

Department of Defense
Improving Water Security and
Efficiency on Installations
Report to Congress



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Introduction

This report responds to the request for information in House Report 115-676, pages 93-94, accompanying H.R. 5515 of the National Defense Authorization Act for Fiscal Year (FY) 2019, which requests the Office of the Secretary of Defense (OSD) submit a report on the following requirements:

1. innovative ways to reduce water use across installations in order to strengthen base readiness through improved water security; and
2. opportunities to replicate across installations some of the successful water-saving tactics already being deployed at some bases.

Specifically, this report discusses water security and efficiency, innovative ways the DoD is reducing water use across its installations through system upgrades, alternate water resources, and water-use related changes, and opportunities to replicate projects across installations.

Demand for water for all sectors in the United States is primarily met by surface water (i.e., rivers, lakes, and reservoirs) and groundwater (i.e., shallow and deep aquifers) resources. Water demand is expected to increase with population and economic growth, including in areas that are susceptible to drought. In many regions, surface water resources are already fully allocated under non-drought conditions and groundwater withdrawals exceed the rate of recharge, which leads to declining groundwater storage, sea water intrusion in coastal aquifers, and, in some cases, land subsidence. State water managers in 40 out of 50 states expect freshwater shortages to occur in their states in the next 10 years, which can stress economic growth and social well-being.¹

DoD is not immune to the challenges associated with supply and demand of water resources. Water shortages can significantly impact military readiness through reduced training opportunities and limited operational capacity. Installations and facilities with water shortages may not be able to support residential and operational water demand. Managing water resources appropriately is vital to DoD's mission to "provide the military forces needed to deter war and to protect the security of our country."² Further, DoD's costs will increase without action to address risks posed by water scarcity.

DoD has laid the framework for water security and efficiency through its policies and programs and is implementing them through a variety of initiatives; however, the degree of implementation varies among the Military Departments. DoD is using innovative approaches to conserve water, save costs, and assure access to an adequate water supply for mission success. For example, in FY 2017, DoD used only 82,499 MGal of potable water, a reduction in DoD's potable water intensity by 26.9 percent from its 2007 baseline. DoD's approaches range from

¹National Science and Technology Council. (2018). *Coordinated Strategic Plan to Advance Desalination for Enhanced Water Security*.

²(n.d.). About the Department of Defense. Retrieved from <https://archive.defense.gov/about/#mission>

regular maintenance and water system-related upgrades to alternative water sourcing and changes in water use behaviors and practices. DoD will continue to build on these efforts across its installations while addressing challenges. Overall, DoD has made great progress through its effective policies and programs aimed at increasing water security and efficiency while realizing opportunities to maximize the strategic use of water resources and reduce consumption and unnecessary costs.

Drivers and Policies to Support Water Security and Efficiency

DoD follows federal laws, regulations, and executive orders (EOs) that apply to water security and efficiency. In addition, the Military Departments have developed their own specific policies and guidance to further promote water security and efficiency. Below is a description of these policies and how they positively impact water resources. Military Department-specific policies regarding water conservation and security are listed in Appendix A.

Laws, Regulations, and Executive Orders

The Energy Policy Act of 1992 requires DoD, along with other federal agencies, to explore funding water conservation projects that have a payback period of 10 years or less. The Energy Policy Act of 2005 requires federal agencies to install water conservation measures with payback periods of less than 10 years in government-owned buildings. Additionally, the Energy Independence and Security Act of 2007 requires all federal agencies to audit approximately 25 percent of their covered facilities every year, thus auditing 100 percent of their facilities over a span of four years. Both major infrastructure upgrades and smaller-scale projects (e.g., metering, public education) can reduce water usage and yield major cost savings.

In compliance with EO 13834, Efficient Federal Operations, DoD will continue to reduce potable water intensity and will work to reduce its industrial, landscaping, and agricultural (ILA) water consumption.

DoD Policies

Energy Policies

As energy production and use is water-intensive, energy policies often include direction on water security, the efficient use of water resources, and conservation measures. The Department of Defense Instruction (DoDI) 4170.11, *Installation Energy Management*, directs DoD to audit covered facilities once every 4 years and install metering devices at appropriate DoD water facilities. It also requires the Military Departments to include water management planning into their installation planning, operation, and maintenance efforts, and implement a wide variety of best management practices (BMPs). BMPs include, but are not limited to, auditing to identify water savings areas and leaks, installing water conserving devices (e.g., faucets, showerheads, toilets), and conducting education campaigns to achieve reductions in water usage. DoDI 4170.11 encourages the Military Departments to install meters at 15 percent of water facilities that do not have meters in place. DoDI 4170.11 further states that all large capital energy investments in existing buildings use the most energy efficient designs, systems, equipment, including water conservation. Additionally, it requires that Military Departments to

obtain at least a Leadership in Energy and Environmental Design (LEED) silver level of performance or equivalent, which includes a number of water conservation criteria.

OSD is currently updating DoDI 4170.11 and will continue to implement the following approaches to help DoD achieve greater water efficiencies:

- installing water meters at main distribution lines, central heat and chiller plants, and other large uses (e.g., barracks, pools, hospitals, gyms);
- increasing focus on leak detection and repair;
- supporting water efficiency projects in existing buildings, (e.g., chiller system improvements, high efficiency cooling towers, low-flow fixtures, plumbing retrofits); and
- increasing use of rainwater harvesting systems, drought-tolerant landscaping, and water efficient irrigation.

