PNNL-13511

Market Assessment for Capturing Water Conservation Opportunities in the Federal Sector

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March 2001

Prepared for
the U.S. Department of Energy
Federal Energy Management Program
under Contract DE-AC06-76RL01830

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Pacific Northwest National Laboratory
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Preface

The mission of the U.S. Department of Energy's Federal Energy Management Program (FEMP) is to reduce the cost of government by advancing energy efficiency, water conservation, and the use of solar and other renewable technologies. This is accomplished by creating partnerships, leveraging resources, transferring technology, and providing training and technical guidance and assistance to agencies. Each of these activities is directly related to achieving requirements set forth in the Energy Policy Act of 1992 and the goals that have been established in Executive Order 13123 (June 1999), but also those that are inherent in sound management of Federal financial and personnel resources.

The Pacific Northwest National Laboratory (PNNL) supports the FEMP mission in all activity areas. This report presents the findings of a market assessment that PNNL conducted for FEMP to evaluate the water conservation opportunities and answer the key questions necessary for FEMP to make recommendations on whether or not to proceed with strategies for water conservation primarily through the development of a technology-specific Super-Energy Savings Performance Contract (ESPC).

Summary

The Department of Energy's Federal Energy Management Program (FEMP) is considering the development of a technology-specific Super-Energy Saving Performance Contract (ESPC) for water conservation. Prior to the development, however, FEMP requires the completion of a market assessment to better understand the water conservation opportunities and the strategies available for capturing them. Thus, this market assessment has been undertaken to evaluate the water conservation opportunities and answer the key questions necessary for FEMP to make recommendations on whether or not to proceed with strategies for water conservation primarily through the development of a water conservation ESPC.

The following are the key findings of this assessment:

- ✓ The life-cycle cost-effective water conservation potential today in the Federal sector, based on appropriate off-the-shelf (i.e., non-engineered) technologies is estimated to be 33–49 billion gallons/year. The savings potential—if all these savings were captured today at the mean (average) Federal water/sewer cost of $4/1,000 gallons—is $132–196 million/year.

- ✓ There are several "engineered" water conservation strategies including cooling tower water management, boiler and steam systems conservation, efficient irrigation, ozonated laundering and leak detection, that are appropriate for the Federal sector. These solutions are usually very site-specific and also – in general – cost-effective, particularly if any energy, chemicals and labor savings are incorporated into the analysis. For example, supply-side leak detection can have a payback of several months at water cost as low as $2/1,000 gallons. Savings from implementation of these "engineered technologies" are not quantified due to their site-specific nature and would be in addition to the estimated savings from off-the-shelf technologies.

- ✓ All off-the-shelf water conservation technology retrofits (non-engineered), with the exception of sensor-closing faucets, are life-cycle cost-effective—based on water/sewer savings only—at a combined water/sewer cost of $2/1,000 gallons or greater.

- ✓ There are several private-sector water conservation service providers located throughout the country who are qualified, experienced, highly capable and interested in providing water conservation performance contracting services to the federal sector. Several of these providers are currently involved in water conservation projects in the Federal sector as subcontractors to ESPCs or to the servicing electric utilities.

- ✓ Water conservation projects may be included under the DOE Super-ESPC so long as the primary purpose of the ESPC is energy conservation/cost savings and the water

conservation savings are an integral part an energy conservation project. There is currently considerable latitude by contracting officials in the interpretation and authorization of water conservation (only) projects under the DOE Super-ESPC. There are, however, no restrictions to including water (only) conservation projects in the Department of Defense (DoD) ESPC, so long as the economic criteria of the contract are met.

- ✓ The marginal, or avoided, cost of water supply/wastewater treatment—not the average or current rate that is being paid by a site or installation—is the appropriate cost to use in conjunction with the estimated water cost savings in a performance contract so that the dollar value of those savings can be accurately calculated.

- ✓ Servicing municipal water/wastewater utilities are an unlikely source for engaging in a large-scale water conservation program at the Federal site. The best opportunities to partner with water utilities appear to be taking advantage of rebates and incentives offered for a few specific technologies.

- ✓ Servicing electric utilities have an interest in incorporating water conservation projects into energy savings projects allowable under their services agreements with Federal sites. Energy utilities incorporate both in-house technical staff as well as engage the services of a third party water conservation service provider when undertaking water conservation projects.

- ✓ There is adequate market-based financing available for water conservation performance contracting. The cost of financing will range from ~8% to 14%, depending on the size of the project, the risk, the "guaranteed payment" approach, and monitoring and verification (M&V) requirements.

- ✓ The terms, conditions, and requirements of a performance-based contract are critical to the successful development of water conservation performance contracting. For the best chance of success for a technology-specific ESPC, the contract language and execution should mirror private-sector contracts as much as feasible. In particular, the process must be simple, the time period of negotiations short, and detailed engineering requirements minimized.

- ✓ Minimization of the "guarantee" (the fixed/guaranteed savings or payment stream) to the government in a performance-based contract, combined with careful selection of the most appropriate M&V requirements, will be beneficial for streamlining the contracting process. This in turn may reduce the overall risk to lending institutions (if not self-financed) and thus the project financing costs.

- ✓ Inclusion of all energy cost savings in all water conservation projects will be most attractive to the private-sector providers and will maximize the savings as well as help make projects most cost-effective.

- ✓ The vast majority of water conservation-related activities at a Federal site have a wide-ranging beneficial environmental impact.

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1.0 Introduction

The Federal Energy Management Program (FEMP) currently makes available to Federal sites a number of Super-Energy Saving Performance Contracts (ESPC) that enable sites to contract for energy-efficiency capital improvements with little or no up-front expenditures by the site. These Super-ESPCs are available to Federal sites in two ways. First, DOE has awarded six regional Super-ESPCs covering the entire United States and U.S. territories, which enables a site to procure a full range of energy efficiency technology and energy savings investments, including technologies that save water so long as there is a significant energy savings component of the technology or strategy. Second, DOE has awarded several energy efficiency/energy savings technology-specific Super-ESPCs, which are available nationwide and allow sites to target certain types of technologies. These include parabolic trough water heating, photovoltaics, and ground source heat pumps.

FEMP is also considering the development of additional technology-specific Super-ESPCs, including one for water conservation. Prior to the development, however, FEMP requires the completion of a market assessment. Thus, this market assessment has been undertaken to evaluate and answer the following key questions necessary for FEMP to make recommendations on whether or not to proceed with the development of a water conservation technology-specific performance contract:

- ✓ What is the demand for a technology-specific water conservation performance contract? What is the total application potential for water saving technologies in the Federal sector, including the appropriate technologies, their potential water savings, and their potential cost savings given an assumed level of implementation/penetration?

- ✓ What are the available options for appropriate technology installation? What methods are currently available for project financing and implementation methods?

- ✓ What are the most critical needs, requirements, and factors affecting successful implementation via an ESPC-type contract? What are the critical factors affecting viability including contracting, measurement and verification, and environmental impact?

