdoor recreation. More than 240 developed recreation areas are managed by Reclamation or its non-Federal recreation partners.

Raystown Lake, Seven Points Beach. Labor Day 2018 (photograph: Army Corps, September 2018).

McKay Park/Bend Whitewater Park on the Deschutes River in Bend, Oregon (photograph: Reclamation, July 2018).

Strengths

- The Army Corps' recreation program provides safe outdoor public access and recreation experiences to serve the needs of present and future generations. The program contributes to the quality of American life, while managing and conserving natural resources consistent with ecosystem management principles and protecting all project mission purposes. These recreation areas are located at existing water resource projects, increasing overall project benefits.
- Reclamation's recreation areas evolved from projects that originally focused on single-purpose agricultural objectives. The multipurpose approach to water resource development includes recreation as an important benefit. Reclamation's recreational infrastructure plays a major role in meeting the increasing public demands for water-based outdoor recreation facilities and opportunities.
- The Army Corps and Reclamation both work with Recreation.gov to share recreation opportunities across the country.

Challenges

- Recreation facilities (many constructed 50 to 70 years ago) continue to degrade as public demand for recreational opportunities increase.
- Challenges are faced in maintaining boundaries to protect lands and natural resources, such as timber and cultural sites, due to pressure from increased population size, adjacent development, and adjacent private land ownership.
- Effective management requires balancing a range of competing interests, such as accommodating visitors, accommodating economic and commercial uses, conserving environmental and cultural resources, planning for natural resources management, allowing public access, performing trespass abatement and law enforcement, and remediating damage to land resources.

Reliable Systems

Bridges and Roads

Murray Lock and Dam Bridge, Little Rock, Arkansas (photograph: Army Corps, May 2007).

Transportation infrastructure is critical for supporting the range of missions associated with water-related infrastructure, including flood control, hydropower production, navigation, water supply, recreation and environmental protection. Public roads and bridges are key to allowing safe public access to Federal lands for recreation and for providing critical transportation corridors across or along the projects. Both the Army Corps and Reclamation have a significant quantity of bridge and road assets and participate in the Federal Land Transportation program under the Federal Lands Highways Office.

Bridges provide access to project features for maintenance and operations of mission infrastructure, visitation, and general transportation across the projects. The Army Corps has a total of 959 bridges in their inventory; 252 of these bridges are significant public vehicular bridges and are reportable to the National Bridge Inventory (NBI). The Army Corps has some of the oldest bridges in the Federal inventory; the average age of Army Corps-owned NBI bridges is 55 years, and 21 percent of these bridges are over 75 years old and 5 percent are over 100 years old. Of the Army Corps' NBI inventory of bridges, 5 percent are in poor or worse condition and 17 percent are rated as being in fair or borderline poor condition.

Reclamation bridges provide access to high priority infrastructure, allow for efficient operation and maintenance of Reclamation infrastructure, and provide access to Federal land. Reclamation has a total of 1,436 bridges, of which 286 are significant public vehicular bridges that are reportable to the NBI. The average age of Reclamation's NBI bridges is 53 years; 16 percent are over 75 years old and 3 percent are over 100 years old. In addition, among Reclamation's NBI bridges, 7 percent are in poor or worse condition and 15 percent are in fair condition.

The Philadelphia District's Reedy Point Bridge at the Delaware River (Delaware Route 9), constructed in 1968, spans the Chesapeake and Delaware Canal connecting the Delaware River with the Chesapeake Bay in the states of Delaware and Maryland (photograph: Army Corps, August 2007).

Davis Dam Forebay Bridge at Davis Dam, Arizona. Construction 1949 (photograph: Reclamation, October 2018).

In addition to bridges, the Army Corps and Reclamation maintain more than 10 thousand miles of paved or unpaved public roads. The Army Corps submits an annual inventory on 7,976 miles of public roads that provide access to nearly 12 million acres of land and water, providing access for public use areas, project management offices, and crossings over bridges, dams, and levees. Of the Army Corps' paved road inventory, 30 percent is in fair or poor condition and 45 percent of the unpaved road condition is in fair or poor condition. Reclamation submits an annual public road inventory on 2,780 miles of roads. Reclamation roads provide public access to over 7.7 million acres of public land.