The Army has several policies in place supporting water security and efficiency:

- Army Directive (AD) 2017-07, *Installation Energy and Water Security Policy*, establishes the requirements for Army energy and water security at the installation level. Specifically, it states installations will be capable of providing water for a minimum of 14 days for critical missions and should provide redundant and diverse sources and the infrastructure capable of onsite water storage.
- AD 2014-08, *Water Rights Policy for Army Installations in the United States* sets policy and assigns responsibilities for identifying, asserting, and preserving the Army's water rights to ensure that the Army can carry out its missions without significant disruption.
- AD 2014-02, *Net Zero Installations Policy*, formalizes increased sustainability and water security in support of base operations. Under the policy, installations must implement Net Zero³ energy, water, and waste principles to the maximum extent possible.
- AD 2014-10, *Advanced Metering of Utilities*, establishes policy and assigns responsibility for installing advanced meters on utility systems and installing water meters with remote communication capabilities on buildings where cost effective (determined by the U.S. Army Corps of Engineers' Meter Program Manager). Specifically, this directive requires that by 2020 individual facilities, landscape irrigation systems, and on-post water sources and distribution systems be metered to effectively identify supply quantities and losses.
- Army Regulation (AR) 420-1, *Facilities Management* - Chapter 22 requires the appointment of a full-time trained energy manager whose duties include water management. It also requires installations to conduct leak detection and repair projects and promotes the use of awards and awareness programs to promote water conservation.

³ Net Zero refers to a net zero consumption of energy or water. A building will consume as much energy or water as is created either onsite or through other nearby renewable sources (i.e., solar panels, recycling water).

The Department of the Navy (DON), via the Secretary of the Navy (SECNAV) Instruction 4101.3A, *Department of the Navy Energy Program*, establishes responsibilities, goals, and expectations for energy and water efficiency, for its installations and operations. Specifically, it establishes the goal of DON installations being Net Zero water-use facilities. To achieve this goal, DON installations must employ water metering policies and reduce energy and water consumption along with employing environmentally friendly sustainable technologies. The *SECNAV Shore Policy Memo*, provides further guidance on the SECNAV's energy goals and how to implement them at installations.

The Air Force is updating two of its instructions (Air Force Instruction (AFI) 90-1701, *Installation Energy and Water Management* [Draft] and AFI 32-1061, *Providing Utilities to Air Force Installations* [Draft]) that relate to energy and water management. The updates to these policies will address how the Air Force will further expand its water security and efficiency efforts in its water usage and distribution systems. As Air Force missions often rely on multiple installations, water security must be viewed across the Air Force and not only at the installation level.⁴ To accomplish this, the Air Force directs its installations to understand their energy and water requirements for functions, capabilities, and critical assets.

Military Construction (MILCON) Policies

Per the Department of Defense Directive (DoDD) 4270.5, *Military Construction*, the Military Departments must follow the applicable unified facilities criteria (UFCs) and unified facilities guide specifications. UFCs are documents that provide planning, design, construction, sustainment, restoration, and modernization criteria for the Military Departments. For example, UFC 1-200-02, *High Performance and Sustainable Building Requirements*, requires water conservation measures that demonstrate a return on investment, requires the use of water efficient products (e.g., U.S. Environmental Protection Agency WaterSense products), and mandates at least 50 percent reduction in potable water used in irrigation compared to conventional methods for new construction and major renovations. UFC 3-210-10, *Low Impact Development*, requires installations to implement low impact development to maintain stormwater onsite to mitigate adverse impacts of stormwater runoff and nonpoint source pollution.

To implement MILCON requirements, each of the Military Departments has their own guidance and regulations. *Army Sustainable Design and Development Policy* directs Army installations to include sustainable design practices in infrastructure planning, design, sustainment, restoration, modernization, and construction activities. Additionally, this policy requires Army installations to incorporate water efficient equipment in buildings and to reduce landscape irrigation by 50 percent. Per AR 200-1, *Environmental Protection and Enhancement*, Army installations must use a watershed management approach when evaluating projects. The watershed approach requires Army installations to coordinate, integrate, and manage mission activities that impact water quality on- and off-base with local stakeholders. The DON is using

⁴ Correll, M. (2018). Applying a Top-Down Approach: Assessing Mission Assurance through Energy Assurance. *The Military Engineer*, 713.

the *SECNAV Shore Policy Memo* to meet LEED Gold standards and EnergyStar certification, where possible, and achieve water efficiency levels 40 percent below the goals set by American Society of Heating, Refrigerating and Air-Conditioning Engineers 90.1.⁵ The Air Forces' AFI 32-7062, *Comprehensive Planning*, mandates that the principles of sustainable planning must be incorporated into Installation Development Plans, which includes the integration of regionally-appropriate native or indigenous vegetation to conserve water resources, control erosion, reduce heat island effects, utilize storm water, and mitigate antiterrorism concerns, where practical.

