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IMPLEMENTING A WATER CONSERVATION PROGRAM ON ARMY INSTALLATIONS

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IMPLEMENTING A WATER CONSERVATION PROGRAM ON ARMY INSTALLATIONS

1. Purpose.

a. This PWTB will describe how to implement a water conservation program and provide procedures to accomplish supporting tasks such as conducting an installation water audit or implementing a water loss prevention program.

b. It is essential for personnel to understand the current state of water consumption and use on an installation to meet mandated federal goals such as reducing potable water use by 2% annually for a total reduction of 26% by 2020. Knowing the major water uses and users will help focus opportunities for meeting the required reductions. This PWTB will help installation personnel identify and implement those opportunities.

c. This PWTB complements PWTB 200-1-105, “Water-Efficient Installations” that provides a broad overview of water-efficiency guidance including a review of drivers, technology, and techniques. It also includes reference material and installation examples.

d. All PWTBs are available electronically in Adobe® Acrobat® portable document format) through the World Wide Web at the National Institute of Building Sciences’ Whole Building Design Guide (WBDG) Web page, which is accessible through this link: http://www.wbdg.org/ccb/browse_cat.php?o=31&c=215

2. Applicability. This PWTB applies to all US Army facilities engineering activities within the United States.

3. References.

a. Army Regulation (AR) 200-1, “Environmental Protection and Enhancement,” Washington, DC: Headquarters, Department of the Army, 13 December 2007.

b. AR 420-1, “Army Facilities Management,” Washington, DC: Headquarters, Department of the Army, 12 February 2008.

c. Energy Independence and Security Act, Public Law 110–140, 19 December 2007.

d. Executive Order (EO) 13423, “Strengthening Federal Environmental, Energy, and Transportation Management,” 24 January 2007.

e. EO 13514, “Federal Leadership in Environmental, Energy, and Economic Performance,” 5 October 2009.

f. Scholze, Richard, “Water-Efficient Installations,” Public Works Technical Bulletin 200-1-105, Washington, DC: US Army Corps of Engineers, September 2011.

4. Discussion.

a. Appropriate water use is an important part of resource efficiency. Overall guidance in water efficiency and water conservation is available from many sources (e.g., Scholze 2011; Federal Energy Management Program website) to enable installation personnel and Corps District planners to identify potential at their installations and to learn from experiences at other installations as well as the federal and public sectors. This PWTB helps transition those concepts into implementation of water conservation and water efficiency measures through a well-organized plan.

b. Water conservation and efficiency is required through a number of Army, federal, regional, and state mandates along with requirements such as the requirement that all new Army construction meet Leadership in Energy and Environmental Design (LEED) Silver certifiability. Water efficiency/conservation is all about maximizing the use of available water at an installation through a variety of measures to get maximum benefit.

c. AR 200-1 sets forth policy, procedures, and responsibilities for the conservation, management, and restoration of land and natural resources consistent with the military mission and in accordance with applicable federal, state and local laws and regulations regarding water resources management.

d. AR 420-1 addresses the management of Army facilities. Policies, procedures, and responsibilities for the Army Energy and water Management Program are described in chapter 22.

e. EO 13423 requires installations to reduce water use through water efficiency improvements and continues the leadership of previous EOs in requiring water reductions on federal facilities. EO 13514 builds on EO 13423 and continues to require a 2% annual reduction in potable water use on Army installations for a total reduction of 26% by 2020. Additionally, reductions are mandated in irrigation, agricultural, and industrial consumption.

f. EISA 2007 requires comprehensive energy and water evaluations/audits and the implementation of energy and water efficiency measures. It also requires putting in place plans for operation and maintenance of those measures and for measuring and verifying energy and water savings.

g. A typical water conservation plan contains the following sections: Introduction and Summary, Study Area Characteristics, Analysis of Historical and Projected Water Demand, Water Supply, Reclaimed Water Plan, Current Water Conservation Program, Alternative Water Conservation Measures, Evaluation of Long-term Water Conservation Measures, Recommended Plan, and Water Shortage Plan.

h. Appendix A contains background on water conservation and provides a typical conservation plan.

i. Appendix B describes how an audit should be conducted to allow: consumers to understand ways to improve water efficiency, an installation or water service provider to distribute conservation information and install devices, and accumulation of information on how water is used in the service area.

j. Appendix C provides a method to estimate water usage when the water supply is unmetered.

k. Appendix D lists references used in this PWTB.

l. Appendix E lists abbreviations used in this PWTB.

