FINAL

Water Management Plan for Nellis Air Force Base

Prepared for

HQ Air Force Civil Engineer Support Agency and HQ Air Combat Command

Prepared by

CH2MHILL

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Notice

CH2M HILL has prepared this report for the Air Force for the purpose of aiding in the implementation of this water conservation evaluation. It is not an endorsement of any product. The views expressed herein are those of the contractor and do not necessarily reflect the official views of the publishing agency, the Unites States Air Force or the Department of Defense.

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Acronyms and Abbreviations

ACC	Air Combat Command
ACFT	Acre Feet
AFB	Air Force Base
AFCESA	Air Force Civil Engineer Support Agency
AFI	Air Force Instruction
AWFC	Air Warfare Center
AWWA	American Water Works Association
BMP	Best Management Practice
CE	Civil Engineer
DESC	Defense Energy Support Center
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DUERS	Defense Utility Energy Reporting System
DVQ	Distinguished Visitors Quarters
EC	Evaporative Cooler
ECAMP	Environmental Compliance Assessment and Management Program
ECIP	Energy Conservation Investment Program
EO	Executive Order
ESPC	Energy Savings Performance Contract
FEMP	Federal Energy Management Program
FY	fiscal year
gpf	gallons per flush
gpm	gallons per minute
HQ	headquarters
HVAC	heating, ventilation and air conditioning
ISR	Interim Status Report
IWRAPS	Installation Water Resource Analysis and Planning System
KGAL	thousand gallons
MILCON	Military Construction
MFH	military family housing
MBH	Million British Thermal Units per Hour
MBTU/SF	Million British Thermal Units per Square Feet
NAF	non-appropriated funds
NCO	non-commissioned officer
NTTR	Nevada Test and Training Range
O&M	Operation and Maintenance
POC	Point of Contact
POTW	Publicly Owned Treatment Works
RED HORSE	Rapid Engineer Deployable Heavy Operations Repair Squadron
ROM	rough order of magnitude
RWP	Recurring Work Program

SCADA	Supervisory Control and Data Acquisition
SF	square feet
SIOH	supervision, inspection, and overhead
TDY	temporary duty
TLF	temporary living facilities
UESC	Utility Energy Service Contract
UFC	Unified Facilities Code
UPC	Unified Plumbing Code
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
VOQ	Visiting Officer Quarters

Certification of Final Review and Submission

The undersigned certifies the attached installation-specific water management plan has been appropriately reviewed, and with their signature submits the plan in compliance with Executive Order 13123 and associated DOE implementation guidance.

Authorizing Signature,

_____

Barry Flynn
Civil Systems Engineer
99th Civil Engineer Squadron
Nellis AFB, Nevada

Purpose/Disclaimer

Executive Order 13123, *Greening the Government Through Efficient Energy Management,* established seven energy conservation goals for federal facilities. One of the goals seeks to conserve energy through water conservation. This Water Management Plan was prepared in support of Nellis AFB's overall energy management program. The publication of this Plan satisfies one of the requirements identified by the Department of Energy as necessary to comply with the Executive Order's water conservation goal.

The purpose of this Water Management Plan is to provide Nellis AFB with a general planning document for its water conservation program. This Plan is not intended to be directive in nature. The information and recommendations presented in this Plan provide general guidance for Nellis AFB Civil Engineering. The ability to implement any of the initiatives or programs is dependent on available funding and staffing.

This Water Management Plan was developed using the *Air Force Water Conservation Guidebook (May 2002).* It is intended to be a living document and should be reviewed and updated regularly as Water Conservation Program items change.

Executive Summary

This Water Management Plan (WMP) demonstrates Nellis Air Force Base's (AFB's) compliance with the water conservation requirements established by Executive Order (EO) 13123 and the U.S. Department of Energy (DOE) corresponding implementation guidance. This Plan documents Nellis AFB's historic and projected water use by category, includes incremental costs for potable water supply and wastewater disposal, evaluates water conservation efforts relative to DOE's ten Best Management Practices (BMPs), and recommends water conservation implementation measures.

Exhibit ES-1 presents Nellis AFB's historic and projected water use by category.

EXHIBIT ES-1
Historic and Projected Water Use
Nellis AFB WMP

Category	Historic Annual Consumption (kgal)	Historic Annual Consumption (% of Total)	Projected Annual Consumption (kgal)	Projected Annual Consumption (% of Total)
1 – Housing	94,127	6.8	0*	0.0
2 – Commercial	265,359	19.0	263,812	24.1
3 – Irrigation	628,807	45.1	456,916	41.8
4 – Leaks/Losses	318,505	22.9	287,025	26.2
5 – Industrial	86,190	6.2	86,190	7.9
Total	1,392,988		1,093,943**	

* Privatization of MFH in FY 2004 will eliminate MFH form reporting in DUERS report.

** Projected water use is estimated based on FY 1999 through FY2003 historic water consumption and planned changes for Nellis AFB.

The blended incremental cost of the potable water supply was determined to be $0.79 per kgal based on the basic rate of each source, the weighted distribution of water from each supplier, and the operation and maintenance (O&M) costs for the Base distribution system. A projected incremental cost of wastewater was not determined because the wastewater disposal cost is a fixed annual amount.

Exhibits ES-2 and ES-3 summarize the evaluation of Nellis AFB's water conservation measures relative to the ten BMPs.

Water conservation projects were identified and simple payback calculations were prepared for each BMP. The projects were developed to help achieve credit for BMPs or to achieve further water savings. **Exhibit ES-4** presents the enhancement projects, in rank order, and associated cost, annual savings, and projected simple payback period.

EXHIBIT ES-2
Summary of Compliant BMPs
Nellis AFB WMP

BMP	Credit	Notes
4 – Toilets and Urinals	Yes	Approximately 75 percent of the toilets and urinals Basewide have been replaced. The remaining are being replaced with an on-going replacement program as needed.
5 – Faucets and Showerheads	Yes	Approximately 90 percent of the faucets and showerheads Basewide have been replaced. The remaining are being replaced with an on-going replacement program as needed. 500 low-flow (1.5 gpm) showerheads were purchased and will be installed in Base dormitories.
6 – Boiler/Steam Systems	Yes	All boilers are de-centralized, except the hospital central heat plant and appear to have excellent O&M procedures in place.
7 – Single-Pass Cooling Systems	Yes	The only single pass cooling systems identified on Base consist of 14 water-cooled ice machines. The Base has an effective recurring work program (RWP) for the ice machines.
8 – Cooling Tower Management	Yes	The 19 Base cooling towers are in good to excellent condition; each operates chemical feed pumps as well as auto blowdown.

EXHIBIT ES-3
Summary of Non-Compliant BMPs
Nellis AFB WMP

BMP	Credit	Notes
1 – Public Information and Education Programs	No	Publish water conservation information on a seasonal basis. Provide facility manager training that emphasizes water conservation as well as energy conservation.
2 – Distribution System Audits, Leak Detection and Repair	No	Conduct AWWA leak detection survey. Continue to upgrade water distribution system.
3 – Water Efficient Landscaping	No	Water-efficient landscaping is used about 50 percent on Base. Implement irrigation scheduling and continue desert landscaping of turf areas on the main Base.
9 – Miscellaneous High Water-Using Processes	No	Install water-efficient devices in dining halls or other high-use water facilities. Optimize water softeners to reduce excess water use from excess regeneration.
10 – Water Reuse and Recycling	No	Further use of non-potable water sources for on-Base and golf course irrigation requirements by utilizing non-potable Base wells.

EXHIBIT ES-4
Enhancement Projects, Cost, and Annual Savings
Nellis AFB WMP

Rank	BMP Enhancement	Cost ($)	Annual Savings ($)	Payback (yrs)
1	#2 – Conduct AWWA leak detection survey in water distribution system	59,700	56,687	N/A *
2	#1 – Upgrade water conservation awareness program	6,160	5,186	N/A **
3	#9 – Optimize Main Hospital Softeners	10,500	209,844	0.5
4	#6 – Install RO as Makeup for Hospital Boilers	41,400	24,907	1.7
5	#9 – Optimize Hospital Steam Plant Softeners	10,500	3,976	2.6
6	#8 – Soften Makeup Water at Building 200 Cooling Towers	3,570	1,279	2.8
7	#8 – Soften Makeup Water at Hospital Cooling Towers	3,570	1,089	3.3
8	#3 – Implement Irrigation Scheduling on the main Base	60,000	7,978	7.5
9	#3 – Implement xeriscaping in 30 of the 42 irrigated acres on the Main Base	3,332,340	273,919	12.2
10	#5 – Update Remaining 10 percent of Faucets and Showerheads Basewide.	43,675	2,565	17.0***
11	#4 – Update Toilets and Urinals in Industrial and Commercial Facilities	303,360	2,654	116***

* No simple payback provided since estimated implementation costs are for the AWWA Leak detection survey only and do not include costs to repair leaks or replace water distribution system pipes

** No simple payback provided since estimated implementation costs and water savings vary from year to year.

*** Ongoing projects.

Air Force policy requires the implementation of at least four BMPs. Nellis AFB has selected BMP #s 4, 5, 6, 7, and 8 for implementation based on completed and on-going water conservation initiatives. Additional BMPs could be implemented that would substantially conserve more water in the future. Nellis AFB has achieved credit for five BMPs. However, Nellis AFB can achieve greater water conservation in the future by implementing projects associated with BMP 3 and by replacing pipeline as suitable after leak detection surveys for BMP 2. BMPs 2 and 3 have the greatest potential savings, if funding is available.

SECTION 1

Introduction

1.1 Overview

This Water Management Plan (WMP) was written to assist Nellis Air Force Base (AFB) in meeting water conservation requirements of Executive Order (EO) 13123, *Greening the Government Through Efficient Energy Management.* This EO mandates an aggressive policy for reducing potable water consumption at federal facilities. Implementation guidance from the U.S. Department of Energy (DOE) set a requirement for each federal agency to "reduce potable water usage by implementing life cycle, cost effective water efficiency programs that include a water management plan, and not less than four Federal Energy Management Program (FEMP) Best Management Practices (BMPs)" (*Appendix A, A-1, Executive Order 13123*).

To comply with the EO, and subsequent implementation guidance, each federal facility is required to develop an installation-specific WMP by 2005. The plans must also be incorporated into current operation or facility plans. Compliance further requires the following percentage of Air Force bases to implement at least four BMPs by the dates shown.

- 5 percent of bases by 2002
- 15 percent of bases by 2004
- 30 percent of bases by 2006
- 50 percent of bases by 2008
- 80 percent of bases by 2010

The DOE will review progress in 2005 and may revise the water efficiency improvement goal at that time.

Headquarters Air Force Civil Engineer Support Agency (HQ AFCESA) developed the *Air Force Water Conservation Guidebook* (May 2002), hereafter referred to as the *Guidebook*, to help Air Force installations meet the EO's water conservation goal. This WMP was developed specifically for Nellis AFB in accordance with the processes outlined in the Guidebook. It documents Nellis AFB's water use profile and utility cost parameters, identifies progress relative to implementing the FEMP BMPs, and recommends steps Nellis AFB can take to further implement water conservation measures.

1.2 Background

1.2.1 Nellis AFB Overview

Nellis AFB is located adjacent to the City of North Las Vegas, Nevada. The Base supports more than 6,859 military personnel, 11,174 military personnel family members, 2,808 civilians, and 1,340 temporary duty (TDY) personnel. Nellis AFB is Air Combat Command's (ACC) largest Base. The Base covers approximately 13,347 acres in three areas. Area I includes the main Base and Nellis Terrace Housing. Area II includes munitions/weapons storage, the 820th and 555th

Rapid Engineer Deployable Heavy Operations Repair Squadron (RED HORSE), the 896th Munitions Squadron, and the Nellis Federal Prison Compound. Area III includes Manch Manor Housing, the Mike O'Callaghen Federal Hospital, Armed Forces Reserve Center, and some industrial activities. The Nevada Test and Training Range (NTTR), approximately three million acres, is also associated with Nellis AFB, but not included as part of this WMP.