Other Program Policies Addressing Water Security and Efficiencies

Under the 1997 amendments to the Sikes Act, DoD installations must create and maintain Integrated Natural Resources Management Plans (INRMPs) in which the installation must describe the installation's environmental protection measures, the natural resources' biological needs, and the role of the installation's natural resources in its surrounding ecosystem. Ecosystem management which includes water resources protection and conservation efforts, is a vital component of INRMPs. Water resources protection and conservation are enhanced through activities such as stream and watershed restoration, invasive species prevention, xeriscaping⁶, and planting native species. OSD and the Military Department's natural resources policies specifically address the needs for landscape maintenance and restoration activities to use water saving efforts by designing and planting native and low maintenance vegetation along with practicing water-efficient landscape maintenance.⁷

Mission Assurance Policies

Under DoDD 3020.40, *Mission Assurance*, the "DoD Components will maintain sufficient resources to meet Defense Critical Infrastructure responsibilities for identifying, assessing, managing, and monitoring risk to critical infrastructure and align associated security, protection, and risk management efforts under an MA construct." The DoD Components are working to complete mission assurance assessments, which are multi-phase assessments that analyze critical systems and their vulnerabilities to multiple hazards and formulates risk management plans and investment strategies. Water infrastructure and supply are critical facets of mission assurance and can be vulnerable to a host of intentional, accidental, deferred maintenance, or natural complications.⁸ The Army continues to prioritize meeting the water requirements for critical missions while working to meet all installation water requirements by improving resource access, system condition, and system operation. As Army installations complete the Installation Energy and Water Plans (IEWPs), water requirements for critical missions will be refined and projects will be scoped to address any deficiencies. To date, the Air

⁵ American Society of Heating, Refrigerating and Air-Conditioning Engineers 90.1 is the standard for commercial building energy codes.

⁶ Xeriscaping is defined as a landscape style that requires little to no irrigation.

⁷ Under Secretary of Defense (AT&L). *Natural Resources Conservation Program* (DoD Instruction 4715.03). Secretary of the Air Force. (2014, November 18). *Integrated Natural Resources Management Air Force Instruction 32-7064*. Department of the Navy. (2014, January 10). *Environmental Readiness Program* (OPNAV Instruction 5090.1D). Department of the Navy. (2018, June 11). *Environmental Compliance and Protection Program* (Marine Corps Order 5090.2). Department of the Army. (2007, December 13). *Environmental Protection and Enhancement* (Army Regulation 200-1).

⁸ While these mission assurance assessments can include evaluation of support water infrastructure, if appropriate; they will not assess all critical water requirements associated with DoD Components' critical missions.

Force has sufficient access to water to meet mission requirements. Air Force leadership recognizes that water is a critical resource and supporting system for Air Force missions, thus, the Air Force is developing a water resources management program that will take a risk-based approach to achieve water assurance for mission assurance. Currently, the Air Force is developing the analytical foundations to determine which regions and installations are at greatest risk for water supply shortages. The Air Force is also creating the framework for Installation Energy Plans, which will identify water requirements and include long-term plans for water resilience strategies, such as eliminating single points of failure. While having your own water supply does not ensure water resilience, many Navy and Marine Corps installations report that they have sufficient water to meet their requirements – and many installations have their own water supply. However, where Navy installations depend on public utilities for their water supplies, personnel regularly coordinate with their utility counterparts to ensure water security. Through the Navy Readiness Sustainment and Compatibility program, access to adequate water is monitored closely in areas where resources are depleted or where there is increased competition. As prescribed in the Office of the Chief of Naval Operations Instruction 3502.08, *Mission Assurance*, the Navy follows a uniform approach for the assessment and management of water security through protection programs and activities at both the installation and command levels.

Innovative Ways DoD is Reducing Water Use Across Installations

DoD is conserving water on its installations and capitalizing on opportunities to reduce water use, improve water security, and ensure mission readiness. BMPs at installations nationwide range from system-related upgrades (e.g., sustainable construction, fixture replacement), alternative water sourcing (e.g., recycling, reclamation), to water use-related changes (e.g., landscape and irrigation changes, public education, outreach). By increasing water efficiency in all DoD operations, the Department can decrease its vulnerability to fluctuations and shortages of these resources and reduce its water usage and costs.

System Upgrades

DoD is achieving water efficiencies and realizing cost reductions through routine maintenance and upgrades of water infrastructure and building sustainably. The Military Departments continue to invest in infrastructure improvements to facilitate water security and efficiency. Aging infrastructure and leaks are among the top issues facing DoD's effort to increase water security and efficiency. Many Army installations have water distribution infrastructure that is over 50 years old and is typically in poor condition. For example, at Fort Carson, an Army base in Colorado, the Army retrofitted nearly 200 buildings with high-efficiency plumbing fixtures. The Iowa Army Ammunition Plant decreased facility water use by more than 33 percent by replacing existing water mains throughout the facility. At Fort Irwin, an Army installation in the Mohave Desert of California, a new water treatment plant enabled the construction of a new recycled water line for irrigation through a utility privatization contract. This investment is reducing potable water consumption by 11.9 million gallons (MGal) annually at Fort Irwin.⁹

⁹ Office of the Under Secretary of Defense for Acquisition and Sustainment. (2019). *Requested Information on Water Resources*.

Small changes in infrastructure across the Military Departments are helping DoD conserve water. At its Fleet Readiness Center in California, the Navy installed a waterless steam cleaning system, a low-water steam assist rinse system, and retrofitted low volume aircraft washing hoses. In tandem these systems have immensely increased the Center's manufacturing and painting facilities' water efficiency. The United States Marine Corps (USMC) Air Station Miramar made irrigation upgrades to their water distribution lines that are expected to result in annual potable water savings of 11 MGal per year, or more. The Army implemented an advanced irrigation control system at Fort Carson that uses weather data to optimize the irrigation schedule. In combination with retrofitting plumbing fixtures, Fort Carson was able to achieve a 47 percent reduction in water use intensity across the base.¹⁰ At Nellis Air Force Base (AFB) in Nevada, the Air Force's use of robots to clean their solar panels, resulted in a 75 percent reduction in water use compared to manual methods.¹¹

Leak detection and repair is also increasing water efficiency at DoD installations. At Naval Shipyard Portsmouth Virginia, the Navy repaired an on-going leak which reduced the shipyard's water consumption by 500,000 gallons a day.¹² The Army has had great success at Blue Grass Army Depot, in Kentucky by installing a leak detection system to aid in prioritizing repairs and replacements of water distribution lines. At the Iowa Army Ammunition Plant, replacement of aged water mains throughout the facility decreased the facility water use by more than 33 percent.