5. Points of Contact.

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APPENDIX A

IMPLEMENTING A WATER CONSERVATION PROGRAM ON ARMY INSTALLATIONS

Background

Water conservation can be best described as any beneficial reduction in water use or in water losses. Conservation can be achieved through technical measures (water-saving fixtures, efficient irrigation systems, improved leak detection and repair); process or use changes (more efficient industrial processes, water reuse, and low-water-use landscaping [xeriscaping]); regulatory action, including metering and pricing policies; and public education to help people modify their behaviors to use less water without impacting life styles.

Water-use efficiency has been defined as the accomplishment of a function, task, process, or result using the minimal amount of water feasible. Conservation can be used to reduce both annual average demand and monthly, daily, or hourly peak demand. Peak and average demand have different effects on the need for capital facilities. Reducing average demand primarily affects raw water storage requirements. Reducing peak demand reduces the costs for new treatment, conveyance, and distribution and can save vital resources by delaying or eliminating the need for additional reservoirs, wells, or treatment facilities.

Why emphasize water conservation and efficiency? The shortest and most immediate answer is supply limitations. Water scarcity is expected to worsen in coming years both nationally and globally. Some installations already are becoming “water-limited” and pushing against restrictions on consumption. Relative importance varies from location to location although no region is exempt. Additional drivers include energy savings, local control of the water supply, and reliability of supply. Drivers encouraging water conservation and efficiency include individual installation sustainability plans, Army Environmental Policy, the Army Water and Energy Campaign Plan, LEED requirements for Silver certification in all new construction, and various iterations of Energy Policy Acts and Executive Orders requiring substantial reductions in water use through the next several years. These and others are described in more detail in “Water-Efficient Installations” (USACE 2011).

Drought has had a major national impact in recent years in many parts of the country and is impacting numerous installations, and not just those in the arid and subarid regions of the country. Relative importance varies from location to location. As the Army becomes more sustainable, one of the options for increased sustainability is water efficiency and conservation. An adequate quantity of well-managed water is vital to support installations as they pursue their missions and maintain an acceptable quality of life. The remainder of this appendix describes a typical water conservation plan and its implementation.

Typical Water Conservation Plan Outline

A typical water conservation plan will usually cover the following categories of information. However, some portions may or may not be relevant for a particular installation.

Introduction and Summary

- Purpose and scope of plan
- Plan submittal requirement
- Plan development and public participation
- Plan elements
- Resolution for adopting the plan

Study Area Characteristics

- History of water system
- Demographic forecasts

Analysis of Historical and Projected Water Demand

- Historical water use
- Analysis of water use by customer group

Summary of Historical and Projected Demand without Conservation

- Impact of new plumbing code on water use

Water Supply

- Sources of water
- Groundwater
- Surface water
- Overall supply and demand balance

Reclaimed Water Plan

- Results of previous studies
- Plans for reuse

Current Water Conservation Program

- Measures implemented by water wholesalers and the installation
- Management of nonrevenue water

Alternative Water Conservation Measures

- List of conservation measures considered

Evaluation of Long-term Water Conservation Measures

- Menu of water conservation alternative programs
- Estimated water savings
- Costs of measures
- Results of benefit-cost analysis

Recommended Plan

- Selection criteria
- Description of recommended plan
- Projected water savings
- Benefits

- Implementation schedule
- Budget and staffing

Water Shortage Plan

- Worst case water supply
- Plan elements
- Water use restrictions
- Water supply emergency
- Water rate structure

Guidelines for Designing a Water Conservation Program

It is essential to involve relevant stakeholders. For most installations, these are the Directorate of Public Works (DPW) community and major tenants. Often, water is of regional importance and managed on a watershed basis, which encourages the involvement of external stakeholders including nearby municipalities, Indian tribes, and other state or federal agencies.

Research Regulatory Requirements

Legal requirements may affect which conservation measures can be implemented on an installation. Applicable local, state, and federal regulations, including Department of Defense (DoD) and Army, should be reviewed as part of program development. Many of these requirements, such as mandatory water use reductions, have been discussed elsewhere (USACE 2011; Jenicek and Meyers 2009).