Nellis AFB is Headquarters for Air Warfare Center (AWFC). AWFC has three primary wings and one tenant wing at Nellis AFB that include the 57th Wing (57 WG), the 98th Range Wing (98 RANW), the 99th Air Base Wing (99 ABW), and the 53rd Test Evaluation Group (53 TEG). The 57 WG oversees the flying operations. The 98 RANW develops, operates, and maintains the NTTR at Nellis AFB. The 99 ABW provides support and logistics functions to oversee the day-to-day operations at Nellis AFB and NTTR. The 53 TEG is the operations group for testing all fighters, bombers, simulators, support equipment, and weapons for the command.

1.2.2 Nellis AFB Water Program Overview

Nellis AFB's annual water consumption has fluctuated between 1,248,000 kgal and 1,521,000 kgal over the past 5 years (fiscal year (FY) 1999 through FY 2003). Potable water from local municipal suppliers and Base-produced potable wellwater is readily available and relatively inexpensive to pump, treat (chlorination), and distribute to end users on Base. While there have been few environmental drivers encouraging water conservation, the Base is located in an arid region of the United States and must actively implement water-conscious practices.

1.2.2.1 Water Conservation Initiatives

Nellis AFB has, or is currently, implementing the following water conservation initiatives:

- Water restrictions are issued during drought conditions.
- Facility renovations, to include the replacement of existing or broken lavatory and kitchen appliances with water-conscious versions.
- New facilities are designed and fitted with low-flow toilets, urinals, faucets, and showerheads. New construction also complies with the Unified Facilities Code (UFC), which provides design, planning, and construction and restoration guidelines.
- Water-efficient landscaping is used extensively throughout the Base. Native plants are used to reduce the need for irrigation. Excluding the golf course and MFH, there are approximately 40 acres of landscape on Base supported by irrigation systems.
- Approximately 50 percent of MFH lawns utilize water-efficient landscaping.
- The Base has purchased 500 ultra low-flow showerheads to be used in the Base dormitories.

1.2.2.2 Future Water Use

Nellis AFB's future water consumption and costs will be affected by the following planned changes.

- Water-efficient landscaping is planned for new construction.
- Military family housing (MFH) will be privatized in May 2004.

The Las Vegas area is experiencing significant population growth. This growing population will also cause an increased demand for water and subsequent consumption from the local water sources. This will increase the role and importance of water conservation in Nellis AFB's overall water management program.

1.3 Objective

The objective of this WMP is to comply with water conservation goals of EO 13123 and associated DOE implementation guidance. This Plan provides:

- documented water consumption and cost data;
- categorized water use;
- incremental cost of water and wastewater disposal;
- an assessment of current compliance with FEMP BMPs;
- identification of additional BMPs that can be implemented;
- identification of potential funding sources for identified BMPs; and
- an implementation plan.

A Draft WMP was prepared for Air Force review in March 2004. Consolidated comments from Air Force internal review and resolution of these comments are presented in **Appendix A**. This Final WMP was prepared to include the Air Force review comments and responses provided for the Draft WMP.

SECTION 2

Methodology

This WMP was developed using the six-step process provided in the Guidebook and developed by HQ AFCESA to help Air Force installations develop WMPs that meet the requirements of the EO and DOE's implementation guidance. **Exhibit 2-1** describes each of these steps.

EXHIBIT 2-1
Six-Step Process
Nellis AFB WMP

Process Step	Description
STEP ONE	Collect Required Background Data
STEP TWO	Investigate and Categorize Water Use at Installation
STEP THREE	Calculate Incremental Costs of Water and Sewage Disposal
STEP FOUR	Investigate BMPs for Potential Implementation
STEP FIVE	Begin Implementation
STEP SIX	Monitor the Program

"While implementing these steps is not complex, the process does require careful planning and participation from different levels of personnel" (Section 2.2, page 2-2 of the Guidebook). Thus, to ensure comprehensive and compliant plans are developed, HQ ACC and HQ AFCESA implemented an MAJCOM-wide effort to develop plans for all of ACC's installations. The benefits of this approach include standardization and economies of scale.

Based on the data collected at Nellis AFB, the Base's current and historic water consumption was determined. Each category was then evaluated relative to the implementation of applicable BMPs. Simple payback calculations were performed for O&M and Retrofit/Replacement recommendations to demonstrate compliance with the respective BMPs or to evaluate recommended new, or improvements to existing, water conservation measures. Section 3.0, Water Management Analysis, documents each of the six steps performed and includes all assumptions used and quantity and cost derivations.

SECTION 3

Water Management Analysis

3.1 Step 1 – Required Background Data

CH2M HILL performed a site visit to assist Nellis AFB in assembling the data necessary to complete the WMP. The site visit occurred between November 12 and 14, 2003. Prior to the site visit, a data needs questionnaire was developed and distributed to the different organizations that would support the data collection process. A summary of the project kick-off meeting and Base site visit activities are contained in the Orientation Meeting Minutes memorandum presented in **Appendix B**. The notes collected as part of the data collection phase during the site visit are documented in the Final Interim Status Report (ISR) in **Appendix C**. Photographs taken during the data collection phase are included in **Appendix D**. Data collected during this effort was grouped according to:

- current utility providers;
- water management program; and
- historic water consumption and cost.

3.1.1 Current Utility Providers

Nellis AFB obtains potable water from three suppliers: the Colorado River Commission (CRC) through the distribution system managed by the Southern Nevada Water Authority (SNWA), the North Las Vegas Water District (NLVWD), and 10 on-Base wells. Wastewater is discharged off-Base to the Clark County Sanitation District for treatment and disposal.

3.1.1.1 Water Utility Providers

The major components of the Base's water distribution system infrastructure include 10 potable water well sites and two municipal connections. The NLVWD source connects to the Base through a 10-inch distribution pipe from the east. The SNWA source connects to the Base through a 24-inch line located in a vault in Freedom Park. The Base has a 12-inch and an 8-inch connection to the SNWA source. The SNWA source continues also serves other area water users. The distribution system includes water towers at Bldg. 1721 (300 kgal), Bldg. 561 (500 kgal), Manch (100 kgal), and Area II (100 kgal). The distribution system also incorporates ground water storage tanks at Bldg. 491 (500 kgal), Bldg. 562 (200 kgal), 1725 (2.3 million gallons), Area III (3 million gallons), and Area II (300 kgal). The Base has 422 miles of distribution piping.

The point of contact (POC) information for Base produced water follows:

Nellis AFB Water Shop, Bldg. 565
SMSgt Charles Rowland, MSgt Jerry Griggs,
5960 Swaab Blvd.
Nellis AFB, NV 89191-7061
(702) 652-3047, (702) 652-2737

The POC information for SNWA follows:

Southern Nevada Water Authority
Michael Dishari
1001 South Valley View Blvd.
Las Vegas, NV 89153
(702) 862-3451

The POC information for the CRC follows:

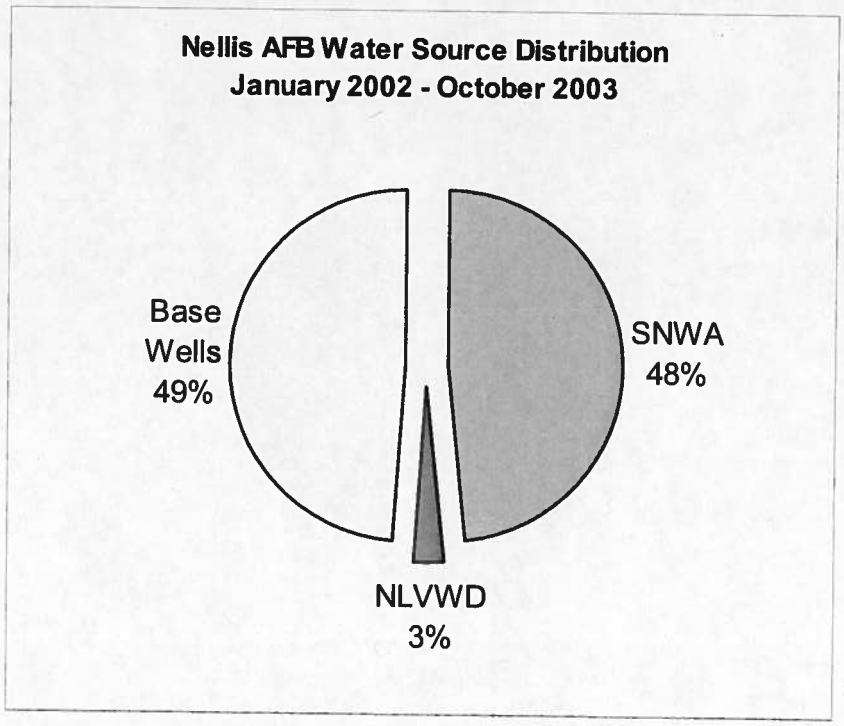
Colorado River Commission
Jim Davenport
555 East Washington Ave. Suite 3100
Las Vegas, NV 89101
(702) 486-2670

The POC information for NLVWD follows:

North Las Vegas Water District
2200 Civic Center Drive
North Las Vegas, NV 89030
Phone: (702) 633-1484

Exhibit 3-1 shows the distribution of the Base's suppliers by source. SNWA and NLVWD supply approximately 51 percent of the total Base demand with the remaining 49 percent being produced by Base wells.

EXHIBIT 3-1
Water Consumption by Source
Nellis AFB WMP



3.1.1.2 Wastewater Utility Provider

All wastewater from Nellis AFB is treated by the Clark County Sanitation District, which is approximately fifteen miles south of Nellis AFB. Wastewater is discharged from the Base using multiple lift stations through a forced main to Clark County Sanitation District.

The POC information for the Clark County Sanitation District follows:

Clark County Sanitation District
5857 East Flamingo Road
Las Vegas, NV 89122
(702) 434-6600

3.1.2 Nellis AFB Water Management Program

The Nellis AFB water management program is divided into two categories:

- Roles and Responsibilities
- Plans and Guidance Documents

3.1.2.1 Water Management Program Roles and Responsibilities

The Nellis AFB Civil Engineer (CE) Squadron operates and maintains the Base's water distribution system. The CE Squadron has designated a Base Utility Manager who is responsible for tracking overall water use and implementing water conservation measures. Distribution system O&M is accomplished by the CE Operations Flight. **Exhibit 3-2** lists the primary roles and responsibilities for personnel directly responsible for water management and conservation at Nellis AFB. Other Base functions, such as environmental, contracting, legal, and others, also support the overall water management program.

EXHIBIT 3-2
Water Management Program Roles and Responsibilities
Nellis AFB WMP

Organizational Role	Water Management Responsibilities
PROGRAM MANAGEMENT	
Base Civil Engineer	Oversees engineering activities and provides direction to the energy management program which includes water management.
Deputy Base Civil Engineer	Supports and participates in decisions relating to water projects and the performance of the program.
Operations Flight Chief	Oversees and provides direction to maintenance operations and program management of the Energy Manager and Utility Manager.
PROGRAM EXECUTION	
Energy Manager	Responsible for communicating and directing Basewide energy and water management policies, initiates and manages water conservation projects and manages Energy Savings Performance Contract (ESPC)/Utility Energy Service Contract (UESC) projects.
Utility Manager	Negotiates and monitors water utility contracts for Nellis AFB. Monitors Basewide water consumption and adjusts utility orders to minimize costs and reports water consumption for Defense Utility Energy Reporting System (DUERS) tracking.
Infrastructure Supervisor	Manages and directs personnel responsible for operations and maintenance of utility system infrastructure.

EXHIBIT 3-2
Water Management Program Roles and Responsibilities
Nellis AFB WMP

Organizational Role	Water Management Responsibilities
Facilities Supervisor	Oversees maintenance of industrial and mechanical equipment including chillers, cooling towers and steam line distribution.
Shops	Responsible for O&M of the distribution system, as well as the maintenance of facility water appliances such as showerheads, toilets, urinals and faucets.

3.1.2.2 Water Management Plan and Guidance Documents

Nellis AFB is located in an area of the country where high temperatures are typical, the predominant landscape is desert, and rainfall is sparse. These conditions have forced the Base to implement water-conscious practices for emergency shortage and drought management procedures. These practices have not been formally documented.

Emergency Water Shortage Plans and Procedures
The Base does not have a formal emergency water shortage plan. The Base utilizes the storage capacity of the water distribution system storage tanks as an emergency shortage reserve. This procedure is followed when water curtailments from SNWA occur. This happens in the summer months.