2.0 Federal Legislation, Rulings, Interpretations, and Action Toward Water Conservation Goals

Executive Order (E.O.) 13123 encourages Federal agencies to reduce costs and implement cost-effective water efficiency improvements at Federal facilities. The Secretary of Energy must provide guidance to assist each agency to determine a baseline of water consumption, and will establish water conservation goals for Federal agencies. In addition, as part of E.O. 13123, agencies shall establish baseline potable water usage at facilities owned by the U.S. Government. The baseline year is defined as FY00 (October 1, 1999 through September 30, 2000) [1].

FEMP has been providing technical and policy guidance to Federal agencies to assist in meeting the goals of E.O. 13123 though the auspices of the Interagency Energy Management Task Force Water Conservation Working Group (WWG). The WWG has established guidelines to help interpret the E.O. and to assist the agencies in developing strategies to meet water efficiency goals.

The WWG has determined that the best strategy for achieving life-cycle cost-effective water conservation goals is through the development of a water management plan and implementation of the FEMP *Water Efficiency Improvement Best Management Practices (BMP).* The BMP approach was modeled after that used in California by the California Urban Water Conservation Council (CUWCC) [2]. The agreed-upon BMP for the Federal sector were developed using the CUWCC BMP as a starting point and modified using other Federal-based guidelines such as the GSA Water Management Guide [3] and The Water Conservation - Military Handbook 1165 [4]. The BMP does not require setting a numeric reduction goal; rather it evaluates performance and success based on how many best management practices for water conservation are implemented (i.e., leak detection surveys, public information programs, plumbing retrofits, etc. [1]).

The water management plan is to be incorporated into existing facility planning processes and operating plants. It is to include applicable operations and maintenance options for reducing water use and a review of appropriate retrofit/replacement technologies for water conservation at least every two years. FEMP is also committed to supporting agencies to implement water conservation by identifying and assisting agencies to overcome major issues and barriers.

In addition to a water management plan and implementation of BMP, Federal agencies have been apprised of additional resources to meet water efficiency goals. These include:

- ✓ Guidance found in the General Services Administration (GSA) *Water Management Guide*, which provides comprehensive and detailed guidance on how Federal agencies can meet the requirements of EO 13123 [3].

- ✓ Guidance found in *The Water Conservation - Military Handbook 1165*, a technical handbook on conservation practices [4].

- ✓ Guidance found in *The Energy Resource Management Program (ERMP)/DoD Energy Managers Handbook* to incorporate water management plans into existing energy/installation/facility operating plans [5].

- ✓ Guidance found in *The Navy Water Conservation Guide*, a reference sources for conservation practices [6].

- ✓ Any technical and financial assistance offered by servicing water and energy utilities (e.g., appliance rebates, landscape design assistance, project financing, etc.)

For some Federal agencies, water conservation goals can be achieved by including water conservation projects as part of additional Energy Savings Performance Contracting strategies offered through the Department of Defense (DoD). Under the DoD contracts, the ESPC approach can, and does, include water (only) conservation projects. Within its ESPC, DoD allows bundling of water conservation projects with energy conservation projects to achieve an overall payback that falls within ESPC contract parameters. The Air Force in particular has taken advantage of water conservation within the ESPC with 21 bases currently undertaking water conservation projects/task orders within the base ESPC [7]. Most water conservation projects are a small component (in terms of installed costs/savings) of the overall ESPC and are generally implemented through a contractor who specializes in water conservation and is the second-tier contractor to the primary ESPC contractor.

Other Federal agencies (primarily non-DoD) that choose to use the DOE Super-ESPC may be more limited in the ability to incorporate water (only) conservation projects into this performance contract depending upon the interpretation of the contracting officer administrating the contract.[1] The Assistant General Counsel (GC) for Procurement and Financial Assistance has rendered a legal opinion that water conservation projects can only be included in the DOE Super-ESPC "… as long as the energy conservation or energy savings is the primary purpose of the contract, reduction in costs attributable to water conservation may be included as part of energy savings for purposes of calculating the contractor payment where such water conservation savings are integral parts of the energy project" [8]. Thus, water-savings-only projects (e.g., more efficient irrigation, low-flush toilets, leak detection and repair) where energy savings are very small (i.e., pumping) may not be allowed, depending on the review and interpretation of the proposed projects by the assigned contracting officer. Clearly, however, water savings projects with primarily energy savings driving the economics (e.g., high-performance clothes washers, low-flow showerheads) would most likely be included under the DOE Super-ESPC.

[1] For example, a DoD contracting officer may allow water-only projects implemented at a DoD site that chooses to use the DOE Super-ESPC contract vehicle.

The Office of Management and Budget (OMB) has also provided ESPC Guidelines on Recurring Legal Issues related to water conservation measures [9]. Consistent with the OMB, the Department of Energy General Counsel for Procurement and Financial Assistance has stated that "Water conservation may be a subpart of an energy conservation measure so long as the primary purpose of the project is energy cost or use saving." And furthermore …"reduction in costs attributable to water conservation may be included as part of energy savings for purposes of calculating the contractor payment where such water conservation savings are integral part of the energy project."

The following summarizes the current state of water conservation policy:

- ✓ E.O. 13123 requires a potable water use baseline to be developed and encourages water conservation at Federal agencies.

- ✓ FEMP has responded to the E.O. with guidance on the establishment of the water use baseline, guidelines for developing water efficiency goals through a site water management plan, and the deployment of BMPs, adopted from the CUWCC-developed BMP.

- ✓ Many Federal agencies, particularly DoD, can and include integrated water conservation measures into ESPC activities taking place at the sites. Many projects involve bundling water conservation measures with water/wastewater (only) dollar savings with energy conservation measures to meet ESPC economic criteria.

- ✓ DOE and other Federal agencies deploying the Super-ESPC may be precluded by GC and OMB rulings from incorporating water (only) conservation technology into the ESPC unless there is a "primary" energy saving component associated with that water savings project or technology or allowed by the contracting officer per their discretion.

3.0 Appropriate Water Conservation Technologies, Savings, and Applications

Table 1 summarizes the most common and appropriate technology-specific water conservation technologies for the Federal sector. This table also provides data on a range of estimated savings and the applications for the technologies.

The following descriptions are brief summaries of process-oriented/site-specific water conservation technologies and techniques that are generally cost-effective and have appropriate application in the Federal sector. These technologies are generally site-specific and their application can result in significant cost-effective water savings. However, due to their site-specific nature, the potential savings are not easily quantified and thus are not included in the determination of water saving potential in the Federal sector. Thus, the savings potential determined is conservative; significantly more water savings may be possible by incorporating site-specific/process-oriented technologies.

3.1 Cooling Tower Management

Cooling towers are often one of the largest water users for large office buildings, hospitals, and industrial-type facilities. Water is lost in a cooling tower through evaporation, bleed-off, and drift. As water is evaporated through the tower, dissolved solids remain in the system and build up over time. To maintain proper water quality, the water must be purged through the "bleed-off." Several technologies and techniques can be used to maintain proper water quality and reduce bleed-off. These are briefly described below.

- ✓ Chemical Treatment: sulfuric acid or absorbic acid adjusts the pH of the system, limiting scale buildup, thus reducing bleed-off.