The following should be considered:

- Federal and military programs and activities
- State statutes and administrative codes for water use and water supply, including water rights law, environmental permits, water and energy programs, and building and plumbing codes
- Interstate agreements, court decrees, and regional water agreements

- Local ordinances and programs, including water use ordinances and regulations, rate structures and policies, land use planning and approval procedures, and local building and plumbing codes

Some of these regulatory requirements may complement certain conservation measures and make them easier to implement, while others may interfere with their use.

Establish Conservation Goals

Using available utility data and applicable regulatory requirements, establish conservation goals and select measures to best fulfill these goals. In addition to the EO 13514 and other mandatory reduction requirements, other possible questions include the following:

- If there is a water supply shortage, is it limited to one portion of the service area or is it system-wide?

- Is the supply shortage primarily short-term (drought, emergency shortage) or long-term (more than 1 year)?

- Is the shortage current or is it projected to occur in the future?

- What is the primary cause of the long-term supply shortage? Possibilities could include system leaks, inadequate water rights, pipeline delivery limitations, or inadequate water supply.

- Does the supply shortage occur during peak demand periods each day, during high water-use seasons of the year, or is it spread throughout the year?

- When should these savings be achieved?

- Does there need to be a reduction in water use to meet state or federal regulatory requirements?

- Is the reduction in response to public or environmental concerns?

Answers to such questions can be used to develop specific goals. Several specific goals from federal, Army, and DoD already exist. Others can be added. They may also be impacted by local and state requirements and special circumstance driven by other considerations.

Select Plan Measures

The Federal Energy Management Program (FEMP) presents an overview of best management practices for water efficiency, as listed below.

- Water Management Planning
- Information and Education Programs
- Distribution System Audits, Leak Detection, and Repair
- Water-Efficient Landscaping
- Water-Efficient Irrigation
- Toilets and Urinals
- Faucets and Showerheads
- Boiler/Steam Systems
- Single-Pass Cooling Equipment
- Cooling Tower Management
- Commercial Kitchen Equipment
- Laboratory/Medical Equipment
- Other Water Intensive Processes
- Alternate Water Sources

With several to dozens of components under each possibility, there are a myriad of conservation measures which could be selected. Among measures, those that are the easiest to apply, meet goals at minimum cost, and indicate greatest potential for savings should be selected first. A variety of tools can be used to estimate savings for different measures. Online calculation tools may be available from the state, from the Alliance for Water Efficiency, or other sources.

Determine What is Applicable, Feasible, and Acceptable

In evaluating conservation measures, focus on those that are applicable and appropriate to the area. Landscaping conservation measures may not be appropriate if there is no significant increase in water use from irrigation during the summer months or if outdoor water use has not been identified as a large percentage of water consumption.

If a goal is to reduce wastewater inflows to an overburdened treatment plant, landscape conservation measures may be ineffective if the system is served by a separate stormwater collection system.

Existing conservation measures should be considered. Feasibility within the budget is also critical. Measures must be acceptable to the installation’s consumers; otherwise, their success rate will be low.

Determine Acceptable Non-economic Impacts

Changes required to reduce water use may have non-economic impacts, which can be categorized as social/political, environmental, technical, and consumer. These impacts are more difficult to quantify than economic impacts, but they may be significant. Non-economic impacts can be characterized as shown in Table 1.

Table A-1. Non-economic Impacts of Conservation Measures Impact.

Environmental/Technical • New source development postponed or reduced • Reduced building/resident owner energy consumption • Reduced utility energy consumption • Increased life of water and wastewater treatment facilities • Increased streamflows
Social/Political • Create new jobs locally • User and special interest group opposition to program • Requires mandatory ordinances • Cooperation of enforcement authority to implement program may be difficult • Fairness of measure • Requires landscaping attitude change • Customer costs not equally shared between existing and new customers • Costs not equally shared between customer classes • Users who conserve will have lower energy bills • Health and safety • Significant customer expense if mandatory
Adapted from Planning and Management Consultants, Ltd et al. 1992

To evaluate non-economic impacts for an installation, comprehensive lists of possible impacts should be compiled and a decision made on whether a particular measure has positive, negative, or no impact. It should be noted that, while some concerns cannot be measured or assigned a value, they may still be very important. A non-economic negative impact may be significant enough to stop a program that otherwise has a favorable benefit-cost ratio.