Drought Management Plans and Procedures
The Base does not have a formal drought management plan. The Base follows the water restrictions set forth by the local jurisdiction. MFH residents are given a water schedule detailing the time of day and frequency of outdoor watering.

3.1.3 Historic Water Consumption and Costs

Exhibit 3-3 illustrates the water volume consumed by Nellis AFB during FY 1999 through FY 2003. Water consumption for each FY is based on DUERS water data.

Exhibit 3-3 shows that:

- Total Base water use was fairly consistent between FY 1999 and FY 2003, ranging between 1,248,000 kgal and 1,521,000 kgal.
- The average water use over the 5-year period was 1,392,988 kgal per year.

Exhibit 3-4 illustrates the cost of water over the past 5 FYs. Water cost for each FY was based on water costs reported in DUERS.

EXHIBIT 3-3
Water Consumption
Nellis AFB WMP

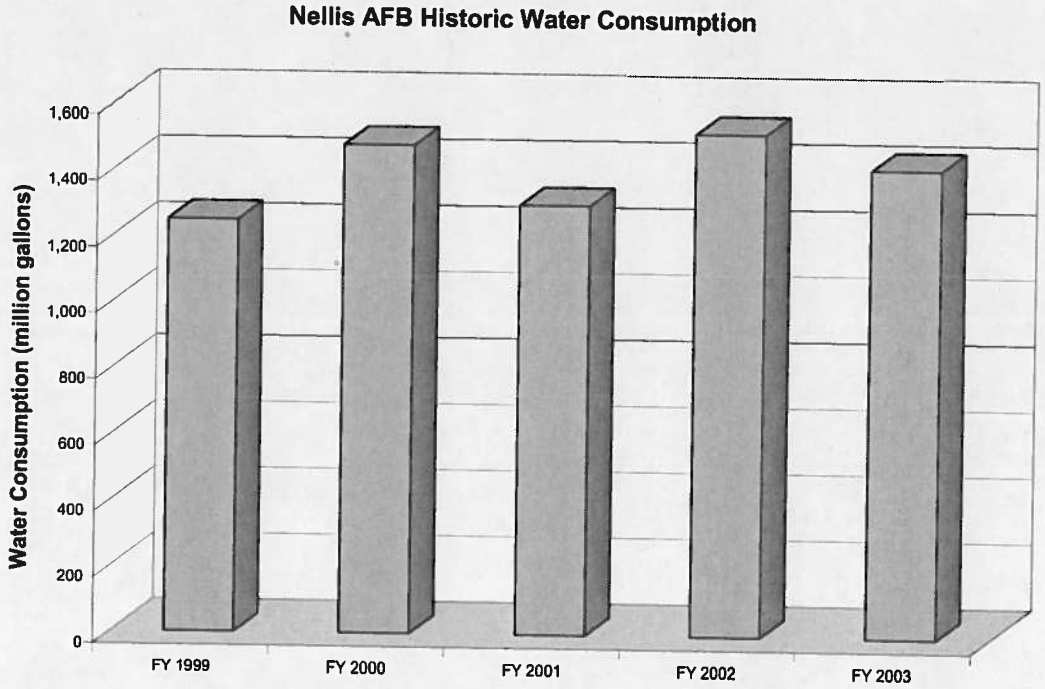


EXHIBIT 3-4
Water Costs
Nellis AFB WMP

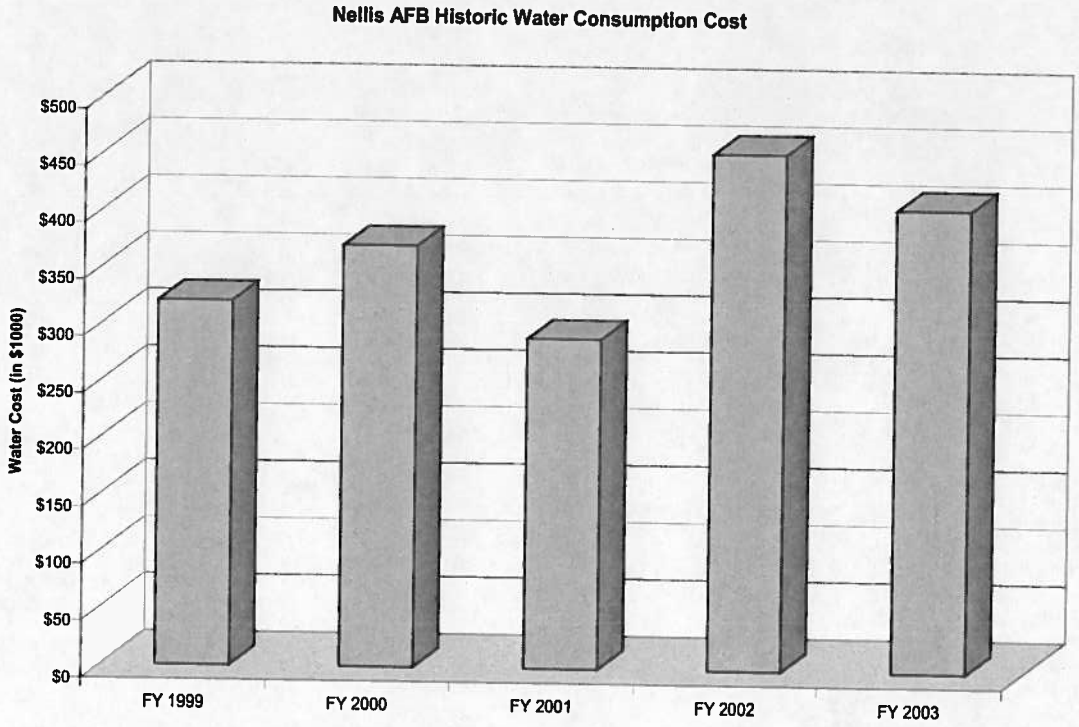


Exhibit 3-4 shows that:

- The 5-year average cost for potable water was approximately $368,000 per year.
- The Base's annual cost for potable water varies substantially from year to year with small variances in actual consumption. The primary cost variances arise from the use of multiple sources with widespread incremental rates. A further discussion of this is included in Section 3.3.1.

Exhibit 3-5 illustrates the typical seasonal cycle for water consumption at Nellis AFB. The figure is constructed using metered data from the DUERS Report. The figure shows the average annual water consumption for the past 5 FYs and the annual water consumption for FY 2003.

EXHIBIT 3-5
Seasonal Water Consumption
Nellis AFB WMP

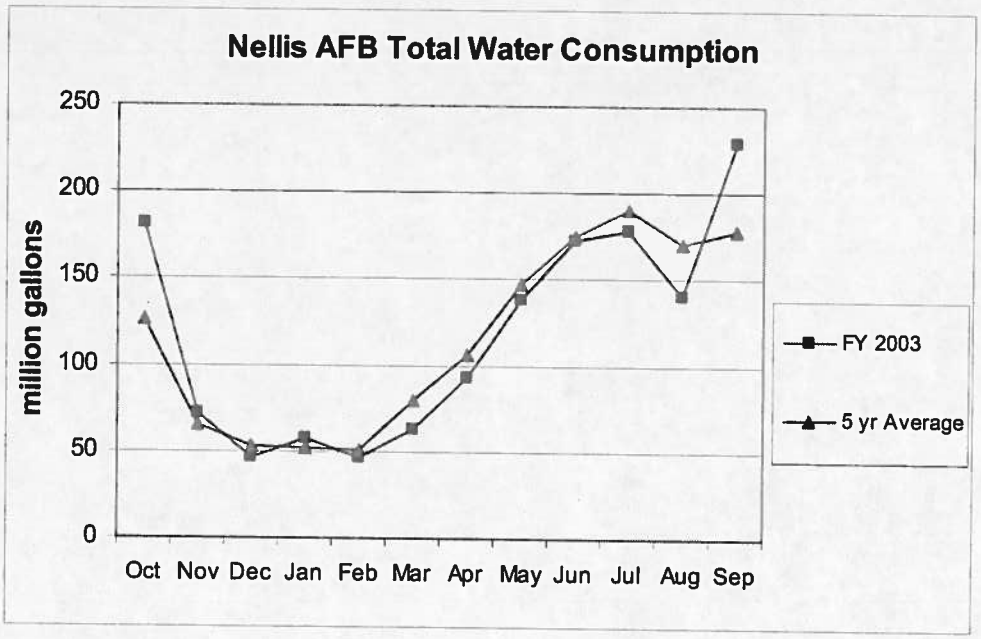


Exhibit 3-5 shows that:

- There are measurable increases in water consumption during the warmer months. While the increases in water use during the summer months may be attributed to evaporative coolers, cooling towers, and swimming pools, irrigation is expected to be the largest summer water use.
- FY 1999 through FY 2002 show similar trends, however, for clarity, only FY 2003 and the 5-year averages are shown.

3.2 Step 2 – Investigation/Categorization of Water Use

The *Air Force Water Conservation Guidebook* outlines the process of categorizing water as a means to develop a "credible and defensible estimate for water use by facility category." With water

categorization, estimates can be developed to determine where water is used, how much is used, and what the most efficient means to better conserve water are. Categorization of water use provides focus for determining where to implement BMPs. The Air Force has determined the following 5 categories provide a sufficient representation of water use on Air Force installations:

- Category 1 – Housing. This category includes water use specific to MFH units. This category does not include irrigation for MFH units, which is included in Category 3 or leaks and losses for MFH, which is included in Category 4.
- Category 2 – Commercial. This category includes administrative buildings, dining halls, hospitals, schools, and dormitories.
- Category 3 – Irrigation. This category includes MFH irrigation and Base landscape irrigation, typically for parks, parade grounds, ball fields, greenbelts, and the golf course. The irrigation water included in this category is potable sources of irrigation only.
- Category 4 – Leaks, Losses, and Unaccounted for water. This category represents water losses from the water distribution system.
- Category 5 – Industrial. This category includes hangars, testing, and maintenance and repair facilities.

3.2.1 Data Used to Investigate/Categorize

The following sources of information were used to determine water use for each category.

- Meter data
- DUERS reports
- Utility water consumption data sheets
- Historic water use studies
- *Nellis AFB Master Plan*
- Installation Water Resource Analysis and Planning System (IWRAPS) coefficients
- Real Property records (RP-7115)
- DOE water use indices
- *Air Force Water Management Guidebook*

3.2.2 Water Use by Category

Using the 5-year average for water consumption as the baseline, the following sections present the steps and data used to determine the water consumption for each of the five categories.

3.2.2.1 Category 1 – Housing Facilities

There are 1,278 MFH units at Nellis AFB encompassing approximately 1.69 million square feet of living area, or 26 percent of total water using facility area.

- 350 units in the new Nellis Terrace area, constructed in 1998.
- 329 units in the old Nellis Terrace area, constructed in 1970/1975.
- 593 units in the Manch Manor area, constructed in 1960, 1971, and 1975.
- 6 homes in Dunning Circle, constructed in 1957, 1968.

The Nellis Terrace and Dunning Circle MFH units are located in Area I of the main Base. The Manch Manor MFH units are located in Area III of the main Base. The MFH units are connected to the Base distribution system. Through multiple sub metering locations water consumption for these areas is summed by the Base Utility Engineer and recorded on the monthly MFH DUERS reports. The annual consumption reported for MFH was 356,000 kgal in FY 1999, 399,000 kgal in FY 2000, 428,000 kgal in FY2001, 129,000 kgal in FY2002, and 175,490 kgal in FY 2003. Therefore, the average consumption based on DUERS was 297,498 kgal per year.

- The water consumption data in the DUERS reports for MFH include interior use (cooking, washing, and showering), residential irrigation, and leaks and losses. For the purpose of this report, Category 1 water use includes only the amount of water used for interior use. MFH irrigation water use is reported in Category 3 and MFH leaks and losses are reported in Category 4. The MFH irrigation water consumption and MFH leaks and losses are presented here and repeated in their subsequent sections to give an overall insight into what the MFH DUERS data represents.