- ✓ Side Stream Filtration: filters out sediment and returns filtered water back to tower to reduce the amount of bleed-off needed.

- ✓ Copper Silver Ionization and Zeolite Media: an alternative to chemical treatment—copper/silver ions kill bio-matter to reduce scale build-up and also act as seed crystals for the formation of scale (calcite); crystallization is completed in the zeolite media and backwashed out of system daily.

- ✓ Ozonation System: an alternative to chemical treatment—ozone disinfects water supplies to reduce bleed-off (reduced chemical cost is an added benefit to the ozone method).

Table 1. Water Conservation Technologies for Federal Applications

Technology Category	Specific Type	Federal Application (building type)	Water Usage		Savings Potential	Comments
			Traditional Fixture	New Fixture		
Faucets	Aerator	All buildings with sinks (except possibly hospitals) [4]	3 gal/min	0.5-2 gal/min	~1-6 gallons per day	Simple and very cost-effective retrofit.
	Self-Closing	Any facility with high restroom usage: barracks, offices, recreation facilities, or service	3 gal/min	depends on aerator, as low as 0.5 gpm	~1-6 gallons per day	Manual fixture that stops water flow after specified period of time once the faucet on/off control is depressed.
	Sensored	Any facility with high restroom usage: barracks, offices, recreation facilities, or service	3 gal/min	depends on aerator, as low as 0.5 gpm	~1-6 gallons per day	Sensor activates faucet when it detects movement at sink, and water flows for a specified time.
Showerheads	Ultra-Low Flow	Barracks	3.5-5 gal/min	1.5-2.5 gal/min	8-28 gallons per use (based on 8-minute shower)	Showerhead flow rate decreases over time due to scale build-up. Flow rate at replacement may be 75% of manufacturer rated flow.
Toilets	Ultra-low Flush Tank	Residential housing	Pre1980 5-7 gal/flush 1980-91 3.5-5 gal/flush	1.6 gal/flush	5.4-1.9 gallons per flush	Historically, there has been some concern of “double-flushing” but newer models are designed to eliminate this problem.
	Pressur-ized	Commercial facilities and barracks	Pre1980 5-7 gal/flush 1980-91 3.5-5 gal/flush	1.6 gal/flush	5.4-1.9 gallons per flush	Supplemental supply-line pressure used to assist in flushing.
	Flush Valve	Commercial facilities and barracks	Pre1980 5-7 gal/flush 1980-91 3.5-5 gal/flush	1.6 gal/flush	5.4-1.9 gallons per flush	Valve acts as a flow reducer, yet flushing action still effective.
Urinals	Ultra-Low Flush	Commercial facilities and barracks	1.5-3 gal/flush	1 gal/flush	2-0.5 gallons per flush	Proven technology in widespread use.
	Waterless	Commercial facilities; remote application with limited water and high use	1.5-3 gal/flush	0 gal/flush	3-1.5 gallons per flush	Some maintenance and user acceptability issues but increasing in use in Federal sector.
Clothes Washers	High Perform-ance	Barracks, lodging, recreation facilities	Vertical axis: 35-55 gal. per load	High Performance: 18-25 gal. per load	10-37 gal/load (FEMP Tech. Impl. Project)	Big water+energy savings from high number of loads/day offsets increased first cost. Front and top loaders available.

3.2 Boilers and Steam Systems

Large Federal facilities often use boilers and steam systems such as central plants, hospitals, large office buildings, barracks, research and development facilities, and industrial and process plants. The amount of water that is consumed by the system depends on the size and water quality, and whether a condensate return is installed and maintained properly. The following bullets briefly describe the techniques that can be used to save water in boilers and steam systems.

- ✓ Proper Maintenance: Routinely inspect and maintain steam traps, steam lines, and condensate pumps.
- ✓ Leak Detection and Repair: Routinely inspect for leaks in condensate return line and steam lines.
- ✓ Condensate Return: Properly maintain condensate return, which recycles condensate for reuse in the system thus reducing water and chemical consumption and cost.
- ✓ Blow-down: Minimize blow-down by maintaining adequate water quality through routine inspection and maintenance of boiler water and fire tubes (reducing scale build-up), continuous monitoring and skimming of the blow-down, and automatic chemical treatment to control water quality of makeup water.
- ✓ Steam Tracers: Shut off steam tracers in the summer. (Steam tracers are used for freeze protection in the winter.)
- ✓ Boiler Efficiency and Size: Replace boilers that are inefficient or over-sized to reduce water requirements.

3.3 Efficient Irrigation

Many Federal facilities have irrigated landscape—office buildings and hospitals usually have peripheral turf or landscaped beds and military bases commonly have recreation fields and golf courses. These irrigated areas are often sources of large water consumption and are prime targets for efficiency measures. The following list is typical technologies and techniques that can help to significantly decrease water irrigation consumption. This is commonly undertaken through Xeriscaping™.[1]

[1] Xeriscaping = Quality landscaping that conserves water and protects the environment.

✓ The seven principles of Xeriscaping are:

1. Appropriate Design: Use a design that considers soil types and drainage, limits turf area, etc., so that landscaping requires limited irrigation.

2. Soil Improvements: Apply appropriate nutrients to soil to help maintain healthy plants so that minimum water is required.

3. Reduced Turf Area: Limit turf to areas for recreation purposes only.

4. Mulching Beds: Mulch reduces moisture evaporation off surface of beds and controls weed growth.

5. Efficient Irrigation: (also see retrofit options below)

   - Early morning or late evening watering reduces evaporation.
   - Automatic irrigation controls.
   - Appropriate watering schedule to fit plant need and climate
   - Deep watering less often.
   - Soil moisture sensor (tensiometer) or rain sensor connected to controls to avoid over-watering.

6. Climate-appropriate plants: Native and other low-water-demand plants that are specifically geared for the particular region reduce both water requirements and maintenance.

7. Maintenance:

   - Proper maintenance and adjustments of sprinkler heads ensures appropriate watering.
   - Routine inspection of irrigation system for leaks and broken heads.
   - Maintain weeds, fertilize properly, and prune as recommended.

✓ Efficient Irrigation Retrofit Options:

- Low-Volume Drip System: Applies water at a constant rate directly to the root zone of the plant, eliminating runoff and over-spray and limiting evaporation

- Sub-Surface Drip System: Delivers water to root zone of the plant through underground piping, eliminating runoff, over-spray, evaporation and reducing maintenance requirements.

- Reuse System: Reuses water from other applications, such as cooling tower bleed-off or other reclaimed water, to irrigate recreational fields or golf courses. (For example, Ft. Carson Army Base uses treated water from the wastewater treatment plant to irrigate the base's golf course.)

3.4 Ozonated Laundering

Ozone acts as biocide destroying bacteria by rupturing cell membranes. In this way, ozonated laundering systems act as a bleaching agent that disinfects fabric. Ozonated laundering systems are most appropriate for applications where laundry does not get overly soiled and where disinfection is an important feature that is needed such as hospitals. Also, ozone laundering is appropriate for facilities that launder large amounts of towels and sheets such as barracks and other lodging type buildings.