Strengths

- For bridges, both Reclamation and the Army Corps employ systematic programs that follow Federal Highway Administration and American Association of State Highway Transportation Officials rating methods. Routine inspections are generally completed every 24 months. Certain bridges also receive more advanced inspections such as fracture-critical inspections or underwater inspections.
- For roads, Reclamation and the Army Corps both use industry standard condition metrics such as Pavement Condition Rating and Pavement Surface Evaluation and Rating for condition assessments, performed on a five-year cycle. For roads within a recreation area, the Army Corps has integrated the manual visual assessment version into operational condition assessments.
- New road design, construction, maintenance, and management technologies and techniques are constantly being developed and both agencies incorporate new methods as possible. The Federal Highway Administration helps support innovations such as the use of 3D engineered models for more accurate and efficient planning and construction; new methods to determine how to best preserve pavement; and tools to make permitting reviews more efficient. New materials and technology, such as increasing the use of permeable paving materials to reduce storm runoff and using recycled materials in pavement, are also helping roads become more reliable and resilient.

Challenges

- Narrow roadways at project sites do not always safely accommodate recreational vehicles and pedestrians, especially roadways built on structures.
- Both agencies maintain a large inventory of aging bridges that ensure that mission requirements, public traffic requirements, and basic needs for project access are met. Funding needs are increasing as more bridges become structurally deficient due to the inventory nearing the end of its design life, and capital investments have not always kept pace with deteriorating conditions. Ongoing work also involves the need to fully inventory all bridges (agency-owned or owned by others) that cross project facilities.
- Reclamation is completing its first cycle of road condition assessments. The agency is currently about half way through the first comprehensive condition assessment of public roads as performed by the Federal Highway Administration. The Army Corps is integrating road condition assessments into the Operational Condition Assessment process.

Levees

The Ceredo-Kenova Local Protection Project manages flood risk from the Ohio River and Big Sandy River to the cities of Kenova and Ceredo, Wayne County, West Virginia (photograph: Army Corps, circa 2001).

The Lawrenceburg levee system in Dearborn County, Indiana reduces flood risk from the Ohio River to the City of Lawrenceburg, Indiana (photograph: Army Corps, June 2010).

Levees are typically earthen embankments or concrete floodwalls, designed and constructed to contain, control, or divert the flow of water to reduce the risk of temporary flooding. The Army Corps Levee Safety Program portfolio is prioritized by a risk-informed decision making process. One of the Army Corps' primary missions is flood risk management, and levees have been successful in reducing flooding during many events. Although not all levee systems in the Army Corps portfolio are managed by the Army Corps, risk information is provided to local or regional levee managers to inform management improvements and resource prioritization. It is anticipated that this risk information can also be used by levee sponsors to demonstrate and communicate funding needs.

The Army Corps' levee portfolio includes about 2,220 levee systems totaling 14,287 miles in length. Levee sponsors operate and maintain over 2,000 levee systems that make up roughly 70 percent of the length contained in the entire portfolio; the remaining systems are operated and maintained by the Army Corps.

Strengths

- The Army Corps' Levee Safety program mirrors its Dam Safety program, which prioritizes its portfolio through a risk-informed decision making process.
- The Army Corps is leading efforts to identify best practices in levee safety to help other agencies and the Nation develop procedures for levee safety programs and submit information to the national levee database.

Challenges

- Changing flood conditions, magnitudes, frequencies, and increased population density can increase risk.
- Resources are increasingly focused on reacting to and recovering from significant natural catastrophic events.
- Challenges are faced in effectively communicating risk to the public.
- Maintenance and replacement needs and costs are increasing. If not addressed, deferred maintenance may result in additional levee safety issues.
- A careful balance is required to manage the safety of facilities while minimizing impacts to the environment.

Keeping Communities Safe

Dam Safety Programs

Anderson Ranch Dam, Idaho. Construction 1941-1950 (photograph: Reclamation, October 2018).

Water-related infrastructure and associated facilities produce a wide range of benefits across multiple business areas. For instance, while the original authorization for a given lock and dam may have focused purely on flood control, the pool created by these assets may also provide recreation and water supply opportunities that influence benefits such as economics, environmental conditions, and quality of life.

The condition of Army Corps and Reclamation infrastructure is regularly evaluated through several programs for the review of operation and maintenance of assets. The Army Corps and Reclamation use risk-informed evaluation methodologies to assess the current asset condition and the consequences of asset failure. Evaluation findings are used to establish a relative risk indicator to support portfolio investment decisions within an authorized project.

As an example of a key review, the Army Corps and Reclamation administer High- and Significant-Hazard Dam Examination programs. The detailed evaluations ensure that high- and significant-hazard dams are operated and maintained properly and effectively, that they will continue to provide project benefits, and that they will not create unacceptable risks to public safety and welfare, or to property and the environment.