- The MFH residential water use was estimated based on total square footage of housing and the winter baseline IWRAPS water use coefficient (0.16681 gallons per day per square foot). The total area for housing was recorded as 1.69 million square feet in the Nellis AFB Real Property report. The IWRAPS coefficient provides an estimated daily water use rate; therefore, a 333 day per year occupancy rate was assumed.[1]

  - ✓ 1,694,521 sf x 0.16681 gal per sf per day = 282,663 gal per day.
  - ✓ 282,663 gal per day x 333 days per year/1000 = 94,127 kgal per year.

- The estimated MFH irrigation water use was determined using a summer minus winter consumption approach. The average monthly summer consumption was determined by averaging the FY 1999 through FY 2003 MFH DUERS data for the months of March through November. The average monthly winter consumption was determined by averaging the FY 1999 through FY 2003 MFH DUERS data for the months of December through February. The irrigation months were determined by distinct breaks in the water consumption data. The estimated annual water consumption for MFH irrigation is as follows:

  - ✓ 29,566 kgal per month (5-year summer monthly average) – 10,467 kgal per month (5-year winter monthly average) x 9 summer months = 171,891 kgal per year.

- The estimated MFH leaks, losses, and unaccounted for water use was determined using a mass balance approach:

  - ✓ MFH (DUERS) – MFH (Category 1) - MFH (Irrigation) = MFH (Leaks and Losses)
  - ✓ 297,498 kgal – 94,127 kgal – 171,891 kgal = 31,480 kgal per year MFH Leaks and Losses.

Based on information provided during the site visit, the following planned changes will affect the projected water consumption for the housing category:

- Privatization of MFH has been approved and will commence in October 2004. All of the 1,278 housing units on Base will be privatized in FY 2005 and MFH water consumption will no longer be included in the DUERS totals reported by Nellis AFB.

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[1] An average of 333 days per year occupancy was estimated by subtracting 15 days per year for vacations and holidays and multiplying by the occupancy rate of 95 percent.

- The projected annual water consumption for the housing category is:
  - ✓ 0 kgal per year.

3.2.2.2 Category 2 – Commercial Facilities

The Base has approximately 212 commercial facilities connected to the Base water distribution system. These facilities include administrative offices, medical and dental facilities, Base exchange, commissary, a dining hall, Officer and NCO clubs, dormitories, distinguished visitors quarters (DVQ), visiting officers quarters (VOQ), temporary living facilities (TLF) and schools. These facilities occupy 2.75 million square feet of area or 42 percent of the total Base water using facilities area.

The Base does not generally have secondary meters on commercial facilities. The population information available does not provide accurate information on the occupancy of commercial facilities. Real Property records provide reliable information about the size and use of each of the commercial facilities. Therefore, the best estimate of commercial water consumption is based on the size, use (estimated days of operation per year), and the IWRAPS coefficient for these facilities.

Commercial facilities were identified using the Nellis AFB Real Property report. Likely facilities were identified based on category codes beginning with 17, 51, 53, 54, 55, 61, 72, 73, 74, 75, and 76. The list of likely facilities was reviewed and those not connected to the water distribution system were eliminated. The remaining facilities were then grouped into IWRAPS-defined subcategories. The subcategory square footage was equal to the sum of its facilities' square footages, which were obtained from the Real Property report.

Daily water use was calculated for each subcategory by multiplying the subcategory total square footage by the subcategory's IWRAPS coefficient. The annual consumption was then determined by multiplying the daily total by the estimated operation (days per year). The estimated operation for each subcategory was determined as follows:

- Administrative/Operations – 260 days per year (5 days per week x 52 weeks per year)
- Bowling Center – 350 days per year (365 days per year – 15 days closed for holidays)
- Commissary – 350 days per year (365 days per year – 15 days closed for holidays)
- Community– 350 days per year (365 days per year – 15 days closed for holidays)
- Dining – 350 days per year
- Dormitories – 292 days per year (365 days per year x 80 percent occupancy)
- Exchange – 350 days per year (365 days per year – 15 days closed for holidays)
- Guest Housing – 208 days per year (5 days per week x 52 weeks per year x 80 percent occupancy)
- Gyms – 350 days per year (365 days per year – 15 days closed for holidays)
- Health/Dental Clinic – 260 days per year (5 days per week x 52 weeks per year)
- Hospital – 365 days per year
- Maintenance – 260 days per year (5 days per week x 52 weeks per year)
- Restaurants/Cafeteria – 350 days per year (365 days per year – 15 days closed for holidays)
- Schools (Child Development Center) – 260 days per year (5 days per week x 52 weeks per year)
- Service Station - 350 days per year (365 days per year – 15 days closed for holidays)
- Warehouse – 260 days per year (5 days per week x 52 weeks per year)

The total annual consumption for the commercial category was then determined by summing the totals for each subcategory. **Exhibit 3-6** shows the total water consumption by subcategory for the commercial category.

EXHIBIT 3-6
Commercial Facilities Water Consumption
Nellis AFB WMP

Facility	Count of Facilities	Total Area (SF)	IWRAP Water Use Coefficient (Gal/SF/day)	Estimated Daily Water Consumption (kgal/day)	Estimated Operation (days/yr)	Estimated Annual Water Consumption (kgal/yr)
Administrative/Operations	98	748,629	0.37405	280.0	260	72,800
Bowling Center	1	17,586	0.04341	0.8	350	280
Commissary	4	101,493	0.12706	12.9	350	4,515
Community	16	144,278	0.06078	8.8	350	3,080
Dining	7	103,608	0.39572	41.0	350	14,350
Dormitories	38	798,123	0.15611	124.6	292	36,383
Exchange	3	172,322	0.37506	64.6	350	22,610
Guest Housing	9	32,919	1.82504	60.1	208	12,501
Gyms	4	64,085	0.14719	9.4	350	3,290
Health/Dental Clinic	4	27,550	0.12282	3.4	260	884
Hospital	1	314,618	0.76046	239.3	365	87,345
Maintenance	5	25,120	0.26235	6.6	260	1,716
Restaurants/Cafeteria	3	7,174	0.57273	4.1	350	1,435
Schools	3	41,413	0.10113	4.2	260	1,092
Service Station	3	20,853	0.14200	3.0	350	1,050
Warehouse	13	128,795	0.06034	7.8	260	2,028
Total	212	2,748,566				265,359

Based on information provided during the site visit, the following planned changes will affect the projected water consumption for the commercial category:

- The Base will replace 500 of the dormitories' existing 2.5 gpm showerheads, which are already compliant with *Guidebook* standards, with 1.5 gpm ultra low-flow showerheads. For the projected water use, it is assumed that each showerhead is used by two dorm rooms (2 persons) or 1,000 total persons and that the average shower lasts 5.3 minutes per day per capita (*Air Force Water Conservation Guidebook*).
  - ✓ 1 gpm water savings x 5.3 min per day per person x 1000 persons x 292 day per year/1000 gal per kgal = 1,547 kgal per year.
- The projected annual water consumption for the commercial category is:
  - ✓ 265,359 kgal per year – 1,547 kgal per year = 263,812 kgal per year.

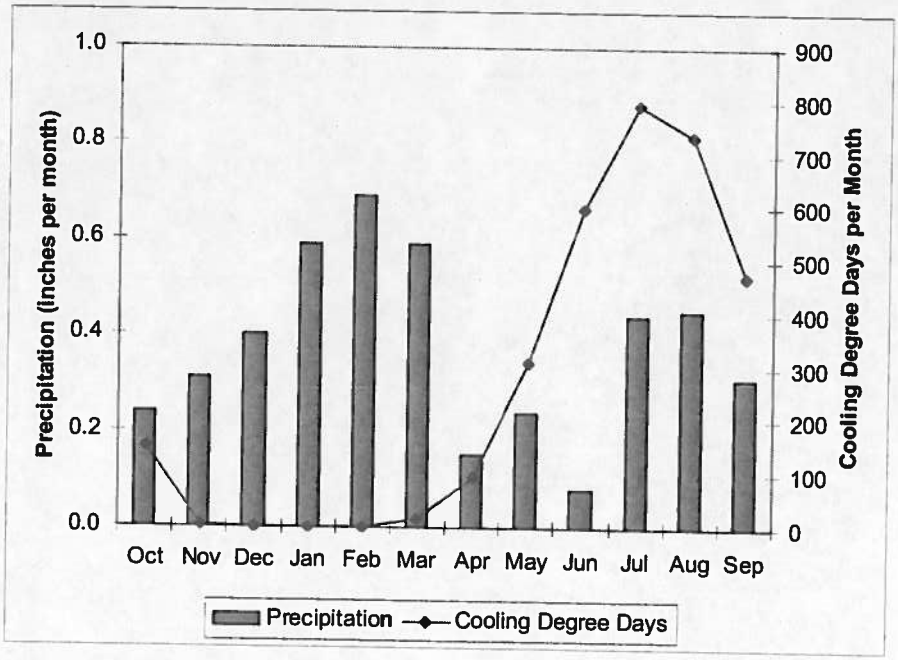
3.2.2.3 Category 3 – Irrigation

Water consumption in this category consists of landscape irrigation of the parks, ball fields, housing areas, the golf course, and other public areas. Landscaped irrigated areas are generally not metered. However, the potable water used at the golf course is metered. All areas that use

irrigation systems have automatic controllers. The Civil Engineer Squadron (CES) Irrigation Shop operates and maintains the automatic controllers, as well as manually administers irrigation on the main Base. Golf course personnel operate and maintain the golf course irrigation system.

- The MFH irrigation water use was estimated using the summer minus winter difference (see Section 3.2.2.1).
  - ✓ MFH irrigation = 171,891 kgal per year.
- The total area of irrigated parks, ball fields, golf courses, and other public irrigated areas on Base is approximately 291 acres. This area does not include the MFH irrigated areas.
- The golf course consists of 249 acres of the irrigated area on Base and the irrigation water use is based on metered data.
  - ✓ Golf Course irrigation = 381,840 kgal per year
- The 42 acres of main Base irrigation water use was estimated based on the deficit in rainfall compared to evapotranspiration (water used by the vegetation). Monthly rainfall and cooling degree days were determined from 30 years of precipitation data from the National Atmospheric and Oceanic Administration (NOAA) for Las Vegas, Nevada. The number of cooling degree days is an indicator of when evapotranspiration rates are high and the vegetation will require more water to survive.[2] **Exhibit 3-7** shows the average number of cooling degree-days as well as the average monthly rainfall for the Nellis AFB area.

EXHIBIT 3-7
Average Monthly Rainfall and Degree Days
Nellis AFB WMP



[2] Cooling Degree-Days. A measure of the warmth of weather to determine cooling requirements. Degree days for a 24-hour period are calculated by adding the day's high and low temperatures and dividing by two, and subtracting the result from a reference point, usually 65 degrees Fahrenheit. Source: http://www.columbiagasohio.com/home/glossary/.

- Water consumption for the irrigated areas on the main Base was estimated based on industry standards, the amount of acreage being irrigated, and degree-days. Healthy growing turf will use a peak of 0.25 inches of water per day. Nellis AFB's irrigation schedule is set by Base personnel (1 March through 30 November) with some limited irrigation in the winter months and follows seasonal weather patterns which corresponds to the number of degree days in the region. The Base irrigation schedule is approximately 274 days per calendar year. During this 274-day time period, the average rainfall was 0.010 inches per day. The annual irrigation water consumption for parks, ball fields, housing areas, golf courses, and other public areas was estimated as follows:
  - ✓ (0.25 inches per day) – (0.010 inches per day) = 0.24 inches per day irrigation demand.
  - ✓ [(0.24 inches per day)/(12 inches per foot)] x (42 acres) x (43,560 sf per acre) = 36,590 cubic feet per day.
  - ✓ (36,590 cubic feet per day x 7.481 gallons per cubic foot)/1000 = 274 kgal per day.
  - ✓ 274 kgal per day x 274 day per year = 75,076 kgal per year.
- The total average annual water use for irrigation of MFH, the Golf Course, and irrigation for parks, ball fields, and other public areas:
  - ✓ 171,891 kgal, MFH + 381,840 kgal, Golf Course + 75,076 kgal, main Base = 628,807 kgal per year.

Based on information provided during the site visit, the following planned changes will affect the projected water consumption for the irrigation category.