Estimate Benefits and Costs

To have a feasible conservation plan, the total positive effects (benefits) of the plan must be greater than the total negative effects (costs). The greater the savings and the smaller the costs of the measures, the more economically attractive they will be.

A detailed benefit-cost analysis will compare the value of demand reduction measures (through conservation) with supply enhancement measures (such as increased system capacity or other structural solutions). Planners can use the analysis to measure the impact of conservation on the capital facilities program to plan for future facilities requirements more accurately.

A variety of options exist on preparing a benefit-cost analysis. Computer models can allow the installation to model benefit-cost analysis using net present value and benefit-to-cost ratio as economic indicators. Examples of models are the Water Conservation Savings Tracking Tool by the Alliance for Water Efficiency, the Demand Side Management Least Cost Planning Decision Support System by Maddaus Water Management, or the IWR-MAIN model of the engineering firm CDM.

Estimating benefits and costs is helpful for informed decision-making, especially when large budget increases are sought. However, estimation is not necessary in order to have a successful water conservation program and may be beyond the capacity of an installation. A more informal approach is presented in the following section. In particular, costs of the water conservation program, including administration, can be calculated and should be mentioned. Installations may find it easier just to calculate the cost of water saved and then select plan measures based on comparing these costs.

Typical Benefits and Costs

Benefits to the DPW/utility/water provider result from both short-term and long-term savings:

- Short-term savings are not related to capital facilities and tend to result immediately from conservation activities. These cost savings originate from the reduced purchase of water, reduced costs of treatment chemicals, and reduction in energy, labor, and materials required to handle water production.

- Long-term savings are those associated with capital facilities (i.e., decreased cost for water and wastewater facilities because of reduced demand).

The costs of water conservation programs fall into two main categories:

- Cost for program implementation itself, which includes staff time, hardware, and information provision.

- Costs to the installation from reduced revenues resulting from lower demand.

Other costs could include increased staff time for other departments such as planning or natural resources to oversee landscape water use or water-efficient landscaping.

Program Implementation Costs

Utility costs

Costs to the utility can be expressed as follows, considering both in-house staff costs and contractor costs (where a contractor performs some of the work).

In-house Cost = Administrative cost
+ Field labor hours x labor hourly rate
+ Unit cost x number of units
+ Publicity cost
+ Evaluation/follow-up

Contracted Cost = Administrative cost
+ Number of sites x unit cost per site; includes program unit costs
+ Publicity costs
+ Evaluation/follow-up

Administration costs

This is the staff time required to oversee staff, the work of consultants, or contracted field labor. Administrative costs are typically 10–15% of total program costs (PMCL 1992).

Field labor costs

In addition to administrative staff time, the utility must supply labor to perform conservation work in the field. Field activities include water audits, leak repair and fixture installation, follow-up site visits, and door-to-door canvassing.

Unit costs

Many measures can be estimated on a unit cost basis or as cost per participant. Examples include retrofit kits, water audit programs, and rebates.

Publicity costs

All conservation programs should contain a public information element. Vehicles for public information include radio and television spots, local newspaper advertisements or articles, flyers and bill stuffers, billboard advertising, workshops and seminars, and special demonstrations (such as booths at community events).

Evaluation and follow-up costs

Typically, two types of follow-up need to be performed. Records must be kept of the impact the conservation measure(s) is having (i.e., water savings). The utility should also monitor how well the measure(s) is performing and whether program goals are being achieved. Costs associated with follow-up activities may include the staff time needed to calculate water savings and the cost of surveys. The best source of information for these costs is the experience of utilities that have run similar programs.

Costs of decreased water revenues

Decreases in water revenues resulting from conservation typically are small and occur over a long time, allowing them to be incorporated into budget forecasts. Reductions in water revenues may be 0.5 to 2% per year over the life of the program, typically less than inflation in other cost areas. Cost savings from the short-term benefits (reduced energy, chemical, and treatment costs) will help offset these revenue decreases. Periodic rate increases can recover the lost revenue.

Consider other perspectives on benefits and costs

It may also be important to evaluate benefits and costs from other perspectives to determine how willing these sectors might be to participate in the program. The most obvious group is customers who will be voluntary or involuntary participants in the program. These participants may include residents, tenant activities, industrial processes, greenspace consumers, medical facilities, etc. Be aware that this evaluation may point to different alternatives than were suggested by the original benefit-cost analysis.