Through maintenance management, operational condition assessments, risk assessment, and portfolio analytics, the Army Corps and Reclamation develop risk information that improves inputs to investment decisions. This philosophy ensures a uniform, consistent, and repeatable process to support risk-informed budget decisions that comply with law and appropriations.

Reclamation's world-class Dam Safety Program has established a risk-informed framework to meet the program objectives, requirements of the Reclamation Safety of Dams Act, and the Federal Guidelines for Dam Safety. Risk-informed procedures are used to assess the safety of structures, aid in making decisions to protect the public from the potential consequences of dam failure, assist in prioritizing the allocation of resources, and support justification for risk reduction actions where needed.

Similar to Reclamation, the Army Corps asset management approach makes use of risk evaluations involving determinations of likelihood developed from asset condition ratings and determinations of consequences developed from measures of performance and benefit. A consistent, risk-based approach lends clarity to investment choices.

Keeping Communities Safe

Protecting and Restoring the Environment

Water-related infrastructure plays an important role in managing and protecting the Nation's environment and natural resources. Functioning ecosystems serve as "natural infrastructure" that provides many services to our communities. The Army Corps and Reclamation protect and restore this natural infrastructure through several programs.

The Army Corps' Regulatory program evaluates permit applications for construction activities that occur in the Nation's waters, including wetlands. The program is committed to protecting the Nation's aquatic resources and navigation capacity while allowing reasonable development through fair and balanced decisions. The Army Corps' Natural Resource Management program's mission is to manage and conserve natural resources on Army Corps land and waters, consistent with ecosystem management principles, while providing quality public outdoor recreation experiences to serve the needs of present and future generations. The Army Corps promotes awareness of environmental values and incorporates sustainability into its decision processes and culture.

The Army Corps plays a key role in reducing the negative impacts of invasive species on ecosystems and infrastructure. As the primary Federal agency charged with researching invasive aquatic plants, the Army Corps conducts ground-breaking research to support efficient control while minimizing impacts to natural systems.

Reclamation has significant involvement in the protection of natural resources throughout the western United States. These larger efforts include significant portions of river basins, cover numerous fish and wildlife species and their habitats, and extend over the long term, with planning, implementation, and environmental compliance coverage as much as 50 years into the future.

Reclamation's restoration and enhancement activities are aligned with project purposes. Reclamation has identified nine major river restoration efforts that are tracked for various reporting requirements. In some cases, Reclamation projects have authorizing legislation that includes benefits to fish and wildlife as one of the project purposes, such as the construction of fish passage facilities, fish barrier removal, or river and stream-bank protection and enhancement.

Kissimmee River restoration in south Florida, an element of the Everglades Restoration project (photograph: Army Corps, October 2009).

Water hyacinth is an invasive plant that impedes commercial navigation on the McClellan-Kerr Arkansas River during peak summer growing months. The Army Corps manages water hyacinth across the country through integrated pest management to reduce impacts to all project purposes and minimize negative impacts on the environment (photograph: Army Corps, September 2018).

Strengths

- Restoration activities by the Army Corps and Reclamation often support efforts to protect and recover species listed under the Endangered Species Act, such as salmon.

- Most of the Army Corps' and Reclamation's restoration, enhancement, and land management activities involve partnerships and cooperation with: Federal, state, and local agencies; Tribal Governments; and various non-profit environmental conservation organizations and stakeholders. Partnerships help ensure successful implementation through cost-sharing efforts that provide hundreds of millions of dollars in funding.

- The Army Corps constructs barriers to keep invasive Asian Carp out of the Great Lakes. Reclamation and the Army Corps both support invasive species control across service areas and collaborate with states and other partners to construct watercraft inspection stations to prevent the spread of zebra and quagga mussels, and to prevent infestations which could cause billions of dollars in damage to private and publicly-owned infrastructure such as power plants and water intakes.

- The Army Corps attempts to incorporate natural and nature-based features into its projects in all mission areas through its Engineering with Nature Program.

Challenges

- Changing landscapes, competing demands for water, and dynamic environmental conditions continue to create challenges in designing, prioritizing, and implementing restoration projects nationwide.

- The demand for restoration projects continues to increase and challenges limited Federal resources to complete, maintain, or initiate new projects.

- Invasive species will continue to threaten infrastructure and ecosystems throughout the United States. Preventing the spread of and early eradication of invasive species is critical to protection of our nation's infrastructure and economy.