Key benefits to ozonated laundering are:

- ✓ Water Savings: Ozone process requires no rinsing.

- ✓ Energy Savings: Heated water is not required in the ozone process because cold water absorbs more ozone.

- ✓ Elimination of Detergent: Ozone replaces the need for detergent (except in heavily soiled clothing where detergent is combined with ozone).

3.5 Leak Detection and Repair

Water distribution systems often are huge sources of water loss, especially in the case of military bases that have old (pre-1940s) systems. Leaks often occur from loose joints or service connections in the system and corrosion, splits, and cracks along the piping wall. Typically, leak detection is done as part of a comprehensive water audit to help determine the source of unaccounted-for water consumption at the site. Leak detection is often done by outside contractors because determining the exact location of a leak requires training and appropriate tools. Sample leak detection technology includes listening devices—sonic for metal piping or ultrasonic for PVC piping—aerial thermal imaging, and sub-floor water leak alarm systems.

A study done by the U.S. Army Corps of Engineers' Construction Engineering Research Laboratory calculated water losses at four Army sites. Water losses ranged from 9% to 36% of the total water consumption at the particular site. Leak detection and repair projects at four Federal sites during 1995–1999 show an average water loss recovery of 144,000 gallons/day and a payback after repair of 18 *days* [10].

Some of the key benefits to regular system audits, leak detection, and repair programs are as follows:

- ✓ reduced water loss
- ✓ lowered cost for quality water (pumping, treating, etc.)
- ✓ reduced operating costs
- ✓ increased knowledge of system
- ✓ reduced legal liability and potential property damage due to leaks, thus lowering insurance costs
- ✓ safer and more reliable system (less likely to have contaminated water supply, increased reliability of fire protection systems)
- ✓ better use of resources that ensures more reliable supply for the future.

4.0 Cost-Effectiveness of Implementing Water Conservation

To determine the cost-effectiveness of implementing water conservation in the Federal sector, an estimate of the installed cost of water conservation technologies was developed. With that information, and assumptions on the remaining life of current technology and the current discount rate, the cost-effectiveness was calculated based on a range of water/sewer rates. From this analysis, data were developed that show those technologies that are cost-effective above minimum water/sewer costs of $1/1,000 gallons and $2/1,000 gallons. Data are also presented on Federal water/sewer rates and their changes in the past several years to document the wide variance in rates across the Federal sector.

4.1 Federal Water/Sewer Rates and Costs

Water rates across the Federal sector vary widely and the variance is heavily influenced by whether water is purchased (most likely from a municipal supplier) or generated on site. Water rates are also influenced by geographic location and agency contracting mechanism. Two of the larger Federal water users, GSA and DoD, highlight the wide variance in water cost.

4.1.1 General Services Administration

GSA predominantly purchases water from local suppliers and municipalities, which results in a higher-than-average cost. A 1999 survey of GSA water rates found a range of combined water and wastewater costs of $2.75/1,000 gal to $7.01/1,000 gal [11]. Table 2 presents these data by GSA region for the years 1993 and 1999. It is interesting to note the 22% increase in combined cost over this 6-year period.

4.1.2 Department of Defense

DoD rates are notably lower than GSA rates. One study surmises that this is because DoD does not include capital amortization in its rate calculation [12]. In contrast, the higher GSA rates not only include capital amortization but also recent infrastructure upgrade costs.

One study of DoD rates [13], in this case U.S. Army Forces Command (FORSCOM) sites, found combined water and wastewater rates at 10 Army bases to vary between a low of $0.55/1,000 gal to a high of $4.34/1,000 gal. The study found the variance to be more a function of inconsistencies in rate calculation from site to site than in actual cost of water. The weighted average combined cost from these 10 FORSCOM sites is $1.29/1,000 gal. Table 3 shows the findings of this study.

Table 2. Average GSA Combined Water and Sewer Rates

GSA Region #-Center	1993 Combined Water Sewer Rate $/1000 gal	1999 Combined Water Sewer Rate $/1000 gal	Percent Change
1 - Boston	$7.16	$7.01	-2%
2 - New York	$2.35	$3.01	28%
3 - Philadelphia	$2.80	$3.97	42%
4 - Atlanta	$2.82	$4.15	47%
5 - Chicago	$2.31	$2.87	24%
6 - Kansas City	$2.19	$2.75	26%
7 - Ft. Worth	$3.87	$4.15	7%
8 - Denver	$1.22	$3.49	186%
9 - San Francisco	$4.39	$4.16	-5%
10 - Seattle	$3.86	$5.45	46%
11 - D.C.	$4.67	$4.91	5%
Average	**$3.42**	**$4.17**	**22%**

Table 3. FORSCOM Average Water and Sewer Rates

Installation	Average Water Use (million gal/day)	Water Rates ($/1,000 gal)	Sewer Rates ($/1,000 gal)	Combined Water Sewer Rates ($/1,000 gal)
Fort Bragg	6.06	$0.34	$0.21	$0.55
Fort Campbell	4.67	$0.43	$0.54	$0.97
Fort Carson	2.84	$1.82	$1.42	$3.24
Fort Dix	1.92	$1.81	$2.53	$4.34
Fort Drum	2.02	$0.34	$1.12	$1.47
Fort Hood	6.22	$0.27	$0.32	$0.59
Fort Lewis	6.01	$0.23	$0.45	$0.68
Fort Polk	5.02	$0.92	$0.91	$1.83
Fort Sam Houston	3.40	$0.34	$1.42	$1.76
Fort Stewart	3.11	$0.14	$0.44	$0.58
Weighted Average		**$0.55**	**$0.74**	**$1.29**

A follow-on study to the FORSCOM rate study highlighted the importance of proper rate calculation [14]. This analysis details the proper methodology for calculating the "marginal cost" of water and wastewater when evaluating projects. ***The marginal, or avoided, cost is the appropriate cost to use in conjunction with the estimated water cost savings in a performance contract so that the dollar value of those savings can be accurately calculated.*** For this reason, it is important that only the variable costs, which are based on the amount of water used, are included. A cost is considered variable if the amount of water used affects the dollar amount paid. Fixed costs associated with the water bill, such as minimum monthly charges, labor, or infrastructure debt service requirements, will be paid despite any increase or reduction in water usage, and therefore do not affect the marginal cost.

4.2 Technology Cost-Effectiveness Assessment

The technologies examined in this analysis were standard "off-the-shelf" water conservation measures. While engineered solutions (i.e., conservation measures designed for a specific application or water-using process at a specific site) are acknowledged to hold significant potential for water savings in the Federal sector, their site-specific nature would have made it difficult to analyze and quantify savings. It should be noted that while leak detection was not included in this analysis due to its site-specific nature, it has one of the greatest potentials for water savings of any water conservation measure. This is particularly true in the Federal sector where the infrastructure is old and maintenance is often neglected.