- MFH Privatization will eliminate MFH water use from the DUERS reporting. This will in turn eliminate MFH irrigation from the irrigation total. Therefore, the projected annual water consumption for the irrigation category is:
  - ✓ 628,807 kgal – 171,891 kgal = 456,916 kgal per year.

3.2.2.4 Category 5 – Industrial Facilities

Industrial facilities include approximately 2.05 million square feet of area or 32 percent of the total Base water using facilities on Nellis AFB. These facilities consist primarily of hangers, fuel storage, explosive storage, and aircraft and vehicle maintenance facilities. The Base's primary mission does not require a large industrial water use.

The Base does not have secondary metering at the facilities in this category. The Base Utility Engineer currently estimates water consumption for DUERS reporting of the facilities included in this category. The population information available does not support obtaining accurate information on the occupancy of the facilities in this category. Real Property records provide reliable information concerning the size and use of each of the facilities in this category. Therefore, the best estimate of industrial water consumption is based on the size, use (days in operation), and IWRAPS coefficient for the facilities.

Industrial facilities were identified using the Real Property report. Likely facilities were identified based on category codes beginning with 12, 13, 14, 21, 22, 81, 82, 83, 84, and 89. The list of likely facilities was reviewed and those not connected to the water distribution system were eliminated. The remaining facilities were then grouped into IWRAPS-defined subcategories. The subcategory square footage was equal to the sum of its facilities' square footages, which were obtained from the Real Property report.

Daily water use was calculated for each subcategory by multiplying the subcategory total square footage by the subcategory's IWRAPS coefficient. The annual consumption was then determined by multiplying the daily total by the estimated operation (days per year). The estimated operation for each subcategory was determined as follows:

- Administrative/Operations – 260 days per year (5 days per week x 52 weeks per year)
- Maintenance – 260 days per year (5 days per week x 52 weeks per year)
- Warehouse – 260 days per year (5 days per week x 52 weeks per year)

The average annual consumption for the commercial category was then determined by summing the water use for each subcategory. **Exhibit 3-8** shows the average water consumption by subcategory for the industrial category. Average annual Industrial water use was determined through IWRAPS and Real Property records to be 86,190 kgal/year.

EXHIBIT 3-8
Industrial Facilities Water Consumption
Nellis AFB WMP

Facility	Count of Facilities	Total Area (SF)	IWRAP Water Use Coefficient (Gal/SF/day)	Estimated Daily Water Consumption (kgal/day)	Estimated Operation (days/yr)	Estimated Annual Water Consumption (kgal/yr)
Administrative/Operations	44	443,739	0.37405	166.0	260	43,160
Maintenance	52	339,107	0.26235	89.0	260	23,140
Warehouse	89	1,268,052	0.06034	76.5	260	19,890
Total	185	2,050,898				86,190

- Based on information provided during the site visit, there are no planned changes that will affect the projected water consumption for the industrial category. Therefore, the projected annual water consumption for the industrial category is:
  - ✓ 86,190 kgal per year.

3.2.2.5 Category 4 – Miscellaneous: Leaks, Losses and Unaccounted for Water

- Miscellaneous water use at Nellis AFB includes leaks, losses, and unaccounted for water. Most of these losses result from potable water lines, but fire hydrant testing and potable water line flushing are also included. In addition to flushing lines following repairs, the Base occasionally flushes sections of the distribution lines to maintain chlorine levels. Nellis AFB's water distribution system has an estimated 2.2 million linear feet, or 422 miles, of potable water mains and sub distribution systems.

The Base does not track or maintain any records documenting water consumption from line flushing or hydrant testing. Therefore, water consumption for this category was determined by mass balance analysis, adding categories 1, 2, 3, and 5 and subtracting their totals from the total average annual water use determined in Section 3.1.3. **Exhibit 3-9** shows the basis for determining the total annual water attributed to leaks, losses, and unaccounted for uses of water based on historic consumption.

EXHIBIT 3-9
Leaks, Losses, and Unaccounted for Water Use
Nellis AFB WMP

Category	Basis for Estimated Annual Water Use	Estimated Annual Water Use (kgal/yr)
Category 1 – Housing	A (see 3.2.2.1)	94,127
Category 2 – Commercial	B (see 3.2.2.2)	265,359
Category 3 – Irrigation	C (see 3.2.2.3)	628,807
Category 5 – Industrial	D (see 3.2.2.4)	86,190
Subtotal Categories 1, 2, 3, and 5	E = A + B + C + D	1,074,483
Total Annual Consumption	F (see 3.1.3)	1,392, 988
Category 4 – Leaks & losses	G = F - E	318,505

Based on information provided during the site visit, the following planned changes will affect the projected water lost due to leaks and unaccounted water use:

- MFH Privatization will eliminate water use from the DUERS reporting. Therefore, the projected annual water consumption for the Leaks, Losses, and Unaccounted for Water category is:
  - ✓ 318,505 kgal - 31,480 kgal = 287,025 kgal per year.

3.2.2.6 Summary of Findings

Exhibit 3-10 shows the current and projected distribution of water by category at Nellis AFB. Privatization of MFH will be the major contributor in reducing the total Base water consumption. The projected water use is based on the average FY 1999 through FY 2003 historic water consumption and current changes that will take place at Nellis AFB.

EXHIBIT 3-10
Historic and Projected Water Use
Nellis AFB WMP

Category	Historic Annual Consumption (kgal)	Historic Annual Consumption (% of Total)	Projected Annual Consumption (kgal)	Projected Annual Consumption (% of Total)
1 – Housing	94,127	6.8	0	0.0
2 – Commercial	265,359	19.0	263,812	24.1
3 – Irrigation	628,807	45.1	456,916	41.8
4 – Leaks/Losses	318,505	22.9	287,025	26.2
5 – Industrial	86,190	6.2	86,190	7.9
Total	1,392,988		1,093,943	

3.3 Step 3 – Calculation of Incremental Costs of Water and Sewage Disposal

3.3.1 Historic Rates

Nellis AFB obtains all potable water from three sources: SNWA, NLVWD and 10 on-Base wells as discussed in Section 3.1.1.1. All three sources have basic rates that vary significantly (**Exhibit 3-11**). NLVWD water use is minimized because the basic incremental rate for this water is over $2 per kgal, which is approximately four times the incremental rate of the SNWA source. The Base produced potable water has the lowest unit cost.

The Base's Utility Sales Rates Worksheet incremental (DOD Agency) rate for potable water is based on a blended rate, due to multiple suppliers, and the annual cost variances for maintenance, repairs, replacements, and materials. The historic average incremental cost of water for the last 3 FYs is $0.69 per kgal as determined from the FY 2001 through FY 2003 Utility Sales Rates Computation Worksheets.

The average incremental wastewater rate for the Base was $2.26 per kgal based on the Bases Utility Sales Rate Computation Worksheet for FY 2001 through 2003. This rate was based on a fixed annual disposal cost and an estimated volume of sewage, which was based on an Equivalent Residential Unit (ERU) analysis for the Base. The ERU analysis is evaluated approximately every 10 years. The wastewater unit rate was not used in project calculations because it is a fixed annual cost and will not change if water saving projects reduce the discharge from the Base.

- **Exhibit 3-11** summarizes the rates the Base paid for potable water and wastewater treatment during the past 3 years.

EXHIBIT 3-11
Historic Annual Water and Wastewater Rates
Nellis AFB WMP

	Supplier Basic Incremental Rates*			Water**	Wastewater
Year	SNWA Basic Rate ($ per kgal)	NLVWD Basic Rate ($ per kgal)	Base Produced ($ per kgal)	Combined Total Rate ($ per kgal)	Total Rate ($ per kgal)
FY 2003	0.57	2.29	0.14	0.63	1.93
FY 2002	0.56	2.59	0.11	0.63	2.33
FY 2001	0.43	2.21	0.09	0.80	2.51
Average				0.69	2.26

* The basic incremental rates were determined by dividing the annual consumption cost by the annual consumption from each source based on Utility Sales Rates Worksheets for the corresponding FY.
** The combined total water rate represents the blended incremental DOD Agency rate and includes the basic rates, line losses, and O&M costs associated with the distribution system.

3.3.2 Projected Rates

Projected rates will be used to perform simple payback analyses for proposed water conservation projects identified to meet or enhance BMP requirements. To determine the cost savings, estimated water use savings for each project are multiplied by the projected incremental rate. Some projects may generate wastewater savings as well. However, the

wastewater disposal is a fixed annual cost and the incremental wastewater rate was not used or projected for project calculations.

Currently the entire Southern Nevada region is exceeding the Colorado River Commission limit of 300,000 acre-feet from Lake Mead. The region is using approximately 477,000 acre-feet and will need to reduce to the set limit while experiencing a high population growth rate. The NLVWD incremental water rates will double over the next 3 years as a means to reduce water consumption for the area. Nellis AFB averages 2,200 to 2,500 acre-feet of water use annually, which is below the Base's allotment. This could become a driver for the SNWA to renegotiate the 4,000 acre-foot limit set for Nellis AFB. The true value of the water, as an asset of sustainability for the Base, must be considered when deciding on potable water sources and operational costs. If the Base does not use the allocated SNWA water, it could possibly lose the rights to that water. Thus, a decision based on the incremental unit cost of water to optimize operating cost cannot be the sole factor in balancing the distribution from any particular source. The Base's goal is to maximize the use of the SNWA water source and keep the Base wells in an operating capacity state. However, a formal strategy has not been applied and the projected water rates will be based on the current weight distribution of the three sources.

- The projected basic incremental rate for potable water is based on a weighted average taking into account each sources' future incremental rate and the current volume of water attributed to that incremental rate. **Exhibit 3-12** summarizes the projected rates used in the WMP for BMP project analysis.

EXHIBIT 3-12
Projected Incremental Water Rate
Nellis AFB WMP

Year	SNWA Basic Rate ($ per kgal)		NLVWD Basic Rate ($ per kgal)		Base Produced ($ per kgal)		System O&M ($ per kgal)		Combined Total Rate ($ per kgal)
Projected Rate*	0.71		4.58		0.16		0.23		
	x		x		x		x		
Weight %	48%		3%		49%		100%		
Weighted Rate**	0.34	+	0.14	+	.08	+	0.23	=	0.79

* The projected rates were determined as follows:
- The SNWA source was projected at 3percent per year increase for the next 5 years from the current basic rate of $0.63 per kgal.
- The NLVWD rate is expected to double in the next 5 years. The projected rate is 2 times the current rate of $2.29 per kgal.
- The Base produced water was projected at a 3 percent year increase for the next 5 years from the current basic rate of $0.14 per kgal.
- The Line Losses/O&M projected rates used were the historical average.

** The SNWA has averaged 48 percent, the NLVWD has averaged 3 percent, and the Base produced potable water has averaged 49 percent of the total Base water volume as determined from January 2002 through October 2003 metered water use.

- The projected incremental rate for water is $0.79 per kgal. No projected upgrades or other changes to the water distribution system have been included in the projected rate.
- A projected incremental rate for wastewater disposal is not applicable.

3.4 Step 4 – Investigation of DOE FEMP BMPs

Executive Order 13123 promotes water conservation through the "*Guidance to Establish Water Efficiency Improvement for Federal Agencies.*" Under this EO and the subsequent DOE guidance, Nellis AFB has developed this WMP and will implement at least four water efficiency BMPs. Each BMP consists of O&M and retrofit and replacement options. O&M options involve optimizing existing equipment and fixtures to minimize water use. Retrofit and replacement options involve modifying or replacing outdated fixtures and equipment.

This section describes the analysis performed to evaluate Nellis AFB's compliance with each of the ten BMPs listed in the DOE guidance. An ISR (see **Appendix C**) with preliminary water categorization and BMP evaluations was prepared and internally reviewed by the Air Force. During preparation of the ISR, a BMP Evaluation Matrix was developed summarizing the Base's compliance with the ten BMPs (see **Appendix** E). Compliance was determined by evaluating O&M practices and other applicable programs, projects, and water conservation measures already implemented at the Base, relative to the requirements listed in the *Air Force Water Conservation Guidebook*. This evaluation identifies projects or operational changes necessary to achieve compliance or to further enhance existing water conservation measures and provides assumptions, supporting calculations, basis for compliance, and recommendations for each BMP.