MILCON offers the Military Departments a structure for implementing water conservation at the beginning of an infrastructure project. For example, in FY 2015, the Army added 122 buildings to its high-performance sustainable buildings inventory through MILCON projects, making a total of 790 buildings.¹³ The DON requires that all future Navy MILCON projects be designed to meet LEED gold standards, which include metrics for water efficiency.¹⁴

Alternative Water Sources

DoD is successfully using alternative water resourcing, including water recycling to achieve water continuity¹⁵ and efficiencies. Ensuring continuing access to water is necessary for DoD installations to achieve their missions. Documenting and ensuring DoD maintains their water rights, is an important component of assuring access to sufficient water quantities for mission requirements.

¹⁰ Office of the Assistant Secretary of Defense for Energy, Installations, and Environment. (2017). *Annual Energy Management and Resilience Report (AEMRR) Fiscal Year 2016*.

¹¹ Sierra Hicks. "Powering the Department of Defense." *American Security Project* (2017).

¹² Office of the Assistant Secretary of Defense for Energy, Installations, and Environment. (2017). *Annual Energy Management and Resilience Report (AEMRR) Fiscal Year 2016*.

¹³ Office of the Assistant Secretary of the Army for Installations, Energy and Environment. (2016). *Army Sustainability Report 2016*.

¹⁴ (n.d.). LEED Certified Buildings. Retrieved from <http://navysustainability.dodlive.mil/environment/land-based-efforts/leed-certified-buildings/>

¹⁵ Water continuity refers to assured access to an adequate water supply.

Reusing water for purposes other than its intended use saves money and lowers overall consumption. At Cannon AFB in New Mexico, the Air Force increased the volume of reclaimed wastewater available for non-potable uses from 0.2 to 9.0 MGal and used the reclaimed water for its MILCON needs. The dry soil at Cannon AFB must be compacted with water for construction; the installation has utilized reclaimed wastewater for this purpose to reduce potable water use. The Navy uses reclaimed water for irrigation and other non-potable uses at Naval Support Activity (NSA) Monterey in California. The Army is using alternative water at 29 installations including Fort Carson and Fort Huachuca, where the Army is using reclaimed water to irrigate golf courses.

The USMC is continuing to expand on-site creation and use of reclaimed water for irrigation and closed loop industrial systems, thereby reducing reliance on external water providers and local aquifers. The Defense Intelligence Agency (DIA) is leveraging a comprehensive water conservation program that resulted in a 37 percent decrease in its water use intensity. DIA has and continues to pursue permits to use non-potable water in its cooling towers, further decreasing DIA's potable water consumption.¹⁶ In FY 2017, the National Security Agency initiated the purchase of reclaimed water, primarily as water for cooling towers, resulting in an approximately 58 percent decrease in potable water use from FY 2016.¹⁷

Water-Use Related Changes

Reduced water use is a key feature of water efficiency and savings efforts, further supporting an installation's sustainability and resilience. DoD uses planning, land management changes, public outreach efforts, water utilities privatization, and third-party financed projects (e.g., Energy Savings Performance Contracts (ESPCs) and Utility Energy Service Contracts (UESCs)) to improve water security and efficiency.¹⁸ For example and as stated earlier in this report, in FY 2017, DoD used only 82,499 MGal of potable water, a reduction in DoD's potable water intensity by 26.9 percent from its 2007 baseline.¹⁹ Tobyhanna Army Depot in Pennsylvania won a Federal Energy Management Program award in 2018 for achieving a 52 percent reduction in their water use in FY 2017 from their FY 2007 baseline. Program efforts at Tobyhanna Army Depot included a robust data collection and monitoring system, investments in water saving technologies (e.g., rain water harvesting, wastewater reuse), and leak detection equipment.

Utilities privatization supports water security and efficiency by using private capital to make and sustain necessary infrastructure improvements. Established in 1998, DoD's Utilities

¹⁶ Office of the Under Secretary of Defense for Acquisition and Sustainment. (2019). *Requested Information on Water Resources*.

¹⁷ Office of the Assistant Secretary of Defense for Energy, Installations, and Environment. (2017). *Annual Energy Management and Resilience Report (AEMRR) Fiscal Year 2016*.

¹⁸ Office of the Under Secretary of Defense for Acquisition and Sustainment. (2019). *Requested Information on Water Resources*.

¹⁹ Office of the Under Secretary of Defense for Acquisition and Sustainment. (2019). *Requested Information on Water Resources*.

Privatization Program supports DoD conveying utility infrastructure to local utility providers.²⁰ Since 1998, the Military Departments have privatized 592 utility systems, of which 147 (25 percent) are water systems and 117 (20 percent) are wastewater systems.²¹ The following examples illustrate how the Military Departments are using privatization alternative financing to support water security and efficiency. Under the Army's Sustainable Design and Development Policy, all new privatized housing will be encouraged to meet the Army sustainable design and development standards, including considerations to manage stormwater, indoor and outdoor water efficiency, and metering, as appropriate.²² DON is focusing on incorporating water conservation efforts into its larger ESPC and UESC project scopes (e.g., the UESC at Naval Construction Battalion Center Gulfport). Currently the Navy has a UESC in place at Naval Station Mayport focused on improving energy efficiency at 50 facilities on base and is expected to save \$600,000 in water and energy costs along with 2.9 MGal of water each year.²³ DON has identified a suite of potential opportunities and associated project funding mechanisms that it can implement in the coming years.