A 25-year life-cycle cost analysis was performed to determine cost-effectiveness. Once developed, the analysis was performed for combined water and wastewater costs ranging from $1.00/1,000 gal to $6.00/1,000 gal. A key finding of this analysis is that all but one of the conservation measures examined (sensor closing faucets) proved life-cost effective at combined water and wastewater costs of $2.00/1,000 gal or greater. A summary of the results of this analysis is presented in Table 4.

As previously mentioned, additional cost-effective water savings are expected from the engineered water conservation solutions; however, their site-specific nature precludes their inclusion in this analysis and thus their quantification.

4.3 Financial/Financing Issues

An underlying issue concerning the cost-effectiveness of water conservation projects is the financing aspects and/or the availability and cost of money for purchasing and carrying the debt of the installed technologies over the lifetime of the performance contract. Most (if not all) private-sector water efficiency/conservation service providers must go to the marketplace to acquire financing; few providers have the resources to self finance and if they do, the size of the project that is self-financed would typically be small.

Table 4. Water Conservation Measures Cost and Cost-Effectiveness

Technology Category	Specific Type	Savings Potential	Technology Installed Cost	Life-Cycle Cost Effective at $1/1,000 gal	Life-Cycle Cost Effective at $2/1,000 gal
Faucets	Aerator	~1 - 6 gallons per day	$13	Yes	Yes
	Self-Closing	~1 - 6 gallons per day	$127	Yes	Yes
	Sensored	~1 - 6 gallons per day	$390		**No**
Showerheads	Ultra-Low Flow	8 - 28 gallons per usage*	$23	Yes	Yes
Toilets	Ultra-Low Flush Tank	5.4 - 1.9 gallons per flush	$208	**No**	Yes
	Pressurized	5.4 - 1.9 gallons per flush	$278	**No**	Yes
	Flush Valve	5.4 - 1.9 gallons per flush	$303	**No**	Yes
Urinals	Ultra-Low Flush	2 - 0.5 gallons per flush	$370	Yes	Yes
	Waterless	3 - 1.5 gallons per flush	$480	**No**	Yes
Clothes Washers	High Performance Front or Top Loading	High-performance machines can save 50% of water and 60% of energy compared to standard machines	$1,000	Yes	Yes

Private sector water efficiency/conservation service providers who are currently partnering with ESCOs and/or utilities in Federal facility water savings projects have identified the following key financing aspects and issues that apply to water savings performance contracting [15].

- ✓ The requirement of a “guarantee” (the fixed/guaranteed savings or payment stream) to the government required in common energy savings performance contracts may increase the cost of borrowing for a stand-alone performance-based water conservation contract, depending on the size of the project (dollar volume) and credit-worthiness of the contractor. Minimization of the guarantee, or writing the contract so that if the guaranteed payment—assigned to the financier—is not met, the government will have an alternative recourse with the contractor. This approach will likely reduce the risk to the project financier. This reduced risk may in turn reduce the financing costs for the project.

- ✓ The larger the project, the lower the financing costs. Thus, bundling small projects into larger projects or bundling projects across several sites to create a single large project will reduce financing by ~4-5%. Accordingly, small projects (<$1M) could be financed for

~13-14% whereas projects in the range of $5-10M could be financed for ~8-10%. Even more attractive financing could be obtained for a single "project" that is $25-50M rather than 10 projects that are $2.5-5M.

- ✓ Projects under a 10-15 year contract are more attractive to financial markets than projects with a 15-20 year contract.

- ✓ The financial stability and the size of the companies engaged in providing performance contracting services are important for obtaining the best rates.

- ✓ Selecting the most appropriate and thereby likely reducing measurement and verification (M&V) requirements may significantly reduce many of the most costly requirements. This in turn may reduce the overall project risk and thus the overall project costs.

- ✓ Tax-exempt leasing (of equipment) is an option that is available to the Federal/public sector and financing for these projects is generally available at 30-70 basis points (0.3-0.7%) above the prime rate. A life-cycle cost/net present value analysis of purchasing through a traditional performance contracting approach vs. leasing under a performance contract—using the correct financing costs—needs to be undertaken to make a determination whether or not leasing is a cost-effective option.

- ✓ Most technology-specific retrofits can be cost-effective under a performance contract at water/sewer costs as low as $1/1,000 gallons. Of course, the cost of financing will impact this cost-effectiveness.

5.0 Cost-Effective Savings Potential in the Federal Sector

To ascertain the cost-effective water conservation potential in the Federal sector, the total Federal water use was first estimated. Next, the cost-effective savings percentage (of the total water use) was calculated to determine what percentage could be saved cost-effectively. Factors were then applied to this value to account for a certain level of existing penetration of efficient technologies, and to take into account the water use by equipment not covered by this analysis (e.g., site-specific processes and engineered solutions for conservation).

This analysis was done at a very high level encompassing the entire Federal sector. As such, the results are not specific to any given site or Federal agency; rather they are general findings across the entire Federal sector. Furthermore, due to the magnitude of the Federal sector, certain simplifying assumptions were necessarily made—these are discussed below. Finally, the savings potential for any given site should be looked at given that site's specific situation, including specific equipment use and age, as well as the marginal water/wastewater cost, environmental issues, etc.

The assumptions used in this analysis are presented below; where assumptions were made they were done so conservatively.

- ✓ Technologies analyzed are non-engineered solutions, i.e., off-the-shelf retrofit solutions.
- ✓ Technology use profiles are based on typical office/administration building technology (fixture) use profile.
- ✓ Existing technologies are assumed to have a 50% remaining life. This assumes a normal distribution of building and equipment ages across the entire Federal sector.
- ✓ Life-cycle cost assumes a Federal discount rate of 3.4% [16].
- ✓ Only water/wastewater savings are included; energy savings associated with hot water-using technologies were not included.
- ✓ Future water costs are *not escalated*, thus findings represent conservative estimates.
- ✓ Penetration of efficient technologies in the Federal sector is estimated at 25%. This assumption was based on work performed at other Federal sites [13, 14].
- ✓ Off-the-shelf (non-engineered) technologies are estimated to represent 80% of Federal water-using technologies. This assumption was based on work performed at other Federal sites [13, 14].

- ✓ Total water use in the federal sector is conservatively estimated at 300-450 million gallons per day [12].

Total water cost in the Federal sector is conservatively estimated at $229-$500 million per year [12]. Using the above assumptions, this analysis found that 30% of the current water use by the Federal sector could be saved in a cost-effective manner. While these savings should be considered as conservative, because the analysis did not calculate the savings for all water uses, principally process water and site-specific water uses, they represent a realistic potential across the Federal sector and all fall within the range cited in the Lombardo study of 27-40% savings potential [12].

Assuming the conservative Federal water use values from the Lombardo study [12], these savings translate into a total Federal-sector conservation potential of 33-49 billion gallons per year. At an average cost of $4.00/1,000 gallons (based on a Federal water/sewer rate recommended by FEMP [17]), the Federal-sector cost-effective conservation potential today is $132-$196 million per year (in 2001 dollars). While not considered a true marginal cost, the value of $4.00/1,000 gallons is considered reasonable and is consistent with other Federal program water cost findings. Clearly, future efforts at valuing water savings in the Federal sector should include a study of Federal agency marginal water costs.