Fish ladder at John Day Lock and Dam, Columbia River near Rufus, Oregon (photograph: Army Corps, July 2002).

A Reclamation civil engineer with the San Joaquin River Restoration Program in California handles an adult spring-run Chinook salmon (photograph: Reclamation, May 2019).

River restoration to improve salmon and steelhead habitat. Yankee Fork, Idaho (photograph: Reclamation, November 2012).

Security Response Force members at Hoover Dam. Hoover Dam, Nevada (photograph: Reclamation, November 2017)

Keeping Communities Safe

Facility Security

To protect the public, and to protect the Nation's investment in critical infrastructure, Reclamation has actively integrated security into its facility management practices. By developing and implementing a comprehensive risk assessment program that encompasses infrastructure, information, and personnel, the Security Program supports the overall Reclamation mission to deliver water and power. Comprehensive facility assessments provide facility improvement recommendations which are then prioritized by risk. The Program has made significant facility and procedural improvements through the application of fortification funds. By design, these improvements are often invisible to the visiting public. Reclamation actively engages with the Army Corps in a variety of forums to ensure consistent policies and strategies for infrastructure protection. These forums also help support the greater Dams Sector community to facilitate resilience of integrated water systems throughout the United States.

The Army Corps applies an integrated risk management approach to facility security. Risk-informed security strategies that address both physical and cyber security threats are provided to ensure the delivery of the Army Corps mission and to secure the Homeland. Through an integrated protection program, the Army Corps implements multiple security and mission assurance programs across the agency. This approach and associated Army Corps policies, along with accompanying U.S. Department of Homeland Security and Department of Defense policies, outline the risk management to integrate and coordinate security programs and facilitate risk-informed decision making in an all hazards environment.

Imperial Diversion Dam, Lower Colorado River. Construction 1936-1938 (photograph: Reclamation, March 2012).

Protecting Investments and Planning for the Future

Inspection and Asset Management Programs

Reliable performance of the Nation's water resources infrastructure is essential to the asset portfolio's ability to deliver safe and dependable service. The Army Corps and Reclamation operate, maintain, and manage more than $232 billion and $111 billion of the Nation's water-related infrastructure assets, respectively. From navigation locks and hydropower plants to dams and recreation areas, these assets are a vital part of the Nation's economy, safety, and security, and must be managed in an accountable and responsible manner.

Both agencies carry out this responsibility through a "structured asset management system," which is a risk-informed decision-making approach that assesses the life-cycle of a portfolio of projects within a watershed system. By consciously employing an asset management system, the Army Corps and Reclamation seek to optimize value derived from the portfolio for the benefit of the agencies and their stakeholders. The application of a performance-based, risk-informed lifecycle approach across all water infrastructure systems allows for prioritization of limited funding to make improved investment choices at key decision points throughout the complete life cycle of a project.

Both agencies must balance the competing demands of a single asset having multiple functions. Risk-informed evaluation methodologies are used to address the multi-purpose character of their assets, to include assessing the current condition of an asset and the consequences of its failure in order to establish a relative risk index supporting portfolio investment decisions within an authorized project.

The Army Corps and Reclamation Asset Management Programs use a strategic investment framework to optimize the delivery of benefits to the Nation. The framework allows the application of this same approach to planning for new infrastructure as well as the disposition of infrastructure no longer needed. This framework and the implementation of asset management within each agency is aligned with the Institute of Asset Management's (IAM) Conceptual Model to outline a path forward for the management of assets and the actions necessary to enable success. The IAM is a non-profit professional body of asset management experts that provides guidelines and processes that ensure a comprehensive asset management strategy for an organization. While Reclamation and the Army Corps have successfully managed their assets since inception, adopting a formal asset management approach consistent

with modern practices and techniques is necessary to continue that success and meet current challenges:

- Accurate asset information is needed to support budget requests with clear business cases to support infrastructure investments.
- Comprehensive, long-term planning strategies are needed to safely extend the useful lives of these assets, invest limited funds wisely, enhance public safety, and reduce or mitigate the consequences of infrastructure failure.
- Resources are limited for managing and maintaining assets that are reaching or exceeding their design lives.