Fort Bragg and Fort Bliss will be the first Army installations to complete IEWPs, which support water security by documenting water baseline, water needs, threats to water consumption, and opportunities for water efficiency, including water use changes. The Fort Bragg IEWP includes a description of BMPs and plans to complete BMPs installation-wide. In addition, the plan includes specific projects to increase water resilience through efficiency, conservation, and alternate supplies. The Fort Bliss IEWP outlines the garrison-defined critical water needs; deficiencies in water availability, infrastructure condition, and system operation; and concludes with proposed BMPs and projects to address any deficiencies.

The Air Force uses an Installation Development Plan (IDP) to support installation master planning. As part of the IDP, Air Force installations must track metrics on water quality and quantity (e.g., water supply availability during average demand, water supply availability during peak demand, and water supply quality). Tracking progress on these indicators encourages water conservation and sustainable use. The Navy at Naval Weapons Station (NWS) Earle is conducting a joint land use study through the Readiness and Environmental Protection Integration (REPI) Program related to water conservation.²⁴ NWS Earle is partnering with Monmouth County, New Jersey to conserve groundwater recharge areas that protect the installation's water supply from increasing residential development pressure and potential saltwater intrusion. As a part of the USMC Sustainability Plan, the Marine Corps must complete a comprehensive water evaluation of facilities every four years to fix problems and promote innovation.

²⁰ In the privatization process, military installations shift from the role of owner-operators to that of smart utility service customers.

²¹ Office of the Under Secretary of Defense for Acquisition and Sustainment. (2019). *Requested Information on Water Resources*.

²² Secretary of the Army (Installations, Energy and Environment). (2017). *Sustainable Design and Development Policy Update*.

²³ J. D. (2016, September 29). New Energy Efficiency and Water Conservation Program at Mayport Naval Station Expected to Save About 600,000 Annually. Retrieved from <https://www.jacksonville.com/news/2016-09-29/new-energy-efficiency-and-water-conservation-program-mayport-naval-station-expected>

²⁴ DoD's REPI Program funds partnerships to prevent incompatible development and environmental restrictions around DoD installations and ranges in order to maintain military mission assurance.

The Military Departments are incorporating water saving measures into their landscape maintenance and restoration activities. The Army's landscape projects must use water-efficient strategies and consider native plant species and dry-scape design alternatives. Additionally, for new construction projects, the Army requires consideration of alternatives to irrigation and projects that do require irrigation will consider alternative water use in place of outdoor potable water use. The Navy, at Naval Air Station (NAS) Lemoore and Naval Air Weapons Station (NAWS) China Lake, is successfully using xeriscaping and highly efficient irrigation systems to reduce their Industrial, Landscape, and Agricultural (ILA) water consumption. Additionally, the extensive use of artificial turf and rock or mulch groundcover at Naval Base San Diego and NAS Fallon have greatly reduced the Navy's irrigation needs.

The DON continues to develop initiatives to reduce potable water consumption and intensity. At NAS Patuxent River, NSA Annapolis, and Naval Support Facility Carderock, installation personnel are including initiatives for low impact development measures (e.g., rainwater reclamation, graywater reclamation for irrigation, native plant species, bioretention areas for flood control) in the installations' master plans for future projects. These future endeavors will not only reduce potable water consumption but will also aid in aquifer recharge. Further, the USMC is promoting updating water metering systems and xeriscaping as priorities for water conservation at its installations across the country.²⁵ On the West Coast, the USMC xeriscaping efforts replaced water-thirsty plants at seven installations with plants that need less irrigation.²⁶ Additionally, Marine Corps Installations (MCI) West is implementing policies to reduce and conserve water at five major installations in the Southwest through limiting the washing of vehicles, focusing on leak repair, and prohibiting washing down of paved surfaces unless safety dictates. As a result of these and other efforts, MCI West has reduced their water use by 20 percent since 2012.²⁷

DoD funds partnerships to prevent incompatible development and environmental restrictions around DoD installations and ranges in order to maintain military mission assurance through the REPI Program, authorized by 10 U.S. Code §2684a.²⁸ Fort Huachuca, Arizona received \$1.1 million in REPI funding and over \$3 million in partner funding to support the purchase of easements for water conservation to support its mission. The Army will use the funding to establish a conservation easement on 1,150 acres of land surrounding the installation and the San Pedro River Watershed. This conservation easement will protect the surrounding land and its scarce water resources from plans to drill over 200 wells for proposed housing developments.²⁹ Additionally, the Army will use the funding to help identify water conservation opportunities that complement the region's landscape. By investing this funding and conserving the surrounding lands, DoD protects unimpeded military testing and training at Fort Huachuca.

²⁵ United States Marine Corps. (2011). *United States Marine Corps Sustainability Plan*.

²⁶ United States Marine Corps. (2011). *United States Marine Corps Sustainability Plan*.

²⁷ Dominguez, Cpl. S., (2015, June 3). MCI-West Implements New Policy for Water Conservation and Bases. Retrieved from <https://www.pendleton.marines.mil/News/News-Article-Display/Article/590455/mci-west-implements-new-policy-for-water-conservation-on-bases/>

²⁸ Agreements to Limit Encroachments and Other Constraints on Military Training, Testing, and Operations, 10 U.S.C. §2684a.