6.0 Water Conservation Implementation/Deployment Strategies

There are many strategies by which a Federal site can implement water conservation to achieve the requirements of E.O. 13123. Some of these strategies have already been noted above. These possible strategies are summarized in Table 5 below. For each strategy, it is noted whether or not there is existing legislative authority to implement and whether or not the strategy requires appropriated (Federal) capital funding and/or site staff (labor) to implement. Comments on the strategy and the potential for the strategy to have a significant impact on water conservation and E.O. 13123 goals are also provided where appropriate.

Table 5. Water Conservation Project Implementation Strategies

<table>
<tr><th rowspan="2">Strategy</th><th rowspan="2">Legisla-tion in Place? (Y/N)</th><th colspan="2">Requires Federal Appropriated Funds? (Y/N)</th></tr>
<tr><th>Capital</th><th>Site Staff</th></tr>
<tr><td>Site Operations and Maintenance (O&M)</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td colspan="4">Comments: EPact 1992 requires all Federally owned facilities to implement all cost-effective water conservation measures with a payback of 10 years or less. The FEMP BMP strategy supports EPact and incorporates O&M as a key element to water conservation. This strategy requires water management plan and commitment to identify and “fence” funding for water conservation projects. HQ and/or site staff resources are needed to design, procure and implement. E.O. goals may be reached if plan is carefully followed and funding is available. Currently there is no recourse or penalty if plan is not followed.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Energy Conservation Investment Program (ECIP)</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td colspan="4">Comments: This DoD (only) funding traditionally is limited and was not appropriated in FY00. Project approval is predicated on a high investment/savings that is calculated based only on energy savings. Thus, only water conservation projects with substantial energy savings are likely to be funded (e.g., clothes washers). E.O. goals are unlikely to be reached with this strategy.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Super-ESPC (DOE)</td><td>Y</td><td>Y</td><td>Y – to agree on projects/delivery orders and manage the contract.</td></tr>
<tr><td colspan="4">Comments: The DOE General Counsel opinion [8] may preclude inclusion of water-only conservation projects in projects unless a “significant” portion of the savings is energy or are allowed by the contracting officer at their discretion. The E.O. water conservation goal may be difficult to achieve under this strategy for those agencies using the DOE Super-ESPC unless water-only projects are allowed by the contracting officer.</td></tr>
</table>

Table 5. Water Conservation Project Implementation Strategies (contd)

<table>
<tr><th rowspan="2">Strategy</th><th rowspan="2">Legislation in Place? (Y/N)</th><th colspan="2">Requires Federal Appropriated Funds? (Y/N)</th></tr>
<tr><th>Capital</th><th>Site Staff</th></tr>
<tr><td>ESPC (DoD)</td><td>Y</td><td>Y – up-front investment is required for administration and start-up activities.</td><td>Y – required to assist in contract management.</td></tr>
<tr><td colspan="4">Comments: DoD is allowing water conservation projects to be included in its ESPC. Thus, water conservation projects may be “stand-alone” or bundled with energy (only) conservation projects depending on the economic figures of merit. Performance contracting can be combined with any utility incentives/rebates to improve cost-effectiveness. Depending on the verification requirements, economics and payback, E.O. water conservation goals for those agencies that can use the DoD ESPC may be achievable with this strategy.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Water Utility</td><td>Y</td><td>N</td><td>Y – work with servicing utility to identify applications and acquire incentives.</td></tr>
<tr><td colspan="4">Comments: Servicing water utility programs such as technical assistance, financing, and rebates/incentives are generally made available to Federal customers served by the utility. Most water utilities are municipal/public utilities and therefore do not offer financing. Specific technologies generally include low-flush toilets, aerators, showerheads, and high-performance clothes washers. These are either available as giveaways or with rebates. Rebates and incentives are also many times available for engineered solutions depending on the savings. Most water utilities have not worked with Federal customers and those who have report difficulty by Federal customers receiving rebates. There is no evidence of water utilities currently offering financing to a Federal customer. E.O. conservation goals are unlikely to be reached solely through a water utility partnership.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Electric Utility</td><td>Y</td><td>N</td><td>Y – work with servicing utility to identify/ approve applications and manage contract.</td></tr>
<tr><td colspan="4">Comments: Water-conserving technologies (e.g., clothes washer) rebates are available from some electric utilities, particularly those in the West, New England, and Midwest. Electric utilities and their ESCOs have proposed and implemented water conservation projects as part of site-wide performance-based projects. Energy utilities incorporate both in-house technical staff as well as engage the services of a third party water conservation service provider when undertaking water conservation projects.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Water Savings Performance Contractor</td><td>N</td><td>N</td><td>Y – work with contractor to identify/ approve applications and manage contract.</td></tr>
<tr><td colspan="4">Comments: There are several firms capable of developing and undertaking a stand-alone water savings performance contract in the Federal sector. Among these firms are: Water Management Services, Inc., San Diego, CA; Water Management, Inc., Alexandria, VA; Water and Energy Savings Corporation, Lake Lure, N.C.; Energy Masters International, Inc., St . Paul, MN; Utility Services Associates, Seattle, WA; CTSI Corporation, San Diego, CA; Reliance III, Austin, TX; American Leak Detection, Palm Springs, CA; SAMCO Leak Detection Services, Austin, TX; Field Conservation Systems, Milford, OH; and Metrotech, Sunnyvale, CA.

These firms range from those that implement all technologies to technology-specific (e.g., leak detection) services. Some of these firms currently are engaged in water conservation under subcontract to ESCOs and utilities at Federal sites. Others are engaged in water conservation in the Federal sector in HUD public housing under the legislative authority granted by HUD. These HUD water projects also generally involve energy savings projects. Performance contracting can be combined with any utility incentives/rebates to improve cost-effectiveness. E.O. goals could be achieved depending on financing, economics, and verification and guarantee payment requirements.</td></tr>
</table>

7.0 Needs and Recommended Requirements for Successful Performance Contracting

If FEMP determines that a technology-specific water conservation performance contracting approach should be developed and the legislative authority pursued, then that decision should be based on factors such as economics and cost-effectiveness, demand, and need by the Federal sector in order to meet water conservation goals in a timely manner. At the same time, there should be serious interest and capabilities by providers of water conservation performance contracting services. There are several factors and requirements that should be considered in the decision-making process, including:

- ✓ the maturity, availability and savings potential of the appropriate technologies and engineered conservation solutions. As noted in Section 5.0, most technologies and engineered solutions are proven off-the-shelf or installed and evaluated in field installations, are cost-effective, and are generally familiar and acceptable to the Federal sector.

- ✓ the water cost and use savings potential in the Federal sector. As noted in Sections 4.0 and 5.0, the cost-effective savings are substantial and the environmental benefits (Section 8.0) are nearly all positive.

- ✓ the availability of service providers. There is a cadre of private-sector providers of water conservation performance contractors with interest in participating in performance contracting in the Federal sector, and there is adequate resources and financing available to implement. As noted in Section 6.0, there are several private-sector firms currently engaged in a limited amount of water conservation projects in the Federal sector as subcontractors to ESCOs and to servicing utilities. There is considerable interest in expanding this activity throughout the Federal sector and, according to the water conservation service providers, there are sufficient resources and financing to undertake this activity [17, 18].