3.4.1 Analysis of BMP #1: Public Information and Education Programs

BMP Description: A water-related public information and education program is a comprehensive plan to effectively communicate water conservation issues, concerns, emergencies, and processes to Base personnel, both military and civilian, as well as the surrounding community. Such a program can provide significant water savings and promotes goodwill by publicizing the Base's commitment to shared environmental values and concerns. Appendix F discusses BMP # 1 compliance in further detail.

Basis for BMP Credit: Compliance with this BMP is based on implementing the following activities:

- Publish seasonal news articles to encourage water conservation.
- Implement a Basewide energy policy which also contains water conservation guidelines clearly defining irrigation schedules for commercial facilities and Base residences, discussing drought standards, and outlining responsibilities of Base personnel.
- Establish and publicize a water conservation hotline phone number to encourage personnel to report water leaks or submit water conservation ideas.
- Water conservation POC coordinates quarterly facility manager training seminars to educate facility managers of water conservation initiatives.
- Base water conservation surveys and inspections of water distribution system, large water using facilities, and family housing as necessary to maintain informed on current Base conditions.
- Display signs and posters in large water using facilities and public areas. Develop and publish water conservation facts to be distributed to existing and new residents in Base housing.

BMP Credit Status: The following bullets summarize the Base's current public information and education programs for water conservation.

- CE does not develop seasonal water conservation articles for publishing in the Base newspaper, the *Bullseye.*
- The Base's energy policy does not include water conservation guidelines.
- The Base has a customer services hotline. Base residents have access to this number in their Housing information packet and can use this hotline to report water leaks or other water problems.
- Facility manager training does not include water conservation topics with the energy conservation.
- Currently, the water conservation POC does not conduct surveys and inspections of water distribution system and large water using facilities.
- The Base currently publishes water use and water restriction information for MFH in the Base newspaper, the *Bullseye.* This information is also displayed on the Base TV channel. The Base Housing office also provides conservation landscape information to Public Affairs for publishing in the Base newspaper.

BMP Credit Earned: The Base cannot claim credit for BMP #1. While water conservation information is published, it is currently restricted only to notifying MFH residents of water restrictions. Water-conscious communication is best published on a regular basis to impact Basewide water conservation efforts.

Next Steps: To achieve credit for BMP #1, a recurring water conservation program focusing on public education and awareness should be developed. This can be accomplished by meeting the following criteria:

- Develop and publish seasonal news articles that provide conservation tips and water use facts.
- The Basewide energy policy should also contain water conservation guidelines clearly defining irrigation schedules for commercial facilities and Base residences, discussing drought standards, and outlining responsibilities of Base personnel.
- Conduct site inspections of large water using facilities and family housing areas as necessary to keep updated of current Base conditions.
- Coordinate with facility managers training to include emphasis on water conservation awareness.

Additional enhancements to consider include promoting water conservation at public events and developing an awards and recognition program to provide incentive to Base personnel. Further consideration should also be given to developing an energy and water conservation database that would allow CE to choose from a list of already produced articles and quickly customize the chosen article to reflect the current situation.

Exhibit 3-13 summarizes the projects, the estimated savings, costs, and payback period for BMP #1.

EXHIBIT 3-13
Implementation Costs, Savings, and Payback for BMP # 1
Nellis AFB WMP

BMP	Water, Estimated Annual Savings (kgal)	Wastewater, Estimated Annual Savings (kgal)	Estimated Annual Savings ($)	Estimated Implementation Costs ($)	Simple Payback Period (yrs)
Upgrade awareness program	6,564	3,822*	5,186	6,160	N/A

* The wastewater savings are shown but the disposal costs are not included because of the Base's fixed annual wastewater rate structure.

The following assumptions were used to determine the water savings and simple payback period calculation listed in Exhibit 3-13:

- The time necessary to develop a comprehensive water conservation awareness program was estimated at 224 hours per year including Taking into account current awareness programs, a total of 112 hours per year were estimated to implement the program including 32 hours to prepare seasonal news articles (4 articles x 8 hours/article), 24 hours to implement energy policy and water conservation guidelines, 16 hours to schedule and prepare water conservation updates for facility managers training, and 40 hours to conduct weekly water surveys.

- Personnel from CE, Environmental, and/or Public Affairs would write the water conservation material. Assuming a GS-11, step 5 salary, including benefits and a 25 percent markup for general and administrative (G&A) support, the estimated labor cost is $45.00 per hour. Non-labor costs were estimated at $10 per labor hour. These charges are based on previous utility privatization estimates for documentation materials and miscellaneous expenses.

  - ✓ 112 hours x $45.00 per hour = $5,040 labor cost per year.
  - ✓ 112 hours x $10.00 per hour = $1,120 non-labor cost per year.
  - ✓ $5,040 labor cost + $1,120 non-labor cost = $6,160 total cost per year.

- The savings for this BMP was estimated based on an energy study by Florida Solar Energy Center that indicated increased conservation programs resulted in 2 to 4 percent savings in energy consumption. It was assumed that a conservative parallel could be drawn and that a 1 percent savings in water use could be achieved through increased public awareness programs.

- The one percent value was further proportioned into each water conservation program and are classified as: 1) Base implemented, 2) Base required, and 3) Base enhancements. Refer to **Appendix F** for water awareness criteria.

- Current Base implemented programs include service call promotion and sign placement/literature distribution. These programs attribute to approximately 0.2 percent of Base water savings.

- Four Base required water conservation programs (seasonal articles, energy policy update, weekly site inspections, and additional facility manager's training) are estimated to save an

additional 0.6 percent of Nellis AFB's total water use and should be implemented to receive credit as a BMP.

- Further enhancements (electronic media, awards, and public event promotion) represent the final 0.2 percent and are not required to meet BMP standards.
- Water savings from implementing Base required programs were estimated:
  - ✓ 1,093,943 kgal per year (projected) x 0.6 percent = 6,564 kgal water saved per year.
  - ✓ 6,564 kgal per year water x $0.79 per kgal water = $5,186 water cost savings per year.
- The estimated simple payback period cannot be determined from this analysis due to the varying annual costs to maintain the program.

3.4.2 Analysis of BMP #2: Distribution Systems Audits, Leak Detection, and Repair

BMP Description: This BMP involves maintaining an efficient Base program for early detection of leaks in the distribution system and correcting them in a timely manner.

Basis for BMP Credit: Compliance with this BMP is based on the current estimated loss of water from the system due to leaks and other unaccounted for losses. If these losses are less than 10 percent of the total consumption, no further evaluation of this BMP is required. Otherwise, credit for this BMP is based on assessing and remedying water distribution system leaks:

- O&M: Full-scale audit and leak detection survey, consistent with Manual of Supply Practices, AWWA #M36.
- Retrofit/Replacement: Effectively retrofit/replace pipes when leaks are found.

BMP Credit Status: The following bullets summarize the Base's current system audit, leak detection, and repair programs.

- The Base has not conducted an AWWA leak detection survey.
- Retrofit/Replacement: Approximately 55 percent of the water distribution system has been upgraded to C900 PVC piping. Fifty percent of this was upgraded in 1985 to 1986. The remaining original water distribution system is composed of asbestos concrete (AC) and cast iron (CI) pipes.
- Retrofit/Replacement: The Base is programming the repair and replacement of the piping that extends approximately 5 miles to the Craig Road wells.
- Preventive maintenance on the water distribution system is performed by Water Shop personnel under RWP.

BMP Credit Earned: The Base cannot claim credit for BMP #2. The Base has not conducted a leak detection survey. The Base also needs to continue upgrading the distribution system to replace older, more leak prone piping.

Next Steps: To achieve credit for this BMP, the following actions are needed:

- Conduct a comprehensive leak survey in accordance with AWWA #M36.

Exhibit 3-14 shows the projects and estimated savings, costs, and payback period for BMP #2.

EXHIBIT 3-14
Implementation Costs, Savings, and Payback for BMP #2
Nellis AFB WMP

BMP	Water, Estimated Annual Savings (kgal)	Wastewater, Estimated Annual Savings (kgal)	Estimated Annual Savings ($)	Estimated Implementation Costs ($)	Simple Payback Period (yrs)
Conduct AWWA Leak Detection Survey	71,756	N/A	56,687	59,700 *	N/A

** Estimated implementation costs are to conduct an AWWA leak detection survey only and do not include costs to repair leaks or replace water distribution system pipes.*

The following assumptions were used to determine the water savings and simple payback period calculation listed in Exhibit 3-14:

- There are approximately 422 miles of water distribution lines on Base. This includes approximately 19 miles of piping in MFH and 5 miles of piping programmed for replacement that would not be included in the AWWA survey. Based on the *Air Force Water Conservation Guidebook*, the cost to complete the survey is estimated to be $150 per mile of pipe surveyed.
  - ✓ 422 miles – 19 miles – 5 miles = 398 miles to be surveyed.
  - ✓ $150 per mile of pipe surveyed x 398 miles of pipe = $59,700 for the AWWA Leak Detection Survey.
- It is estimated that the current leaks and losses can be identified and then reduced by 25 percent following the leak detection survey and remedy of the identified leaks based on the *Air Force Water Conservation Guidebook*.
  - ✓ Projected leaks and losses are estimated at 287,025 for the main Base. This does not include leaks and losses associated with MFH.
  - ✓ Water savings for surveyed region = 287,025 kgal per year leaks and losses x 25% = 71,756 kgal per year of water savings.
  - ✓ 71,756 kgal per year x $0.79 per kgal = $56,687 per year water cost savings.
- The estimated simple payback period cannot be determined since the cost to repair and replace piping cannot be estimated until after the survey has been completed.

3.4.3 Analysis of BMP #3: Water Efficient Landscaping

BMP Description: Water-efficient landscaping involves applying water-conscious practices to irrigate lawns, golf courses, and other landscaped areas. By definition, its purpose is to not only keep plants healthy, but to also conserve water in the process. Water-efficient landscaping makes use of native plants and grasses to reduce the need for additional irrigation. It also encompasses the use of efficient sprinkler systems with sensors to detect rainfall and

discontinue watering when a particular area has received sufficient water to meet plant requirements.

Basis for BMP Credit: Compliance with this BMP is based on completed and on-going efforts to implement the following activities:

- Install irrigation schedules for landscaping areas.
- Monitor and inspect irrigation system effectiveness.
- Publicize a water conservation telephone hotline to encourage personnel to report broken irrigation systems or water-wasting irrigation practices.
- Retrofit and replace ineffective irrigation controllers.
- Implement water-wise landscape, emphasizing native plants and grasses.
- Follow Air Force and water-efficient design criteria.

BMP Credit Status: The following bullets summarize the Base's current irrigation system programs.

- The main Base uses time based irrigation controllers. The irrigation frequency is adjusted manually based on seasonal changes. Implementation of rain sensors is not feasible for Nellis AFB due to the minimal 4.5 inches average rainfall per year in the region.
- The irrigation system on the golf course is centrally controlled based on weather station data. This type of control system allows for optimal irrigation water use on the golf course. However, this weather station data is not used for other irrigation control systems on Base.
- The Base uses water-efficient design criteria for new buildings or areas.
- Approximately 50 percent of MFH areas use water-efficient landscaping.
- Irrigation monitoring is conducted in MFH to ensure watering is being conducted during permitted times.
- A water conservation hotline is available to report leaks.
- Water-efficient landscaping is used at the Base but there are still significant areas that the Base should consider for xeriscaping. The Base plants and promotes the use of native plants to reduce water use requirements for landscaped areas.

BMP Credit Earned: The Base cannot claim credit for BMP #3. The Base has installed effective irrigation systems at the golf course, however, this control strategy has not been incorporated on the main Base irrigated areas. Currently, xeriscaping is used on the main Base, however there are approximately 42 acres of irrigated areas that include large turf areas.

Next Steps: The Base should consider the following projects listed in Exhibit 3-15 to claim credit for this BMP. The Base can achieve credit for BMP # 3 by implementing irrigation scheduling for the main Base irrigated areas or by converting large grass areas to desert xeriscaping. The conversion of irrigated areas to desert landscaped areas will provide the highest degree of water savings allowing Nellis to reduce the overall Base potable water demand from the Las Vegas area water supply sources.

Exhibit 3-15 shows the projects and estimated savings, costs, and payback period for BMP #3.