²⁹ Readiness and Environmental Protection Integration Program. (2018). *2018 REPI Challenge Awards*.

REPI is also supporting water conservation at Avon Park Air Force Range. Specifically, REPI funding supported increased coordination between DoD and U.S. Department of Agriculture, allowing for the conservation of the lands and waters around the installation, which benefitted both DoD's mission and reduced the installation's impacts on Florida's water resources.

Along with these installation conservation efforts, public awareness campaigns play a large role in supporting water conservation. All the Military Departments have education and public awareness campaigns focusing on reducing water use at installations through a variety of methods. As an example, the Army and Air Force leadership announce Energy Action Month every year in October and highlight the importance of both energy and water resilience to mission readiness and success. An effective public outreach campaign conducted by the Army at Camp Rilea included conservation announcements and base-wide and conservation training for full-time employees.

Annually, the OSD and the Military Departments recognize outstanding installation performance with awards presented in categories related to energy efficiency, energy management, and water conservation. The Secretary of the Navy awarded Naval Hospital Bremerton an Energy and Water Management gold award for its policies, training of personnel, technology, and energy and water saving initiatives. A key success in achieving this award was the focus on staff and public awareness efforts leading to behavioral changes to conserve energy and water.³⁰ The Secretary of the Army awards program recognizes installations annually for achievements in energy and water security. Additionally, a number of Army installations have been recognized for extraordinary water conservation successes by the Federal Energy Management Program (FEMP) through the Federal Energy and Water Management Awards. U.S. Army Garrison Presidio of Monterey California won FEMP awards in 2017 and 2018 for an innovative landscaping project that converted three acres of turf to drought resistant landscape, and a barracks renovation project that reduced water use by 66 percent.

Opportunities to Replicate Projects Across Installations

Potential Areas of Expansion

The Military Departments have opportunities to replicate and expand these successful water conservation initiatives at other installations (e.g., expanding xeriscaping to other installations in the Southwest, increasing water reuse efforts at additional installations).³¹ Additionally, several "pilot" projects across the nation are being deployed only at a small number of installations (e.g., utilities privatization, smart metering), so DoD is interested in expanding those projects and replicating their successful results to other locations, where applicable. Additionally, DoD uses the Strategic Environmental Research and Development program (SERDP) and the Environmental Security Technology Certification Program (ESTCP) to validate and fund innovative technologies, sustainable design initiatives, and cutting-edge technologies that can reduce DoD's water consumption and use and maximize the effectiveness

³⁰ Stutz, D. H. (2016, October 28). Naval Hospital Bremerton Recognized for Energy, Water Programs. Retrieved from https://www.militarynews.com/norfolk-navy-flagship/news/quarterdeck/naval-hospital-bremerton-recognized-for-energy-water-programs/article_ce2386b9-8375-54cb-8a48-cf39046d703c.html

³¹ As these efforts are demonstrating returns on investment, the Military Departments will begin to look at expanding them to other installations.

and efficiency of its water systems. Projects funded through SERDP and demonstrated by ESTCP include improved valves to prevent leakage, leak detection technologies, planning methodologies for assessing building water use, steam trap monitoring, dish room water reductions, and heating, ventilation and air conditioning (HVAC) water efficiencies. Deployment of SERDP/ESTCP validated projects at additional installations has the potential to reduce water usage resulting in decreased costs.

The most promising water conservation strategy that DoD can apply across its installation regardless of type and location is infrastructure leak detection and repair/replacement. Given the fact that the majority of water infrastructure within the DoD is near the end of its useful life, routine maintenance and leak detection technologies are critical to reducing water waste and determining necessary infrastructure upgrades that will provide lifecycle cost savings. However, there is not always an acceptable business case for DoD to justify investment in all water projects. Newly proposed water security projects may not compete well in Military Departments' funding processes.³² Under such circumstances, regular maintenance of infrastructure is then the most advantageous way to increase resilience. Incorporating changes into existing processes, such as routine infrastructure planning and maintenance, will be the most efficient way to address water security and usage on base.

Another major avenue for water conservation at the installation-level is through industrial, landscape, and agricultural (ILA) changes. Efficiency improvements in irrigation and xeriscaping landscapes can significantly reduce an installation's water demand. Changes in ILA practices will be most valuable at installations across the southwestern United States where climatic conditions call for more drought-resistant plant species. Additional examples of projects related to ILA changes are further described in Appendix B. DoD can also promote expanded use of recycled wastewater (e.g., irrigation, toilet flushing) to installations who are not currently recycling water. Reclaimed water effectively reduces an installation's reliance on increasingly scarce potable water sources.

DoD can also expand its use of auditing and metering to monitor water usage where feasible. Installations personnel can install meters on a few representative buildings and use these meters to provide estimates of water usage at similar facilities.³³ Expansion of both auditing and metering efforts would yield further cost and water savings.