- ✓ the ability to "bundle" water conservation and energy conservation projects. There are significant benefits to bundling if both water savings and energy savings are included in a contract. Combining a long-payback project with a short(er) payback project will help the overall project payback meet the economic criteria of the performance contract. Many times, a water (only) conservation project (e.g., low flush toilets, leak repair) has the short(er) payback and thus can be an advantage to bundle with a cost-saving , but marginal-payback (based on contract criteria) energy conservation project.

In addition to the above factors and requirements, a key requirement for a successful performance contracting approach is that the contract and contracting mechanism need to be as streamlined as practicable yet remain in compliance with Federal acquisition/contracting regulations and requirements. Specifically, the following contract features, terms, and conditions should be considered [18, 19]:

- ✓ Make the contract look like the private-sector contracts the water performance contract service providers are most familiar with negotiating and executing.

- ✓ Make the process as simple as possible with simple language and few requirements that lengthen the proposal and award process. For example, minimize requirements to provide detailed and complex drawings and associated detailed costs. Minimize the requirement that <u>all</u> costs be broken out in a project proposal.

- ✓ Include all decision-makers in the contracting process in the initial and final presentations of the proposals. This will speed up the proposal process.

- ✓ Shorten the time for negotiations and award. During the time for drawn-out negotiations, technology costs can increase, possibly at a rate greater than the water/sewer costs, thus reducing the payback and increasing the payback time.

- ✓ Include all energy savings associated with water savings in the determining cost effectiveness and payback of water conservation projects. This will allow all savings to the site or agency to be captured in the economic criteria.

- ✓ Create an approach that provides common guidance for the development of the baseline water usage in a building or a site. Currently, the baseline water use is an elusive and difficult to quantify value for most federal agencies. (FEMP has currently addressed this issue through recent guidance issued to federal agencies [1].)

- ✓ Consider the concept of "bundling" projects across an agency or site. Bundling projects will likely create a large enough capital outlay that financing costs (i.e., cost of money) could be reduced considerably (up to 2-3 percent) [15].

- ✓ Include both engineered/site-specific solutions (e.g., leak detection, cooling tower water recycle) and off-the-shelf technology (e.g., low-flush toilets, high-performance clothes washers) in all contracts, thus capturing nearly all potential cost-effective conservation.

- ✓ Include "qualified" measures that result in dollar savings from switching to the use of reclaimed or recycled water for appropriate applications (e.g., golf course irrigation), sewer effluent penalty reductions in utility bills, rate schedule negotiations, operation and maintenance cost savings, and any ancillary (quantifiable) monetary benefits from any measures such as reduced maintenance or chemical usage in a federally owned and operated wastewater treatment plant.

- ✓ Consider requiring long-term operations and maintenance to ensure maintaining the savings by the technologies, particularly from fixture retrofits. Any domestic fixture retrofit technology should be required to be capable of a robust, accurate, and sustained performance.

- ✓ Properly treat water/wastewater rates and rate escalation in determining projects and project paybacks. The generally accepted metric for determining life cycle cost effectiveness (for projects) is the *marginal* (rather than average) cost of water and sewer. Water and sewer costs also will likely escalate over the time of the project life.

- ✓ Require a reasonable and appropriate level of M&V commensurate with the type of project. Provide guidance for M&V. The measurement protocol should include point-of-service metering on a sample of end-user service points and use engineering calculations and modeling where it is deemed most appropriate and where metering would be cost prohibitive.

- ✓ Include the concept of "service" within a performance contract, which encompasses *chaufage*-type concepts where the contactor acts as the "utility agent" paying the water/sewer bills along with a performance-based lease or rent for "above grade performance" and penalties for not meeting pre-negotiated "goals." Performance factors could include a gallons/unit/time period maximum flow, hot water temperature range set point, hot water demand wait time, sanitary system gallons/time, etc.

- ✓ Allow any and all servicing utility (water, sewer, and energy) incentives for water saving (and water/energy saving) technologies and strategies to be captured by the contractor and included in the cost-effectiveness analysis.

Overall, the most important issue, if a performance contracting approach is pursued, is to create the contract requirements and a process that will be attractive to all potential service providers in a highly competitive environment. This environment should allow the providers a wide and flexible range of water-related conservation and cost saving opportunities that bring innovation and creativity to the federal sector customers while at the same time help the federal customer quickly and cost effectively reach water conservation goals.

8.0 Environmental Benefits and Impacts of Water Conservation

The majority of water conservation and conservation project activities at Federal facilities provide positive environmental impacts to the site as well as to the water/sewer services provider to the site. Even if the site supplies its own water and treatment, there are environmental impacts to the community "outside the fence" that can be impacted by the use of a common water source or aquifer. For example, sites near salt water may have salt-water intrusion issues and sites in agricultural areas may have irrigation issues.

The following are the beneficial impacts from water conservation at Federal sites:

- ✓ Reduced discharge of treated water from wastewater treatment plant into discharge stream.
- ✓ Reduced chemical use at water supply and wastewater treatment plants.
- ✓ Reduced demand on water supply source (river, aquifer, reservoir) thus extending the source for future use and thus preserving increasingly endangered aquatic ecosystems.
- ✓ Reduced pumping requirements, most of which are supplied by electric motors. This, in turn, will reduce the use of electricity and thus, reduce the emissions from electricity generation, transmission and distribution.
- ✓ Improved water quality (due to reduced water requirement and reduced discharge) for urban and agricultural uses.
- ✓ Reactivated and/or maintained ecological processes and structures that sustain healthy fish, wildlife, and plant populations (from increased water flows, reduced temperature changes due to discharges, etc.).
- ✓ Improved air quality from the reduced (long-term) need to construct new water supply sources and/or wastewater treatment facilities.
- ✓ Reduced noise from construction of future new water sources and/or wastewater treatment facilities.
- ✓ More efficient allocation of existing water supplies (i.e., no new sources required) addressing some beneficial uses including population growth needs.

The following are the potential adverse environmental impacts from water conservation at Federal sites:

- ✓ Short-term increase in air pollution, energy use, and noise due to manufacture, construction, and installation of efficiency measures.
- ✓ Short-term increase in traffic due to installation of efficiency measures at the facility or site.
- ✓ Possible site-specific undesirable increase in the water table level at aquifers used for water supply or holding/retention ponds used for irrigation water.
- ✓ Possible site-specific increase in mosquito breeding habitat for certain surface water supplies or discharges.
- ✓ Construction of facilities for storage of gray water and possible odor from use of recycled, re-used and/or gray water for irrigation.

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Appendix A

Water Conservation at Federal Sites

Appendix A

Water Conservation at Federal Sites

This appendix describes four examples of Federal water conservation projects – Fort Polk Joint Readiness Training Center in Louisiana; Sandia National Laboratory in Albuquerque, New Mexico; the Denver Federal Center; and the Metropolitan Development and Housing Agency in Nashville. These four projects have different contracting mechanisms and funding sources and serve as illustrations to show the variety of methods that have been employed to implement water-efficient technologies in the Federal sector.