EXHIBIT 3-15
Implementation Costs, Savings, and Payback for BMP #3
Nellis AFB WMP

BMP	Water, Estimated Annual Savings (kgal)	Wastewater, Estimated Annual Savings (kgal)	Estimated Annual Savings ($)	Estimated Implementation Costs ($)	Simple Payback Period (yrs)
Implement irrigation scheduling of main Base irrigated areas	18,769	0	7,978	60,000	7.5
Implement xeriscaping in 30 of the 42 irrigated acres on the main Base	39,138	0	273,919*	3,332,340	12.2

* Includes upkeep and maintenance cost savings.

The following assumptions were used to determine the water savings and simple payback period calculation listed in Exhibit 3-15:

- Implementation of irrigation scheduling of the main Base irrigated areas will achieve additional water savings compared to the current control systems that are time and frequency based. Incorporating the weather station data from the Golf Course irrigation systems with new irrigation controllers for the main Base irrigated areas would result in estimated water savings of 18,769 kgal per year. The following assumptions were used to determine the implementation costs, water savings, and simple payback period to implement irrigation scheduling. The Base irrigates approximately 42 acres of the main Base with potable water. It was estimated, by reviewing a Base map of the irrigated areas, that this project would require 28 controllers.

- The weather station data from the golf course will give Base-specific irrigation schedules. It was estimated that 28 new satellite controllers would also be needed to implement irrigation scheduling. The projected cost for incorporating weather station data is $4,000 for a computer system and RF interfaces. The cost includes the installation costs for the computer, software, and communication system for satellite controllers. The estimated installation cost for each satellite controller is $2,000. Costs were estimated based on quotes from a landscape irrigation contractor.

  - ✓ $4,000 weather station system + (28 controllers x $2,000 per controller) = $60,000 initial implementation cost.

- Labor to operate, monitor, and maintain the weather station data system and controllers and implement irrigation scheduling is estimated to be 294 hours per year. This was based on 1 hour per day for the entire 274-day irrigation period plus 20 hours for pre- and post- season setup and maintenance. Personnel from CE would operate and maintain the system. Assuming a WG-05, step 5 salary, including benefits and a 25 percent markup for G&A support, the estimated labor cost is $23.30 per hour.

  - ✓ 294 hours x $23.30 per hour = $6,850 labor cost per year.

- Based on industry-wide averages, a 25 percent savings in water consumption is expected as a result of implementing irrigation scheduling. No wastewater savings are anticipated as a result of implementing irrigation scheduling.
  - ✓ 25% x 75,076 kgal per year irrigation water = 18,769 kgal water savings per year.
  - ✓ 18,769 kgal per year x $0.79 per kgal = $14,828 water savings per year.
  - ✓ $14,828 annual water savings – $6,850 labor cost per year = $7,978 net savings per year.
- The estimated simple payback period was calculated by dividing the estimated implementation cost by the estimated annual savings:
  - ✓ $60,000 implementation cost/$7,978 savings per year = 7.5 years until payback is achieved.
- Implementing xeriscaping on the main Base involves the transition from standard grass and floral landscaping to water-efficient landscaping. The main Base is estimated to have 42 acres of irrigated turf areas. Project costs and savings were estimated assuming 30 of the 42 acres currently being irrigated are converted to desert xeriscaping. The estimated cost to convert the landscaping to water-efficient landscaping is $1.70 per square foot based on information provided by Nellis AFB and information published by the Arizona Multihousing Association[3]. General requirements, inflation, contingency, SIOH, and design add an additional $0.85 per square foot. The effective installed cost is $2.55 per square foot.
  - ✓ 30 acres x 43,560 sf per acre sf x $2.55 per sf = $3,332,340 to transition 30 acres of sprinkler-irrigated landscaping to water-efficient desert landscaping.
- Water savings were estimated by calculating the difference between the current irrigation requirement for the landscaped area and the expected irrigation requirement for the same area after it has been transitioned to xeriscaping. Based on industry published water requirements, that incorporate climate, plant density, and plant species, a xeriscaped or water-efficient landscape crop coefficient of 0.3 is used.
- The estimated current irrigation demand of the 42 acres on the main Base was determined in section 3.2.2.3:
  - ✓ Current Irrigation = 75,076 kgal per year.
- Conversion of 30 acres to desert xeriscaping and 12 acres of irrigated turf area reduces the water consumption as follows:
  - ✓ Remaining 12 acres of turf:
    274 days per year of irrigation x (0.25 inches irrigation required per day – 0.01 daily average rainfall during the irrigation period) x 43,560 sf per acre x 12 acres turf area x 7.481 gallons per cubic foot/(12 inches per foot x 1,000 gallons per kgal) = 21,429 kgal per year.
  - ✓ Xeriscape 30 acres:
    274 days per year of irrigation x [(0.25 inches irrigation required per day x 0.3 water-efficient crop coefficient) – 0.01 daily average rainfall during the irrigation period]

[3] http://www.azama.org/news.cfm?NewsID=711

- The estimated simple payback period was calculated by dividing the implementation cost by the estimated annual savings:
  - ✓ $3,332,340 implementation cost/$273,919 estimated savings = 12.2 years until payback is achieved.
- Appendix G contains the 1391 associated with this project.

3.4.4 Analysis of BMP #4: Toilets and Urinals

BMP Description: This BMP addresses the use of low-flow toilets and urinals on Base. The goal of this BMP is to replace older style toilets and urinals, which use up to 7 gallons per flush (gpf) and 2 gpf, respectively, with water-efficient, low-flow toilets and urinals. This upgrade has reduced overall water use by a significant percentage at DOD installations.

Basis for BMP Credit: Compliance with this BMP is based on implementing the following activities:

- O&M: Maintenance program in place to ensure toilets and urinals are operating effectively.
- Retrofit/Replacement: Retrofit and replace older style toilets and urinals with those in accordance with 1997 guidelines.
- Consider installing water saving devices (auto flush, sensors) on toilets and urinals where practical.
- Consider using waterless urinals where practical.

BMP Credit Status: The following bullets summarize the Base's current fixture upgrade programs.

- O&M: The Base has an effective maintenance program through the Plumbing Shop.
- Retrofit/Replacement: Approximately 75 percent of the fixtures on Base have been converted to low-flow units.
- New construction design incorporates low-flow toilets and urinals.
- Sensors or other water savings devices are rarely installed on toilets or urinals.
- Waterless urinals have been considered but not installed because of potential high maintenance requirements.

BMP Credit Earned: The Base can claim credit for BMP #4. The Base has an effective maintenance program and has replaced approximately 75 percent of non-compliant toilets and urinals. New construction and facility remodeling utilizes low-flow toilets and urinals.

Next Steps: The Base has implemented the requirements necessary to claim credit for this BMP. The project listed reflects costs to complete the existing program on Base.

Exhibit 3-16 shows the projects and estimated savings, costs, and payback period for BMP #4.

EXHIBIT 3-16
Implementation Costs, Savings, and Payback for BMP #4
Nellis AFB WMP

BMP	Water, Estimated Annual Savings (kgal)	Wastewater, Estimated Annual Savings (kgal)	Estimated Annual Savings ($)	Estimated Implementation Costs ($)	Simple Payback Period (yrs)
Update Toilets and Urinals in Industrial and Commercial Facilities	3,360	3,360 *	2,654	307,166	116

** The wastewater savings are shown but the disposal costs are not included because of the Base's fixed annual wastewater rate structure.*

The following assumptions were used to determine the water savings and simple payback period calculation listed in Exhibit 3-16:

- The cost to implement low-flow fixtures were based on an FY2002 Phase 2 study performed for another Air Force installation. The study provided a unit cost for replacing all fixtures (toilets, urinals, showers, and faucets) in administrative and dormitory type facilities. It was assumed that costs were equally divided between toilets and urinals, and showers and faucets. Using this assumption and the study results, the implementation cost was estimated to be $0.256 per square foot for these facilities.
- It was estimated that 25 percent of commercial and industrial facilities required toilet and urinal upgrades. Industrial facilities and commercial facilities comprise approximately 4.80 million square feet total. See sections 3.2.2.2 and 3.2.2.4, respectively, for more information.
  - ✓ 4,799,464 square feet x 25 percent = 1,199,866 sf.
  - ✓ 1,199,866 sf x $0.256 per sf = $307,166 implementation cost.
- The savings from implementing low-flow fixtures were based on the FY 2002 Phase 2 study cited above. The study provided a unit savings for replacing all fixtures (toilets, urinals, showers, and faucets) in administrative and dormitory type facilities. It was assumed that savings were equally divided between toilets and urinals, and showers and faucets. Using this assumption and the study results, the resulting savings were estimated to be 0.0028 kgal water savings per square foot per year for these facilities. Wastewater savings were not included because of the fixed wastewater disposal cost for the Base.
  - ✓ 1,199,866 sf x $0.0028 kgal per sf = 3,360 kgal water saved per year.
  - ✓ 3,360 kgal x $0.79 per kgal = $2,654 water savings per year.
- The estimated simple payback period was calculated by dividing the estimated implementation cost by the estimated annual savings:
  - ✓ $307,166 implementation cost/$2,654 savings per year = 116 years until payback is achieved.

3.4.5 Analysis of BMP #5: Faucets and Showerheads

BMP Description: This BMP addresses the use of low-flow faucets and showerheads in all facilities on Base. Federal guidelines mandate that all lavatory and kitchen faucets and

replacement aerators manufactured after January 1, 1994 use no more than 2.5 gpm measured at normal water pressure (typically 80 pounds per square inch). The goal of this BMP is to replace conventional showerheads with a flow rate of 3 to 7 gpm with showerheads that have a flow rate of 2.5 gpm. Lavatory and kitchen faucets and replacement aerators manufactured after January 1, 1994 should use no more than 2.5 gpm measured at normal water pressure.

Basis for BMP Credit: Compliance with this BMP is based on implementing the following activities:

- O&M: Maintenance program to ensure showerheads and faucets are properly maintained. Problems and leaks routinely are reported and efficiently repaired.
- Retrofit/Replacement: Water-saving devices installed in existing faucets and showerheads. Flow restriction devices are used. Faucets and showerheads meet the Federal guidelines of 2.5 gpm.

BMP Credit Status: The following bullets summarize the Base's current fixture upgrade programs.

- O&M: The Base has an effective maintenance program through the Plumbing Shop.
- Retrofit/Replacement: Approximately 90 percent of the fixtures on Base have been converted to low-flow units.
- Retrofit/Replacement: Environmental has purchased 500 ultra low-flow showerheads to be installed in the Base dormitories.

BMP Credit Earned: The Base can claim credit for BMP #5. In addition to the O&M and retrofit and replacement practices noted, all new construction on the Base uses faucets and showerheads that are compliant with 1994 guidance.

Next Steps: The Base has implemented the requirements necessary to claim credit for this BMP. 500 ultra low-flow showerheads are being installed in the Base dormitories. Additional water savings could be achieved by upgrading the remaining showerheads and faucets to be compliant with federal guidelines.

Exhibit 3-17 shows the projects and estimated savings, costs, and payback period for BMP #5.

