

BRIEF DESCRIPTION

While water is abundant at the global scale, only about 3% of Earth's water is fresh water.¹ Despite the finite limit of the fresh water supply, many water-use activities and frameworks today are still once-through processes. In many regions, groundwater is withdrawn faster than it is replenished. Furthermore the energy required to acquire, treat, transport, reuse, and dispose of water represents up to 4% of electricity demand for most communities and up to 19% in irrigation-intensive or conveyance-intensive regions such as California.²

Currently, many locations within the United States (US) and throughout the world are facing significant water shortages resulting from drought, and competing regional requirements for agriculture, municipal consumption, energy production, and environmental requirements. In water-stressed regions, the capability to reuse water is already becoming an important part of the sustainability solution set, as it provides a suitable alternative water source for many water intensive activities. Effective water reuse programs reduce potable water consumption and wastewater discharge.

Purple colored pipe is used to identify and distribute reclaimed or recycled water. It was first adopted by the American Water Works Association (AWWA) California-Nevada Section in 1997. A non-potable water reuse program that uses purple pipe is in line with programs geared at reducing potable water consumption such as the *DoD Strategic Sustainability Performance Plan* and the *Army Net Zero Directive*.

Water used once for washing passing through from kitchen sinks, dishwashers, bathroom sinks, tubs and showers is considered gray water. It's gray water that is carried in purple pipe. With minimal treatment, this type of water can be re-used for lower end uses such as flushing toilets or to irrigate landscape. Gray water is household wastewater, with the exception of wastewater from toilets, typically 50 to 80%. Water from toilets, known as black water, is not used in purple pipe.

¹ OW US EPA, "Water Trivia Facts," accessed September 22, 2015, http://water.epa.gov/learn/kids/drinkingwater/water_trivia_facts.cfm.

² California Energy Commission, "California's Water-Energy Relationship," 2005, <http://www.cacoastkeeper.org/document/california's-water-energy-relationship.pdf>.

Applications

Purple pipe programs can be applied to achieve the following outcomes:

- Reduce the demand on a potable water treatment and distribution system.
- Reduce the demand on water supplies such as surface or ground water sources.
- Recharge diminishing groundwater supplies and/or reduce saltwater intrusion into an aquifer
- Reduce the volumetric loading on a Waste Water Treatment Plant (WWTP) and collection system.
- Reduce the volume of water discharged from the WWTP to the environment.
- Provide a drought-resistant irrigation supply.

Water reuse types and example DoD end uses:

| Use Type | End Use |
|--------------------------------|---|
| Irrigation | Parks Golf courses Cemeteries Parade grounds Athletic fields Building landscapes |
| Industrial recycling and reuse | Cooling water Boiler feed Process water |
| Non-potable | Fire protection Air conditioning Toilet flushing Water features |

Design Notes

Plumbing Code

In 2003 purple pipe was adopted in the Uniform Color Standard of the American Public Works Association (APWA). Since then plumbing codes have been updated to include more guidance specific to water reuse activities. For example, the International Code Council’s 2015 International Plumbing Code (IPC) dedicates an entire chapter (chapter 13) to Non-Potable Water Systems. It provides some general guidance on treatment requirements but defers to local jurisdictions

with respect to specific levels of purity required for reuse activities. More specific guidance is provided in the IPC on the labeling of pipes and fixtures, backflow and cross-contamination prevention, storage system design, and materials. IPC provides guidance for the following systems: collection, on-site gray water treatment and reuse, rain water collection and use, irrigation, and reclaimed water.

Sources of gray water and reuse activities allowed can vary significantly from state to state. DoD installations are generally required to follow state and local codes in regards to water-reuse practices, as summarized in the Unified Facilities Criteria (UFC) for plumbing systems. UFC 3-420-01 Plumbing Systems states:

*"SECTION 602.2.1 Non-potable water exception. A non-potable water supply, when used in an entirely separate system and when approved by **the local health department**, may be used for flushing water closets and urinals, and for other approved purposes where potable water is not required. Piping containing non-potable water, that is water not meeting accepted potable water standards, will be labeled 'NONPOTABLE WATER, DO NOT DRINK.'"*

Related Technologies

Rainwater Harvesting

References/Useful Resources:

- [1] Office of Wastewater Management, National Risk Management Research Laboratory, and U.S. Agency for International Development, "2012 Guidelines for Water Reuse" (US EPA- Office of Wastewater Management, 2012), <http://nepis.epa.gov/Adobe/PDF/P100FS7K.pdf>.
- [2] International Code Council, *2015 International Plumbing Code* (ICC, 2014).
- [3] "Unified Facilities Criteria, Plumbing Systems," September 18, 2015, https://www.wbdg.org/ccb/DOD/UFC/ufc_3_420_01.pdf.
- [4] Office of Wastewater Management, National Risk Management Research Laboratory, and U.S. Agency for International Development, "2012 Guidelines for Water Reuse."
- [5] George Tchobanoglous et al., "Framework for Direct Potable Reuse" (Alexandria, VA 22314: WaterReuse Research Foundation, 2015), <http://www.waterrf.org/publicreportlibrary/4044.pdf>.
- [6] Graywater Application for Army Installations, Public Works Technical Bulletin (Washington, DC: US Army Corps of Engineers, September 30, 2011), https://www.wbdg.org/ccb/ARMYCOE/PWTB/pwtb_200_1_101.pdf.