Fort Polk Joint Readiness Training Center

The Joint Readiness Training Center at Fort Polk, Louisiana, is the national center for soldier combat training, housing thousands of military staff each year. Fort Polk has 31 barracks and other support facilities that use a variety of water-using technologies. Fort Polk has implemented a water efficiency project using performance contracting through the U.S. Army Corps of Engineers' Energy Savings Performance Contract. Water-efficient technologies are being implemented including toilets, showerheads, and faucets. The following list summarizes project details and savings:

- ✓ Johnson Controls contract through Huntsville ESPC.
- ✓ Measures implemented in 31 barracks and other support facilities.
- ✓ Conservation measures: low-flush toilets, low-flush urinal flush valves, low-flow showerheads and bathroom faucets, horizontal axis clothes washers, and hot water loop controls.
- ✓ Total annual savings: $357,000 in water and sewer costs.
- ✓ Total annual water savings: 40 million gallons.
- ✓ Total energy savings: 43,500 therms of natural gas.
- ✓ Horizontal axis washers:
  - Water and sewer savings: 19 million gallons annually.
  - Natural gas savings: 46,000 therms annually.
  - Electricity savings: 135,000 kWh of electricity annually.

- ✓ Hot water loop control (engineered project):
  - Controls that gather historical data on shower use to control water temperature when showers are typically used.
  - Natural gas savings: 517,000 therms annually.
  - Cost savings: $151,000 annually (associated with natural gas savings).

Sandia National Laboratory

Sandia National Laboratory (SNL) located in the high desert of Albuquerque, New Mexico, has instituted a progressive labwide water conservation program. The cornerstone of the program revolves around a memorandum of understanding (MOU) that SNL has entered into with Kirtland Air Force Base and the City of Albuquerque. Kirtland Air Force Base pumps water from the Middle Rio Grande Aquifer, providing water to SNL. This MOU commits SNL to reduce its overall water consumption by 30% by 2004. The nature of this water conservation effort is centered on the local climate and water resource availability of Albuquerque. A study by the U.S. Geological Survey has indicated that the level of the aquifer is dropping so fast that future water demands for Albuquerque will not be met without water conservation.

The water conservation program at SNL has implemented an extensive water resource survey that has calculated the baseline water use of the Laboratory and also identified water conservation measures. A metering system was installed to document pre- and post-retrofit water consumption so that water savings could be verified. The overall conservation program is expected to save $415,000 annually. To date, SNL has financed all of the water projects through appropriated Federal funds, using a variety of accounts such as capital improvement and pollution prevention. The following bullets detail the water conservation efforts that have taken place thus far:

- ✓ Microelectronics Development:
  - Lab's biggest water user, consuming 110 million gallons/year.
  - Uses ultra-pure water through reverse osmosis for processing.
  - Recycle spent rinse water.
  - Improvements to filters and pumps.
  - Annual water savings: 30 million gallons.
  - Annual water and sewer savings: $78,000.
  - Annual energy savings: $22,000.
  - Payback just over one year.

- ✓ Steam Plant:
  - Leak detection and repair program.
  - Recycle spent return water for cooling bearings.
  - Annual water savings: 23 million gallons.
  - Annual cost savings: $100,000.

- ✓ Cooling Towers:
  - 23 cooling towers use 110 million gallons/year.
  - Chemical treatment to minimize bleed-off.
  - Annual water savings: 20 million gallons.
  - Chemical reduction by 35-50%.

- ✓ Fixtures:
  - Fixture replacement to study the cost effectiveness of the retrofit.
  - Retrofit took place at an office building with 300 staff members.
  - Fixtures: low-flush flush valve toilets, low-flow urinals, and automatic faucets with aerators.
  - Initial project cost: $13,000.
  - 50% reduction in water consumption.
  - Payback: 10 years.

Denver Federal Center

In 1996, the Denver Federal Center was chosen as a showcase site to demonstrate the effectiveness of water conserving technologies. This showcase demonstration project was a part of a unique partnership between FEMP, the National Renewable Energy Laboratory, the General Services Administration (GSA), the Bureau of Reclamation, the Environmental Protection Agency, Denver Water (local water utility), and several U.S. manufacturers. This partnership was established under a Cooperative Research and Development Agreement (CRADA) between the Federal agencies and manufacturers of water efficient technology. Through the CRADA, the manufacturers donated the technology and GSA covered the cost of installation. The intention of this CRADA was to demonstrate effective government and industry cooperation in deployment of U.S.-manufactured water-conserving technologies into the Federal sector.

FEMP chose a 14-story office building at the Denver Federal Center, which houses the Bureau of Reclamation and which typifies Federal office buildings. Baseline consumption was measured along with post-retrofit consumption so that accurate measurement and verification of savings could be determined. The latest indoor and outdoor water-conserving technologies were chosen. These are detailed below, along with other specifics of the project:

- ✓ Indoor technologies: Low-flush toilets, waterless urinals, and sensored bathroom faucets. (The waterless urinals were later replaced with low-flush urinals due to a problem with user acceptability. The waterless urinals were successfully reinstalled at the Carl Hayden Visitors Center at Glen Canyon Dam in Arizona. This application was more appropriate for waterless urinals because of the remote location and large number of visitors.)

- ✓ Outdoor technologies: Weather-based irrigation controls (measures the evapotranspiration rate using meteorological data to accurately determine daily water needs of plants), xeriscaped landscaping with drip system.

- ✓ Restroom savings:
  - Men's restrooms: 60% reduction in water consumption of bathrooms after replacement of toilets and urinals.
  - Women's restrooms: 40% reduction in water consumption of bathrooms after replacement of toilets.
  - Total restroom water savings: 140,000 gallons/year.

- ✓ Xeriscape Demonstration Project and Irrigation System:
  - Subsurface irrigation system (delivery of water to root zone of the plant through underground piping), eliminates over-spray, minimizes evaporation, and reduces maintenance requirements.
  - Solar-powered control system for irrigation controls.
  - Landscape area encompasses over 25,000 square feet of 100 various indigenous plants.
  - Post-retrofit water savings is currently being evaluated.

Metropolitan Development and Housing Agency (MDHA)

The MDHA chose the frozen (utility) base incentive to finance improvements of its facilities and the reduction of utility costs. The project, initiated in 1997, was undertaken by Landis and Staefa, Inc., as the prime ESCO with Water Management, Inc., a subcontractor for installation of water conservation measures.

The following measures were installed in 5,620 units:

- ✓ Energy efficient lighting.
- ✓ Water-conserving showerheads.
- ✓ Low-flush toilets.

In addition, energy-efficient refrigerators were installed in 3,480 units.

The total project cost was $11.6 million, with guaranteed savings of $18,194,000 over the 12-year period of the contract. The project is now complete and in re-payment. The actual savings for the first year were $1,310,000, which exceeded the predicted savings of $649,000. No itemized savings are available for just the water conserving projects. Savings continue to be monitored and verified by both the ESCO and the housing authority.

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