Each agency's asset management approach provides common practices for inventorying, assessing, and categorizing assets to help determine each asset's strengths, weaknesses, and value to the system's mission in order to:

- Prioritize lifecycle value at all stages of the project (planning, design, procurement, construction, and operation & maintenance, etc.) to maximize portfolio benefits and minimize cost.
- Maintain asset information corporately so that condition, cost, and resource requirements will be consistently communicated to stakeholders at the national, regional, and local level.
- Systematically monitor and maintain asset condition to prevent, or to diminish to an acceptable degree, the consequences of operational (component or system) failure.
- Structure resource allocation decision-making to optimize value derived from assets, across all agency missions and geographic boundaries.
- Track the execution of the budget in context of the lifecycle plans to ensure planned benefits are realized to the maximum extent possible.
- Provide a strategy for operations, maintenance, capital investment, and disposition decision-making at all levels.
- "Right-size" the asset inventory and balance benefits, consequences of failure, and risk against lifecycle costs.
- Help improve reliability, minimize risk, and meet projected infrastructure demands.
- Formalize business processes that standardize best practices, promote accountability, and predict work requirements.

Consistent asset management approaches throughout the agencies supports the Army Corps and Reclamation in working with Tribal Governments, other Federal agencies, states, local governments, the private sector, and the public to manage infrastructure in a responsible and cost-effective manner.

Arrowrock Dam, Idaho. Construction 1911-1915 (photograph: Reclamation, April 2013).

Protecting Investments and Planning for the Future

Water Supply

Addressing future water supply needs will require effective actions for the maintenance, protection, and enhancement of water-related infrastructure. Careful management of the Nation's water supply is critical to limiting water shortages and lessening the impact of droughts.

Army Corps and Reclamation facilities store water to provide municipal and industrial and irrigation water which supports the health of communities, food supplies, and industry. Reclamation supplies water to 10 million acres of farmland and over 140,000 farmers in the western U.S.

The Army Corps has 136 multiple purpose projects that contain storage for water supply in 26 states. These projects provide nearly 10 million acre-feet of water supply storage for municipal and industrial use, sufficient to meet indoor household needs of 101 million people.

Department of the Interior officials visit a project in Reclamation's Southern California Area Office (photograph: Reclamation, April 2012).

The Army Corps and Reclamation foresee the following challenges in addressing water supply needs into the future:

- Increasing populations in the western U.S. have resulted in an increased need to access and use available water supply storage in reservoirs.
- For Reclamation, droughts have made water supply operations and revenues more variable, and resources are required to meet partner needs and maintain public health and safety.
- The availability of water storage can be limited by siltation issues and dam safety restrictions.
- It will be important to continue to expand coordination with partners and stakeholders in order to balance the costs associated with project rehabilitation and operation and maintenance of facilities.

Through programs such as WaterSMART and the Water Infrastructure Improvements for the Nation Act, Reclamation will continue to work cooperatively with Tribal Governments, states, and local entities to implement actions to increase water supply by modernizing existing facilities and building out new infrastructure. WaterSMART supports investments in existing infrastructure to increase water supply reliability by leveraging Federal and non-Federal funding. The WaterSMART Program includes funding for cost-shared grants for water management improvement projects; collaborative efforts in the Basin Study Program to address imbalances between supply and demand; Title XVI Water Reclamation and Reuse projects; collaborative watershed projects through the Cooperative Watershed Management Program; planning and design activities through the Water Conservation Field Services Program; and drought planning and implementation actions to proactively address water shortages. The programs included in WaterSMART are collaborative in nature and work is done in partnership and cooperation with non-Federal entities and other Federal agencies to reduce conflict, facilitate solutions to complex water issues, and stretch limited supplies.

Protecting Investments and Planning for the Future

How the Army Corps and Reclamation are Working Together

Hoover Dam, Boulder City, Nevada. Construction 1931-1936 (photograph: Reclamation, May 1996).

The Army Corps and Reclamation have a long history of collaborating on the evaluation, construction, and operation and maintenance of water infrastructure projects with a variety of asset types. The agencies have asset management responsibility for a diverse portfolio of water-related constructed assets. With a number of facilities now over 100 years old, both agencies are responsibly managing aging infrastructure issues.

The Army Corps and Reclamation have multi-purpose asset portfolios which include assets that range in size and complexity, span large geographic areas, and serve a variety of functions. Assets range from simple boat launches to massive dams, extensive levee systems, and locks as long as four football fields. These portfolios include structures for river navigation, hydropower, irrigation, flood risk management, recreation areas, fish ladders, utility systems, and laboratories.

A Federal Asset Management Working Group was established to link asset management professionals from the Army Corps, Reclamation, the Western Area Power Administration, and the Bonneville Power Administration to collaborate on asset management best practices and solutions to asset management challenges, and to provide a forum to expand the group's knowledge in order for all agencies to maximize the value of the Federal assets.