Customer Benefits and Costs

Customer costs result from the purchase of special fixtures or other water-saving devices. Obviously, if the customers' costs are too high, they will be reluctant to participate. Increased costs can also occur in commercial, industrial, institutional (CII) facilities where the installation of water-saving equipment requires additional operations and maintenance (O&M) expenditures.

Benefits to the customer will result from reduced utility bills for water, wastewater, and energy. If the measure has a favorable cost-benefit ratio, the customer is more likely to implement it. In addition, secondary impacts on wastewater utilities may occur (reduced wastewater flows, lower cost of treatment, and cost savings from delayed construction).

Develop Alternative Approaches

Conservation measure can be grouped into three general categories:

- Technological changes, the use of water-saving fixtures and hardware, both at the utility and customer level.

- Behavioral (voluntary) measures, such as low water-use landscaping and changes in irrigation practices. These measures could also be targeted.

- Changes in pricing structure to reduce demand. This is probably not feasible on installations as the billing and pricing structures are set by Army regulations.

In designing a conservation plan, a mixture of approaches should be selected to build flexibility into the program and prevent too much dependence on any one technique.

Several measures can be bundled together starting with the most cost-effective until the overall program conservation targets or goals are met. This has been called Conservation Measure Packaging (Maddaus et al. 2004).

Select a Plan

At this point, the DPW has:

- researched applicable regulatory requirements,
- established goals,
- identified measures that achieve water savings goals, are appropriate for the system, and have favorable non-economic impacts,
- made an informal assessment of economic impacts, and
- obtained review comments.

The plan should be reviewed by decision makers, modified to reflect comments, resubmitted to review groups for final approval, and then implemented.

Implementing a Conservation Program

Responsibilities of the Conservation Program Manager

The Water Conservation Program Manager or Water Conservation Coordinator will define the specific tasks to be carried out and determine the schedule and budget for each of these tasks. On a military installation, the Conservation Program Manager may be the sole person performing most of these tasks and may only work part-time on conservation. If the installation is partnered with a nearby large city or water utility, personnel from that entity may be available to help. Some installations also have used contractors for aspects of a water conservation program such as coordinating residential conservation, landscape irrigation programs, commercial industrial and institutional (CII) programs, or education and public information programs. Other programs may be available to assist the Conservation Program Manager such as Energy Savings Performance Contracts, Energy Conservation Investment Program, and others that may be able to supply up-front capital in exchange for sharing in cost savings.

Implementation Tasks

Specific tasks that could be performed as part of a conservation program include:

- Coordinate with programs run by other agencies and neighboring utilities as well as within the garrison

- Disseminate information and conduct public relations activities

- Develop a public information and in-school education program

- Form and conduct a speakers' bureau program

- Oversee a leak reduction program (on an installation this is usually under the O&M mandate of DPW unless an outside provider is performing that function).

- Supervise retrofit device distribution

- Develop low water-use landscaping program working with the installation agronomist

- Work with appropriate entities in a toilet rebate program if that applies to the installation

- Develop incentives to encourage conservation

- Revise local codes and ordinances to require water-saving fixtures. Currently WaterSense standards are mandatory for federal agencies.

For each of these tasks, the program manager should prepare a description of staff responsibilities, estimate budget requirements, and determine a schedule. The budget should include costs of start-up materials and staff training.

Other Program Participants

In addition to the Conservation Program Manager, a variety of other individuals and departments may be involved in program implementation.

Water utility manager

The utility manager approves the final conservation plan and authorizes budget and hiring requests.

Consultant

Consultants are sometimes used to determine water savings that result from conservation. They can also be employed to help launch a new program or expand an existing program.

Public information specialist

This person can handle all aspects of the program relating to publicity and public relations. This task is usually handled in-house. The installation Public Affairs Office will probably be willing to assist.

Various DPW and garrison elements

Coordination and buy-in from planning, roads and grounds, agronomy, O&M, training, housing, medical command, and others may be necessary and should be sought.

Program Monitoring and Evaluation

Two kinds of program evaluations will be conducted:

1. To determine actual water savings from the program and

2. Identify ways to improve and refine the program over time.

Water savings

Direct measurement of water savings is time consuming and may be difficult. See the American Water Works Association (AWWA) M52 Water Conservation Programs – A Planning Manual (Maddaus et al. 2006) and Handbook of Water Use and Conservation (Vickers 2001) for detailed methodologies on evaluating water savings from water conservation measures and programs. An Excel-based tracking tool is also available from the Alliance for Water Efficiency.