**Environmental
Impacts**

Army Directive 2014-02 Net Zero Installations Policy

A net zero water installation recharges as much water back into a local water supply (aquifer) as it withdraws. Purple pipe technologies and projects contribute to this goal by recycling and reclaiming water for reuse, shifting from the use of potable water to alternative sources as much as possible.

DOD Sustainable Buildings Policy 2013

This policy applies to existing and future installation, providing minimum standards following UFC 1-200-02, High Performance and Sustainable Building Requirements dated November 2014. This UFC references the requirements under ASHRAE 189.1-2011 Section 6.4.1 of limiting landscaped water usage to 33% of baseline. It also references Section 6.5.1 of the same standard limiting potable water demand for site irrigation to 35% of baseline.

**Guiding
Principles**

Protect and Conserve Water

Purple pipe can assist in several strategies used to achieve the high performance sustainable building guiding principles.

Minimize indoor water use: Utilizing purple pipe and reclaimed water for flushing toilets can reduce a significant amount of potable water use in buildings.

Efficient Irrigation: Employ water efficient irrigation strategies and utilize purple pipe reclaimed water for irrigation to reduce outdoor potable water consumption.

Alternative Water: Implement cost effective methods to utilize alternative sources of water such as harvested rainwater, treated wastewater, air handler condensate capture, gray water, and reclaimed water, to the extent permitted under local laws and regulations.

**Associated
LEED Credits
(NC 2009)**

Green Building Council LEED BD+C: Water Efficiency (WE)

WE Credit1: Water Efficient landscaping up to 4 points

- Reduce potable water use for irrigation by 50% 2 points
- Reduce potable water use for irrigation by 100% additional 2 points

WE Credit 2: Innovative Waste Water technologies 2 points

Reduce potable water use for building sewage conveyance by 50% through the use of water-conserving fixtures or non-potable water (e.g. captured rainwater, recycled gray water on-site or municipally treated wastewater).

OR

Treat 50% of wastewater on-site to tertiary standards. Treated water must be infiltrated or used on-site

WE Credit 3: Water Use Reduction 2-4 points

Employ strategies that in aggregate use less water than the water use baseline calculated for the building (not including irrigation):

- that result in 30% water savings, 2 points,
- that result in 35% water savings, 3 points,
- that result in 40% water savings, 4 points.

Purple Pipe

[PRODUCT AND ECONOMICS]

Product Images



Figure 1. Gray water treatment system in an out-building at a DoD training barracks. (Source: USACE, ERDC-CERL)



Figure 2. Purple Pipe for building reuse at a DoD training barracks. (Source: USACE, ERDC-CERL)

Cost Range

| System | Approximate Life Cycle Cost* | Unit |
|---|------------------------------|------------------|
| Building Scale Gray Water Reuse System for Irrigation or Toilet Flushing (Retrofit) | \$1.84-\$8.77 | Per 1000 gallons |
| Municipal Scale Reclamation System for Irrigation | \$0.50-1.76 | Per 1000 gallons |
| Municipal Scale Water Reuse System for Industrial Use or Toilet Flushing | \$1.65-4.94 | Per 1000 gallons |
| Municipal Scale Potable Reuse System | \$2.40-5.06 | Per 1000 gallons |

* There are nonmarket benefits that may be calculated, particularly if the purple pipe serves a critical facility. These critical facilities may justify a higher willingness-to-pay cost for water.

Product Types **Building Scale Gray Water Reuse Systems**

- Skid-mounted systems that can be installed in basements, utility closets, or utility sheds to allow gray water to be treated (biostabilization, filtration, and disinfection) such that it can be reused for irrigation or toilet flushing.

Wastewater Reclamation Systems

- Plant-scale wastewater treatment systems that provide sufficient biostabilization, clarification, and disinfection of wastewater to allow its use for non-potable applications such as irrigation.

Potable Reuse Systems

- Plant-scale advanced treatment systems that treat wastewater treatment plant effluents via reverse osmosis and advanced oxidation such that the product water is suitable for potable use or aquifer recharge.

Vendors

The list below is not a comprehensive catalog of vendors, but it reflects some recent contributors to Army demonstration projects.

- WaHaSo Manufacturer and installer of building scale water reuse systems. (Hindsdale, Illinois)
- GE Water Manufacturer of skid-mounted wastewater treatment systems including LEAP-MBR technology. (Trevose, Pennsylvania)
- Bio-Microbics Manufacturer of bio-barrier aerobic membrane bioreactor. (Shawnee, Kansas)
- Sloan Valve Company Manufacturer of under-sink water reuse technologies. (Franklin Park, IL)

Guidelines

Applicable Guidelines for Water Reuse at Army Installations. Public Works Technical Bulletin. 30 June 2014.³

This document provides guidance and valuable references for Army installations that are pursuing water reuse activities. It provides general guidelines for water reuse, lists types of water reuse, offers potential concerns for water reuse systems, and provides links to state-specific information on water reuse.