Expansion of utility privatization efforts may be a means to address some of the initial costs associated with metering or auditing. However, privatization contracts must be properly crafted and negotiated to ensure DoD's long-term water security needs. These contracts can include infrastructure upgrades and new equipment to help the installations reduce energy and water consumption.³⁴ Expanding installation efforts to install low flow or water efficient fixtures (e.g., electronic flush sensors, electronic sensor control valves for faucets, and waterless urinals), where possible, would reduce water usage thus providing cost savings. For example,

³² United States Government Accountability Office. (2014). *Climate Change Adaptation. DoD Can Improve Infrastructure Planning and Processes to Better Account for Potential Impacts.*

³³ Department of Defense. (2005). *Energy Manager's Handbook.*

³⁴ Office of the Under Secretary of Defense for Acquisition and Sustainment. (2019). *Requested Information on Water Resources.*

the DON estimates that water conservation efforts such as installing low-flow faucets and replacing leaking faucets can save between 70 and 200 gallons of water per person over the course of one month. Through utilities privatization, installations can reduce their risk and liability associate with water infrastructure systems, ultimately increasing the Department's water resilience. UESCs and ESPCs can also incorporate water efficiency measures for irrigation and landscaping-related water usage, plumbing, wastewater treatment plant optimization, and more. Combined with other energy efficiency measures, it can be economical to leverage ESPCs and UESCs to include aging water infrastructure upgrades, especially in areas with drought and/or high water/wastewater rates.³⁵

Challenges and Potential Impediments to Expansion

Limited resources pose a challenge to DoD when replicating water security and efficiency efforts. Installation potable water supply is often undervalued when compared to higher cost energy. Water is typically undervalued when considering water stress, both seasonal and chronic, in many regions of the U.S. Low water pricing leads to long payback periods for water investments and can lead to waste and inefficiencies. Another related challenge to low water costs is the way in which Army installations develop water rates. The price of water at an installation is determined either by the source utility, or where installations supply their own water, by governing Army policy for calculating utility resale rates.

In addition to the low cost, the Military Departments do not always have an acceptable business case to justify investment in all water projects. Newly proposed water security projects may not compete well in the Military Departments' funding processes.³⁶ In addition, limited resources dedicated to water resources can trigger a positive feedback loop – worsening water security over time. For example, the use of water distribution networks past their designed service life due to limited funding leads to deferred maintenance and modernization that exacerbate leaks and water loss, as well as diminished water quality due to insufficient water turnover and age.

Older infrastructure can be impacted by changes in climate and associated weather events. Evidence supports that rising sea levels are associated with damage to installation infrastructure and salt water intrusion. In Alaska, climate phenomena have caused erosion, which damages utility infrastructure on base. If climate impacts continue to occur with increased intensity and frequency, then DoD will face increased routine maintenance costs. From this, DoD recognizes potential climate impacts that can detrimentally affect water infrastructure and is working to integrate those into its longer-term infrastructure replacement efforts. However, replacement of infrastructure is often initially costly and may require special financing efforts (e.g., utility privatizing, alternative financing).

Alternative water projects such as rainwater-harvesting and reclaimed wastewater can be challenging for the Military Departments to implement because of high costs, lack of

³⁵Office of the Under Secretary of Defense for Acquisition and Sustainment. (2019). *Requested Information on Water Resources*.

³⁶United States Government Accountability Office. (2014). *Climate Change Adaptation. DoD Can Improve Infrastructure Planning and Processes to Better Account for Potential Impacts*.

infrastructure and technical expertise to properly design and operate systems, and the complex legal requirements of the Safe Drinking Water Act.

Another issue for DoD is limited rainwater and stormwater runoff in desert environments. In drier climates, using reclaimed wastewater may be more practical. Part of the Military Departments' challenge is to determine the best suite of strategies to employ based on climate and weather conditions where the installation is located. Due to the diverse climates and topographies of DoD's installation, there is no one solution to all installations' water usage efforts.

Across the Military Departments there are limited systems and a lack of technical experience to support widespread use of metering. Metering data may not be used or interpreted correctly due to lack of knowledge or resourcing as water management responsibility at the installation level typically falls on the installation energy manager. Filling vacancies, maintaining qualified energy managers, and providing advanced training in water conservation remains challenging. While there are advanced metering systems for electricity on installations, many installations lack advanced water metering systems. Advanced meters can provide detailed interval data that can provide billing data for reimbursable customers, identify abnormal water use such as leaks and other operational issues, and inform estimates of water requirements.

Additionally, barriers to utilities privatization can also be barriers to water conservation. Private utility efforts have improved water efficiency through the systematic replacement and repair of leaking water lines. For example, at Vandenberg AFB, the privatized system owner uses a new technology to recycle and reuse over 1 billion gallons of water per year in their line flushing operations. Reducing barriers to utilities privatizing efforts like these is an important strategy to reduce installation costs along with increasing the installation's water conservation capacity. Conservation measures like these can be instrumental in maintaining mission readiness during times of low water availability.

Continuity of Water Availability

Assured access to an adequate water supply is critical for long-term water security and military readiness. Water service failures present a current and growing risk to installations as it has direct impacts (e.g., disruption, health and safety, financial) on the installations' ability to execute its mission. Installations with the greatest need for increased water efficiencies range in size, scope, hydrology, and location. As DoD expects to face water shortages in the coming decades, OSD has collected water usage data from Military Departments to help identify installations with potential issues. This data, which includes projected future and lifetime water consumption; variation in temperature, and rainfall, is used to prioritize and manage current and future water requirements needed to sustain the mission. OSD is working with the Military Departments to examine which installations can expect to face water supply shortages in the coming decades. Studies reveal that some installations, such as Fort Irwin in California, expect to exhaust their water resources in just a few decades.³⁷

³⁷ U.S. Army Regional Environmental and Energy Office. (2014). *Southern Review of Legislative and Regulatory Actions*.

While most installations appear to have sufficient access to and availability of water, example DoD installations that may benefit using additional water conservation measures to avoid potential water shortages or increased costs associated with water scarcity are listed below.