Water-use data should be saved before, during, and after implementation of a measure. This includes both raw utility pumping water data and customer billing data.

It is useful to have at least 1 year's worth of metered data prior to implementing a water conservation measure. Having this data will subsequently allow an effective evaluation of its impact. Most useful is a billing system that allows data to be transferred to a spreadsheet for analysis. Consumption data from the billing system should be compared for three periods.

- Winter, to evaluate indoor use,
- Summer, to evaluate outdoor use, and
- Annual to evaluate combined impact.

A number of factors and variables make before- and after-analysis of billing data difficult. These include:

- Behavior – Did members of the barracks, family housing, etc. change water-use practices?
- Other retrofits - Were other water conservation devices installed at the same time?
- Family Housing unit size - Did the number of residents change?
- Were there significant movements of troops on or off post?
- Inclusion of outdoor use -If outdoor use is included in the same water bill, were there any changes in outdoor water use, including seasonal use changes?

Possible variables for outdoor water conservation measures are:

- Behavior-Were there any changes in watering restrictions simultaneously in place?
- Behavior - Did the customer use an automatic irrigation system according to a preset schedule or turn the system on and off manually?
- Rainfall and temperature - Were there unusual weather conditions that would necessitate less or more water than average?
- Rainfall and temperature - Did a functioning rain sensor, SMS or ET controller, modify water use? If water savings from these devices are being studied, this question is of interest.

Important information to collect in evaluating program effectiveness, in addition to water savings, are:

- Customer participation rate and customer satisfaction,
- Types and amount of customer contacts, and
- Description of problems and how they were overcome.

Other Estimates of Program Effectiveness and Durability of Savings

Another question is how long do savings last? Following up on the initial evaluation of water savings after several years will allow the installation to investigate and address the question of persistence over time. Surveys can be done in a variety of methods to determine program effectiveness: mail, telephone or email. One problem is that, within residential or family housing on an installation, families are moving in and out of quarters on a regular basis (every 3 or 4 years and the Soldier may or may not be present).

The Installation Conservation Program

Contents of a Comprehensive Water Conservation Plan

Specify conservation planning goals:

- List of conservation planning goals and their relationship to supply-side planning
- Description of community involvement in the goals-development process

Develop a water system profile

- Inventory of existing facilities production characteristics and water use
- Overview of conditions that might affect the water system and conservation planning

Prepare demand forecast

- Forecast of anticipated water demand for future time periods
- Adjustments to demand based on known and measurable factors
- Discussion of uncertainties and “what if” sensitivity analysis

Describe planned facilities

- Improvements planned for the water system over a reasonable planning horizon

- Estimates of the total, annualized, and unit cost (per gallon) of planned supply-side improvements and additions

- Preliminary forecast of total installed water capacity over the planning period based on anticipated improvements and additions

Identify and evaluate conservation measures

- Review of conservation measures that have been implemented or that are planned for implementation

- Discussion of legal or other barriers to implementing recommended measures

- Identification of measures for further analysis

Analyze benefits and costs

- Estimates of total implementation costs and anticipated water savings

- Cost-effectiveness assessment for recommended conservation measures

- Comparison of implementation costs with avoided supply-side costs

Select conservation measures

- Selection criteria for choosing conservation measures

- Identification of selected measures

- Explanation of why recommended measures will not be implemented

- Strategy and timetable for implementing conservation measures

Integrate resources and modify forecasts

- Modification of water demand and supply capacity forecasts to reflect anticipated effects of conservation

- Discussion of the effects of conservation on planned water purchases, improvements, and additions

- Discussion of the effects of planned conservation measures on water utility revenues

Present implementation and evaluation strategy

- Approaches for implementing and evaluating the conservation plan

- Certification of the conservation plan by the system's governing body

System Audit

Most utilities have some amount of water produced but not sold or otherwise accounted for. This is commonly called unaccounted-for water (UAW), and regulators have required this to be under a certain percentage, for example, under 10%. However, with metering becoming more universal, regardless of the system's size water loss should be expressed in terms of actual volume, not a percentage. In this way, the monetary value of water loss can be estimated.