Guidelines for Water Reuse, EPA/600/R-12/618, September 2012.⁴

The EPA's *Guidelines for Water Reuse* is a key reference listed and discussed in the Public Works Technical Bulletin 200-1-101. The broad-reaching EPA document was updated in 2012 to provide comprehensive guidance on water reuse practices that also considers developments that had occurred since the previous 2004 publication. The updated guidelines provide key information about water reuse policy, guidance and practices in various regions. Implementation considerations and frameworks are presented. Updates in the 2012 version include discussions on regional variations in water reuse practice within the United States, technology advancements, and best practices for planning in coordination with community stakeholders. The update also includes examples from other regions of the world, over 100 case studies of water reuse, and key considerations that will influence increased adoption of water reuse technologies as an enabling capability for sustainable development. Several references are made to projects that involved either Army installations or U.S. Army Corps of Engineers (USACE), primarily with respect to surface reservoir and aquifer recharge efforts that utilized reclaimed water.

³ Graywater Application for Army Installations, Public Works Technical Bulletin (Washington, DC: US Army Corps of Engineers, September 30, 2011), https://www.wbdg.org/ccb/ARMYCOE/PWTB/pwtb_200_1_101.pdf.

⁴ Office of Wastewater Management, National Risk Management Research Laboratory, and U.S. Agency for International Development, "2012 Guidelines for Water Reuse."

Fort Carson **Project: Golf Course Irrigation**

Approach:

- Since the 1970's Fort Carson has used treated wastewater to water their golf course. The base reclaims effluent from the treatment plant, and is transported 6 miles to water the golf course. Fort Carson has set the goal of using 100% of their treated wastewater for irrigation during watering season.
- Wastewater effluent is reused for wastewater treatment process to clean the sludge belt.

Results:

- Fort Carson uses treated wastewater to offset approximately 200 million gallons of water demand each watering season.
- Through these projects, Fort Carson conserves about 105 million gallons of potable water annually.
- By using reclaimed water for the golf course and in the sewage treatment process Fort Carson saves about \$222,000 a year.⁵



Figure 3. Fort Carson has changed their water treatment process to recycle water. (Source: Department of Energy)

Aberdeen Proving Ground **Project: Net Zero Water Program- Reclaim water for boiler**

⁵ Department of Energy: EERE, “Water Reclamation and Reuse at Fort Carson” (Department of Energy: EERE, August 2009), http://energy.gov/sites/prod/files/2013/10/f3/water_fortcarson.pdf.

Approach:

- As part of its Net Zero Water program, Aberdeen Proving Ground began a project to reuse effluent water from a groundwater remediation effort to offset water demand at a boiler facility, which provides heating to buildings. The effluent water previously was discharged to a local creek.

Results:

- The project is expected to save close to \$400,000 a year in water costs.

Fort Sill

Project: Cooling tower use and Irrigation use of WW effluent

Approach:

- The Fort Sill waste water treatment plant installed a water reuse system which replaces on-site potable water usage with high-quality wastewater effluent. The recycling distribution network gives Fort Sill the ability to use the treated wastewater in its energy plant's cooling towers and for geothermal heat pumps to condition buildings.
- When Fort Sill began working on the plans for the plant Oklahoma did not have any regulated design guidelines for purple pipe. Working closely with the Oklahoma Department of Environmental Quality Fort Sill designed and developed their project.
- In August 2015, the state of Oklahoma gave Fort Sill a permit to expand the purple pipe project to allow for unrestricted irrigation in public places. Fort Sill has begun laying pipe to irrigate the Polo Field and Post Cemetery.

Results:

- The project conveys about 700,000 gallons per day to be reused in the cooling tower rather than being discharged into the East Cache Creek. Once the water has cycled through the cooling tower, it feeds geothermal pumps in administrative offices.
- The new irrigation capacity from the pipes currently being installed, will reduce water consumption by about 37 million gallons a year.

**ORNG Camp
Rilea**

Project: Golf course and cemetery Irrigation

Approach:

- Through a variety of programs, the installation has reduced potable water consumption and increased aquifer recharge. The installation reuses water through a purple pipe program. The treated effluent from wastewater treatment plant is used to irrigate the parade field.

Results:

- Through innovative projects, Camp Rilea was the first installation to achieve Net Zero Water status. The installation relies on very little potable water for irrigation. In 2014 Camp Rilea used only 265,000 gallons of potable water for irrigation.



Figure 4. Purple Sign at Camp Rilea designating the use of purple pipe. (Source: Jim Arnold, "Net Zero Water ORNG Camp Rilea, Oregon," n.d.)