- Altus AFB
 - Has experienced prolonged periods of severe drought resulting in the lowering of water levels in the base's primary water source, the Tom Steed Reservoir.
- Fort Hunter Liggett
 - Identified by the 2011 U.S. Army Corps of Engineers' Construction Engineering Research Laboratory's water sustainability assessment as one of the most highly vulnerable installations in the U.S.
- Fort Stewart
 - Depends on water from an aquifer considered vulnerable because of the heavy regional demands from Florida, Georgia, and South Carolina.
- Mountain Home AFB
 - Depends on water from the Mountain Home critical declining aquifer that is over-drafted by 30,000 acre-feet annually. It is projected that this falling water table may fail to sustain current pump rates as soon as 2028.
- NAS Lemoore
 - Lies in a groundwater basin identified as critical overdraft by the California Department of Water Resources.
- NAWS China Lake
 - Lies in a groundwater basin identified as critical overdraft³⁸ by the California Department of Water Resources.

Conclusion

Water security and efficiency are critical to installation readiness. DoD relies on water to support training and testing activities, operations, and facility and infrastructure maintenance. DoD is using innovative approaches to conserve water, save costs, and ensure a continued water supply enough to fulfill installations' missions. Innovative approaches range from regular maintenance and water system-related upgrades, alternative water sourcing, and changing behaviors and practices on water use. DoD is developing BMPs on these efforts to help transfer and replicate successful practices. Opportunities exist for the Military Departments to expand water conservation efforts. DoD is using the policies, guidance, and programs it has in place to capitalize on these opportunities. Focusing on installations where the greatest water efficiency needs exist, DoD is working to implement water conservation strategies as quickly as resourcing and manpower will allow.

³⁸ A basin has critical overdraft, per the California Department of Water Resources, when the "continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts."

Acronyms

Acronym	Definition
AD	Army Directive
AFB	Air Force Base
AFI	Air Force Instruction
BMPs	Best Management Practices
DIA	Defense Intelligence Agency
DoD	Department of Defense
DoDD	Department of Defense Directive
DoDI	Department of Defense Instruction
DON	Department of the Navy
EO	Executive Order
ESPC	Energy Savings Performance Contract
ESTCP	Environmental Security Technology Certification Program
FEMP	Federal Energy Management Program
FY	Fiscal Year
HVAC	Heating, Ventilation, and Air Conditioning
IEWP	Installation Energy and Water Plan
IDP	Installation Development Plan
ILA	Industrial, Landscape, and Agricultural
INRMP	Integrated Natural Resources Management Plan
LEED	Leadership in Energy and Environmental Design
MCI	Marine Corps Installations
MGal	Million Gallons
MILCON	Military Construction
NAS	Naval Air Station
NAWS	Naval Air Weapons Station
NSA	Naval Support Activity
NWS	Naval Weapons Station
OSD	Office of the Secretary of Defense
REPI	Readiness and Environmental Protection Integration
SECNAV	Secretary of the Navy
SERDP	Strategic Environmental Research and Development Program
UESC	Utility Energy Service Contract
UFC	Unified Facilities Criteria
USMC	United States Marine Corps

Appendix A. OSD and Military Department Water Policies Index

Department	Policy Code	Policy Title
Air Force	AFI 32-7062	<i>Comprehensive Planning</i>
Air Force	AFI 32-1061	<i>Providing Utilities to U.S. Air Force Installations</i>
Air Force	AFI 32-1067	<i>Water and Fuel Systems</i>
Air Force	AFI 90-1701	<i>Installation Energy and Water Management</i>
Army	AD 2017-07	<i>Installation Energy and Water Security Policy</i>
Army	AD 2014-08	<i>Water Rights Policy for Army Installations in the United States</i>
Army	AD 2014-02	<i>Net Zero Installations Policy</i>
Army	AD 2014-10	<i>Advanced Metering of Utilities</i>
Army	AR 200-1	<i>Environmental Protection and Enhancement</i>
Army	AR 420-1	<i>Facilities Management</i>
Navy	OPNAVINST 3502.08	<i>Mission Assurance</i>
Navy	SECNAV 4101.3A	<i>Department of the Navy Energy Program</i>
OSD	DoDD 3020.40	<i>Mission Assurance</i>
OSD	DoDD 4270.5	<i>Military Construction</i>
OSD	DoDI 4170.11	<i>Installation Energy Management</i>
OSD	UFC 1-200-02	<i>High Performing Sustainable Buildings Requirements</i>
OSD	UFC 3-210-10	<i>Low Impact Development</i>

Appendix B. Water Security Project Examples

Project Category	Project Examples
<i>Alternative Sources</i>	Desalinization of Seawater & Brackish Groundwater Utilities Privatization
<i>Awareness & Education</i>	Innovative Financing Public Awareness Campaigns Advanced Metering Biofoul Prevention Efficient and Automated Cleaning Methods
<i>Infrastructure Improvements</i>	HVAC Water Efficiencies Improved Leak Detection & Repair LEED Design in MILCON Low-Flow Fixtures in Bathrooms and Kitchens Advanced Irrigation Controls Drip Irrigation Irrigation Scheduling
<i>Landscape & Irrigation Changes</i>	Native Plants & Invasive Plant Management Rainwater Harvesting Stormwater/Non-Potable Water for Irrigation Treated Effluent for Irrigation Xeriscaping
<i>Reuse & Reclamation</i>	Grey Water Reuse and Recycling Retention of Chiller Condensate Wastewater Reclamation