The AWWA and the International Water Association (IWA) jointly developed a reliable water audit methodology in 2000. State and regional regulatory agencies in the United States now embrace this IWA/AWWA Water Audit Methodology as (1) an improved and reliable practice compared to the imprecise UAW process, and (2) a standardized approach that can produce data that allows performance comparisons and benchmarking of best practices. Water audit software, developed as part of the new IWA/AWWA methodology, is Excel-spreadsheet based. It is available free from the AWWA WaterWiser website. Using these new tools, the water industry is shifting towards sound water loss management and unaccounted for water is becoming an outdated term. The focus has turned to nonrevenue water (NRW). Real loss, apparent losses, and unbilled authorized consumption make up NRW. Real losses are water lost from the distribution system through leaking pipes, joints, and fittings; leakage from reservoirs and tanks; reservoir overflows; and improperly opened drains or system blow-offs. Apparent losses are inaccuracies in customer metering, consumption data handling errors, or any form of theft or illegal use. All of these reduce revenue to the water purveyor on the installation.

The unbilled authorized consumption portion of NRW includes water supplied for the utility’s operations and the operations of associated DPW activities. Even if unbilled, this water should be metered and accounted for. Several states (including Texas, Washington, and California) now require the use of the IWA/AWWA methodology by utilities.

NRW is measured in two steps: (1) Conduct a water system audit, fairly straightforward for a metered system. An auditing method for unmetered systems is presented in Appendix C. Subsequent audits should take about half the time, since procedures will be in place. (2) Compare the amount of water entering the distribution system to the amount of water supplied to customers. Accuracy of meters should be verified by checking all DPW or agency meters and a sampling of customer meters.

NRW can be expressed in volume or in dollars of revenue lost. Computer software such as AWWA Water Loss can reduce the time required to analyze audit results. An Army spreadsheet model has been developed and is available to assist in this tasking of where water is consumed on an Army installation (USACE 2010).

Summary

Water-efficient installations are essential for the Army to move forward and meet their mission needs while maintaining their reputations as excellent stewards of a valuable resource and being good members of their communities. Recent federal and Army policies and regulations including mandatory reductions in agency water use amounting to 2% annually with a 26% overall reduction by 2020 require significant improvements over current conditions. Numerous opportunities of technology, techniques, behavioral changes, and O&M considerations exist to help in achieving these mandates. Implementation of a well-considered, well-organized water conservation plan and program will allow the Army to meet these requirements.

APPENDIX B

CONDUCTING A RESIDENTIAL WATER AUDIT

A residential audit helps consumers understand ways they can improve water efficiency. It allows an installation or water service provider to distribute conservation information and install water-saving devices. An audit also accumulates information on how water is used in the service area.

Audit staff should work in pairs, carry identification, and have planned their routes based on appointments with residents. They should always explain the tasks they will be performing prior to beginning. Types of activities that can be performed as part of an audit are presented below. Actual content may vary depending upon conservation measures being considered. Vickers (2001) contains more detailed information.

Service Meter

Service meters are currently not common on military installations; however, plans are being made to increase their numbers and new Residential Communities Initiative construction has installed meters in some locations. If a meter is used, these tests should be run:

- Calibration/flow test
- Leak test: To test if a leak is inside the house or outside, the main shut-off valve for water may have to be turned off. Request residents turn off all water-using appliances. Check the meter dial. If the dial is still moving, there is a leak in the service line that should be repaired promptly.

Indoor

- Bathroom
  - o Toilets
    - – Check for leaks.
    - – Place a dye tablet or a few drops of food coloring in the tank. Do not flush the toilet. Do this at the beginning of the indoor portion of the audit and check back.

  - After 15-20 minutes, look in the bowl. Colored water indicates the presence of a leak.

    - Point of emphasis – clean or replace flapper.

    - Point of emphasis – check adjustment of float arm.

  - Check the volume of the toilet using one of several methods.

    - Post-1994 toilets should have volume marked at the back of the seat. Older units may be labeled inside the tank,

    - Volume can be measured by first turning off the water, flushing to empty the tank, and then refilling it from a bucket with a measured amount of water. Fill to the stain line in the tank.

- Shower

  - Check shower flow rate. Using watch with a second hand or a stop-watch, time how many seconds it takes to fill a 1-gallon jug or heavy plastic bag.

  - Divide 60 seconds by the number of seconds it took to fill the jug or bag to the 1-gallon mark to determine gallons per minute (gpm).