The Army Corps and Reclamation also coordinate on dam safety programs. Dams must be operated and maintained

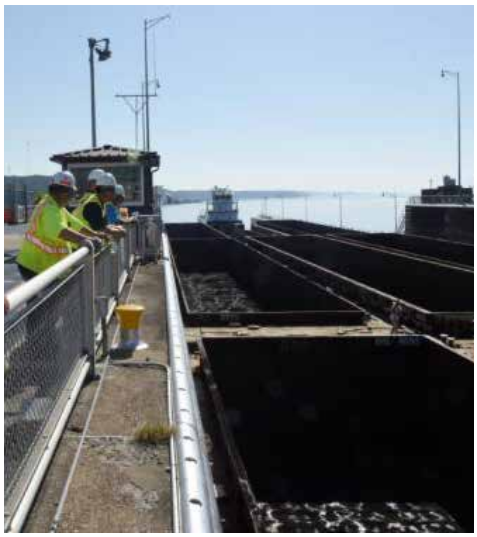
in a safe manner, ensured through inspections for safety deficiencies, analyses utilizing current technologies, and corrective actions, if needed, based on current engineering practices. The Army Corps and Reclamation Safety of Dams programs use similar approaches to evaluate and implement actions to resolve safety concerns at dams. Under these programs, the Army Corps and Reclamation complete studies and identify and accomplish needed corrective action on high- and significant-hazard dams. The selected course of action relies on assessments of risks and liabilities with environmental and public involvement input to the decision-making process.

An example of close collaboration on critical infrastructure needs is the Folsom Dam auxiliary spillway, also known as the Joint Federal Project (featured on the cover and on page 2).

The Army Corps and Reclamation also collaborate to address reservoir sedimentation issues. Federal reservoirs provide the largest percentage of water storage volumes in the United States. Monitoring sediment accumulation and changes in the rate of accumulation in these reservoirs is essential to understanding the magnitude and geographic extent of reduced storage volume due to sediment accumulation. Evaluating reservoir vulnerabilities to changes in sedimentation rates is critical to the long-term management and reliable performance of reservoirs. An interdisciplinary and interagency project team was established that utilizes Army Corps regional technical specialists and the Army Corps Committee on Channel Stabilization. The Army Corps developed a baseline report on reservoir sedimentation status and related efforts leverage existing information and maximize knowledge related to reservoir sedimentation and associated impacts. This work supports further interagency collaboration through the U.S. Geological Survey's interagency Reservoir Sedimentation Database.

More than 70 people attended the October 2015 Arrowrock Dam Centennial celebration in Idaho, including officials, senior leaders, and representatives from the Shoshone-Bannock Tribes, Reclamation, the Army Corps, Senator Jim Risch's office, Senator Mike Crapo's office, Representative Mike Simpson's office, and the State of Idaho (photograph: Reclamation, October 2015).

Moving Forward


The three images above represent the inventory of water-related infrastructure managed by the Army Corps and Reclamation, providing mission-critical power generation, navigation, and water supply benefits to the Nation (photographs: Reclamation, September 2018, left; Army Corps, July 2016, center; Reclamation, September 2018, right).

Over the Nation's history, investments in water-related infrastructure have resulted in a robust inventory of vital, long-term assets. This infrastructure is one of the Nation's most valuable assets and the Army Corps and Reclamation are committed to maintaining, protecting, and improving the infrastructure to ensure continued delivery of power generation, water supply, navigation, public safety, recreation, and other benefits. The agencies will continue to efficiently manage taxpayer funds and will pursue opportunities to respond to evolving influences on water-related infrastructure such as:

- Increases and shifts in population that result in changing water supply and power needs, new recreational demands, changes in potential consequences that affect risk management strategies, and ongoing updates to facility security measures.
- Changes in the magnitudes and frequencies of hydrologic events, resulting in the potential for greater damages to exposed areas and a need for continued and improved monitoring and response capabilities so that water-related infrastructure can provide the Nation with vital benefits long into the future.

List of Acronyms and Abbreviations:

Acronym or Abbreviation	Definition
Army Corps	U.S. Army Corps of Engineers
IAM	Institute of Asset Management
NBI	National Bridge Inventory
PCCP	Prestressed concrete cylinder pipe
Reclamation	Bureau of Reclamation
WaterSMART	Sustain and Manage America's Resources for Tomorrow

Hoover Dam hydropower facilities (photograph: Reclamation, October 2011).

State of the Infrastructure

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