  - A pre-1994 showerhead will typically use over 3 gpm. Low flow requirements since 1992 require only 2.5 gpm.

  - Check for drips and leaks and note these for repair.

- Lavatory faucet

  - Check for drips and leaks

  - Check sink faucet flow rate, as previously described.

  - An aerator may be installed if not already in place.

  - Maximum flow rates of 2.2 gpm have been mandatory since 1994, but faucet aerators with 0.5 gpm have been well-received by customers and are now certified by WaterSense.

   – Offer to install a low-flow aerator.

- Kitchen

  - Check for drips and leaks in the faucet.

  - Check the rate of flow from the faucet.

  - Offer to install a low-flow aerator if one is not already in place.

Outdoor

- Check for leaking faucets

  Both nonautomatic and automatic sprinkler systems can be given audits. Consumer education should be given at the same time covering watering schedules, how to properly apply water, any restrictions imposed by the installation, and education about low water-use landscaping.

  Texas A&M University Extension Service provides a typical approach for doing a landscape audit.

Irrigation audits consist of three main activities: site inspection, performance testing and irrigation scheduling. Each activity can in itself result in significant water and cost savings. Together, they provide landscape maintenance personnel a customized irrigation program based on site specific conditions and irrigation system performance.

Site inspection. Regular maintenance is essential to identify minor operation and performance problems, sunken heads which do not pop up, misaligned spray patters, broken or missing heads can result in significant water waste. Performance problems include head spacing resulting in poor water distribution, and insufficient or excessive pressure.

Performance testing. Sprinkler application devices are designed to operate within specific operating pressures and head spacings. The most accurate determination of precipitation rates is achieved by using catch can tests.

Irrigation scheduling. When water supplies are limited, it is important to fully utilize every drop of water. Run times for irrigation zones should be based on measured precipitation rates, depths of plant root zones, soil types, types of plants, climate trends and rainfall.

APPENDIX C

METHOD TO ESTIMATE WATER USAGE FROM AN UNMETERED SUPPLY

If your system is not metered and is from a pumped source, you can use the readings from your electric power supply meter to calculate water production, using the following formula:

Pumping Volume = Pumping Rate x Time of Operation

1. Calculate the water pumping rate by measuring pump output flow rate (Measure time to fill a water tank and compute rate in gallons per minute.)

2. Calculate the time of pump operation from the electric meter reading. Procedure:

a. Record the beginning and ending power meter dial readings for the period of interest (day, month, year). Figure the total kilowatt per hour (kWh) produced (final minus initial dial meter reading).

b. Multiply the kWh supplied during the period times the scale factor printed on the face of the meter.

c. Record the Kh (kilo hour) factor from the meter face.

d. During pump operation, time the rotation of the meter disc by counting revolutions (for more than 10 revolutions), and record the number of revolutions and the total time in seconds.

e. Compute the instantaneous kilowatt demand with the following formula:

$$\text{kW (inst)} = \frac{\text{(\# revolutions x Kh factor x 3.6)}}{\text{(total time in seconds measured in Step d)}}$$

f. Compute the time of pump operation (in hours) with the following formula:

Pumping Time = Total kWh/kW (inst)

3. Multiply pumping rate (Step 1) by time of pump operation (Step 2) to arrive at volume of water per period (day, month, year).

APPENDIX D

REFERENCES

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APPENDIX E

ABBREVIATIONS

Term	**Spellout**
AR	Army Regulation
AWWA	American Water Works Association
CECW	Directorate of Civil Works, US Army Corps of Engineers
CEMP-CE	Directorate of Military Programs, US Army Corps of Engineers
CERL	Construction Engineering Research Laboratory
CII	Commercial, industrial, institutional
DA	Department of the Army
DPW	Directorate of Public Works
DoD	Department of Defense
EPA	Environmental Protection Agency; also USEPA
ERDC	Engineer Research and Development Center
gpm	gallons per minute
HQUSACE	Headquarters, United States Army Corps of Engineers
IWA	International Water Association
Kh	kilo hour
kWh	kilowatt per hour
LEED	Leadership in Energy and Environmental Design
NRW	nonrevenue water
O&M	operations and maintenance
POC	point of contact
PWTB	Public Works Technical Bulletin
UAW	unaccounted-for water
USACE	United States Army Corps of Engineers
WBDG	Whole Building Design Guide