EXHIBIT 3-17
Implementation Costs, Savings, and Payback for BMP #5
Nellis AFB WMP

BMP	Water, Estimated Annual Savings (kgal)	Wastewater, Estimated Annual Savings (kgal)	Estimated Annual Savings ($)	Estimated Implementation Costs ($)	Simple Payback Period (yrs)
Update Remaining 10% of Faucets and Showerheads in Buildings that include Dormitories and Administrative Facilities.	1,920	1920*	2,565**	43,675	17.0

** The wastewater savings are shown but the disposal costs are not included because of the Base's fixed annual wastewater rate structure.*

*** Includes energy savings.*

The following assumptions were used to determine the water savings and simple payback period calculation listed in Exhibit 3-17:

- The cost to implement low-flow faucets and showerheads was based on an FY 2002 Phase 2 study performed for another Air Force installation. The study provided a unit cost for replacing all fixtures (toilets, urinals, showers, and faucets) in administrative and dormitory type facilities. It was assumed that costs were equally divided between toilets, urinals, showers, and faucets.
- Using this assumption and the study results, the implementation cost and resulting savings were estimated to be $0.091 per square foot and 0.004 kgal water and wastewater savings per square foot per year, respectively.
- This analysis includes upgrading the remaining non-compliant fixtures on Base. These buildings have approximately 4.8 million square feet of total area as determined from the Base Real Property report. Through site evaluations and discussion with Plumbing Shop personnel, it was estimated that 10 percent of the faucets and showerheads at these facilities require upgrading.
  - ✓ 4,799,464 sf x 10 percent to upgrade x $0.091 per sf = $43,675 implementation cost.
- The savings from implementing low-flow fixtures in the remaining facilities:
  - ✓ 4,799,464 sf x 10 percent to upgrade x 0.004 kgal per year per sf water savings = 1,920 kgal water saved per year.
  - ✓ 1,920 kgal x $0.79 per kgal water = $1,517 per year water cost savings.
- Low-flow faucets and showerheads also save energy from reduced hot water wasted. A unit rate for energy saved per square foot was determined using the FY 2002 Phase 2 study performed for another Air Force installation. Using the study results, the resulting savings were estimated to be 0.0004 MMBTU per sf of upgraded area. Gas heating is used to heat the water. Based on Nellis AFB's Utility Sales Rates Computation Worksheets, the applicable natural gas rate for savings calculations is $5.46 per MMBTU ($5.60 per KCF/1.026 MMBTU per KCF).
  - ✓ 4,799,464 square feet x 10% to upgrade x 0.0004 MMBTU per sf of upgraded area = 192 MMBTU per year of energy saved.
  - ✓ 192 MMBTU x $5.46 per MMBTU = $1,048 per year in energy cost savings.
  - ✓ $1,517 per year of water cost savings + $1,048 per year energy cost savings = $2,565 total savings.
- The estimated simple payback period was calculated by dividing the estimated implementation cost by the estimated annual savings:
  - ✓ $43,675 implementation cost/$2,565 savings per year = 17.0 years until payback is achieved.

3.4.6 Analysis of BMP #6: Boiler/Steam Systems

BMP Description: Boilers and steam systems are used to provide heating, humidity control, and domestic hot water for commercial and residential buildings on Base. Industrial facilities can use large quantities of hot water and steam for process systems. Depending on the design, centralized boilers utilize piping, valves, and controls that can leak large quantities of steam. Water consumption rates vary with boiler design and are usually a small cost when compared

to energy cost. However, significant water savings can be achieved from proper maintenance and replacement of boiler and steam systems.

Basis for BMP Credit: Compliance with this BMP is based on implementing the following O&M and Retrofit/Replacement activities:

- O&M: Effectively maintain and operate boilers and associated valves, traps, and receivers based on manufacturer and Air Force guidelines.
- O&M: Ensure effective chemical treatment for scale and corrosion control, optimizing the cycles of concentration.
- O&M: Maintain accurate operation schedules.
- Retrofit/Replacement: Schedule installation program replacement of large boilers (greater than 1 million BTUs per hour, MBH).
- Implement water/energy saving devices such as meters, auto blowdown devices, auto feed pumps, and condensate return.

BMP Credit Status: The following bullets summarize the Base's boiler/steam system programs.

- O&M: Base boilers are decentralized and properly maintained with trained staff and service contracts. Operation schedules and logs are kept. The hospital utilizes a centralized steam plant for its operation and appears to be well maintained. Chemical treatment is provided through a service contract.
- O&M: The boilers utilize automated blowdown to optimize water and energy use.
- O&M: An effective O&M program is in place for boilers, although the Base has not formalized a 5-year HVAC plan.
- O&M: Hospital boilers and steam traps are in good condition and are properly maintained.
- Replacement: The hospital is considering decentralizing the central steam plant.

BMP Credit Earned: The Base can claim credit for BMP #6. The Base has effective programs in place to ensure proper O&M of boiler and steam systems. Systems that have been decentralized are in good to excellent condition.

Next Steps: The Base has implemented the requirements necessary to claim credit for this BMP. Additional water, energy, and chemical savings could be achieved by installing a reverse osmosis (RO) high purity water system to be used as makeup water for the hospital boilers.

Exhibit 3-18 shows the projects and estimated savings, costs, and payback period for BMP #6.

EXHIBIT 3-18
Implementation Costs, Savings, and Payback for BMP #6
Nellis AFB WMP

BMP	Water, Estimated Annual Savings (kgal)	Wastewater, Estimated Annual Savings (kgal)	Estimated Annual Savings ($)	Estimated Implementation Costs ($)	Simple Payback Period (yrs)
Install RO as Makeup for Hospital Boilers	1,465	1,546*	24,907	41,400	1.7

** The wastewater savings are shown but the disposal costs are not included because of the Base's fixed annual wastewater rate structure.*

The following assumptions were used to determine the water savings and simple payback period calculation listed in Exhibit 3-18:

- The installed cost of the RO sized for this application is approximately $41,400 based on a vendor quote. A RO sized with a 20-gpm peak flow rate was used based on the operational parameters of the hospital boiler system.
  - ✓ 20 gpm RO unit x $2,070 per gpm = $41,400
- Water and Energy savings are derived from the mass and energy balances of utilizing RO as the makeup source for the steam boiler. Appendix H provides a summary of the operating cost differences for the current state versus operation with RO.
  - ✓ The net annual water savings for this project are 1,465 kgal per year.
  - ✓ 1,465 kgal per year net water savings x $0.79 per kgal = $1,157 per year water savings
  - ✓ The net annual energy savings for this project are 3,282 MMBTU per year.
  - ✓ 3,282 MMBTU per year energy savings x $5.46 per MMBTU/70% boiler efficiency = $25,600 per year energy savings
  - ✓ $66 per year in softener salt savings.
  - ✓ $1,916 per year of increased electrical demand
- The total savings for this project are:
  - ✓ $1,157 per year net water savings + $25,600 per year energy savings (natural gas) + $66 per year salt savings - $1,916 per year of increased electrical demand = $24,907 per year
- The estimated simple payback period was calculated by dividing the estimated implementation cost by the estimated annual savings:
  - ✓ $41,400 implementation cost/$24,907 savings per year = 1.7 years until payback is achieved.

3.4.7 Analysis of BMP #7: Single-Pass Cooling System

BMP Description: Single-pass cooling systems circulate and then discharge water as waste or into reuse systems. These systems are typically associated with equipment within facilities and include such items as medical equipment, HVAC systems, hydraulic equipment, and condensers.

Basis for BMP Credit: Compliance with this BMP is based on implementing the following O&M and Retrofit/Replacement activities:

- O&M: Develop accurate, updated inventories of all single-pass cooling systems. Install monitoring equipment or inspection procedures to turn off equipment, and associated cycling and water use, when idle. Ensure the equipment is being regularly inspected and maintained so that it operates at intended efficiency.
- Retrofit/Replacement: Upgrade, replace, and modify single-pass equipment to operate as closed loop or air-cooled systems. Investigate alternative uses for reusing single pass discharge water in other applications.

BMP Credit Status: The following bullets summarize the Base's single-pass cooling systems programs.

- O&M: The Base has an effective RWP program for the ice machines. Machines are inspected routinely and filters are changed approximately every two months to maintain efficient operation.
- Retrofit/Replacement: There are approximately 14 ice machines on Base located within the Base dining facilities and at the hospital. These ice machines utilize single-pass cooling water as the heat sink for the ice machine compressors. There is also a single-pass water-cooled vacuum system in the hospital mechanical room. The Base has not developed a replacement plan for the ice machines, however machines not operating effectively are replaced.
- There were no other single pass systems identified on Base.

BMP Credit Earned: The Base can claim credit for BMP #7. The only single pass cooling systems identified on Base consist of 14 water-cooled ice machines. The Base has an effective RWP for the ice machines. Additional water savings can be achieved by replacing the water-cooled ice machines with air cooled ice machines.

Next Steps: To remain compliant in the future the Base will need to continue the RWP. Replacement of the single-pass water-cooled ice machines with air-cooled machines is recommended as the machines reach the end of their useful life.

Exhibit 3-19 shows the projects and estimated savings, costs, and payback period for BMP #7.

EXHIBIT 3-19
Implementation Costs, Savings, and Payback for BMP #7
Nellis AFB WMP

BMP	Water, Estimated Annual Savings (kgal)	Wastewater, Estimated Annual Savings (kgal)	Estimated Annual Savings ($)	Estimated Implementation Costs ($)	Simple Payback Period (yrs)
Replace 14 water-cooled ice machine with air-cooled system	6,321	6,321*	1,936	97,426	50.3

** The wastewater savings are shown but the disposal costs are not included because of the Base's fixed annual wastewater rate structure*

The following assumptions were used to determine the water savings and simple payback period calculation listed in Exhibit 3-19:

- Costs were estimated using the Manitowoc® Ice, Inc. suggested list price of a 600 lb capacity remote air-cooled ice machine with a standard remote cooled condenser, remote tubing kit, and a 430 lb. ice storage bin of $6,959. A remote air-cooled condenser was considered to minimize noise and additional heat rejection impact towards the Dining Hall personnel and HVAC load.
  - ✓ $6,959 per unit x 14 unit = $97,426 cost.
- The ice machines were located in the dining halls and hospital and have capacities of 600 lbs per day. Based on engineering information provided by Manitowoc® Ice, Inc, an ice machine

manufacturer, a single-pass water-cooled ice machine requires 215 gallons of cooling water per 100 pounds of ice production. The Dining Hall POC indicated that the ice machine operates continuously in efforts to keep up with the ice demand. The calculations are based on the capacity of the current ice machine (600 lbs of ice produced per day). It was assumed that the facility operated 350 days per year. The estimated current water and wastewater volume consumed by the water-cooled ice machine is:

- ✓ 14 ice machines x 600 pounds of ice per day per machine x 215 gal cooling water per 100 lbs of ice x 350 days per year/1000 gallons per kgal = 6,321 kgal per year water and wastewater.
- ✓ 6,321 kgal per year water x $0.79 per kgal water = $4,994 per year current operating cost.

- Replacing a water-cooled ice machine with air-cooled ice machines increases energy use. Engineering data from the same source shows an energy consumption of 7.1 kWh to produce 100 lb of ice with a remote air-cooled ice machine, compared to 5.8 kWh for the same amount of ice with a water-cooled model. The difference is the increased energy cost associated with the change.
  - ✓ 14 ice machines x 600 lbs per day per machine x (7.1 kWh per 100 lbs ice, air-cooled – 5.8 kWh per 100 lbs ice, water-cooled) x 350 days per year = 38,220 kWh increased energy use.
  - ✓ 38,220 kWh increased energy x $0.08 per kWh = $3,058 per year electrical energy increase.
- The air-cooled ice machines do not utilize water as its heat sink; thus, the current water use becomes savings. The air-cooled ice machines use additional energy as the heat sink, thus the energy consumption is an additional consumption. The difference between the operating cost of the water-cooled ice machines (current) and the remote air-cooled ice machines (project) are the operational savings.
  - ✓ $4,994 per year current operating cost – $3,058 per year electrical project operating cost = $1,936 per year in operational cost savings.
- The estimated simple payback period was calculated by dividing the estimated implementation cost by the estimated annual savings:
  - ✓ $97,426 implementation cost/$1,936 savings per year = 50.3 years until payback is achieved.

3.4.8 Analysis of BMP #8: Cooling Tower Management

BMP Description: Cooling towers regulate the temperature of air-conditioning systems or process equipment by rejecting waste heat produced during operation. Cooling towers improve thermal efficiency by evaporating large quantities of water. Water is also lost through bleed-off and drift. To replace the lost water and maintain cooling function, make-up water is added to the tower system.

Significant cooling tower water savings can be achieved through water conservation activities and enhanced by savings from reduced chemical treatment. However, there is a balance between reducing make-up water and maintaining equipment operation and efficiency. To reduce water consumption, cooling water is recycled several times through the cooling tower with make-up water providing the balance from water losses. This process increases water

contaminants from air infiltration, thermal and biological reactions, and can foul and corrode HVAC and process equipment heat exchangers, increasing operation costs and reducing equipment life. A coordinated O&M program and a scheduled retrofit and replacement plan are necessary to successfully meet this water saving best management practice.

Basis for BMP Credit: Compliance with this BMP is based on implementing the following O&M and Retrofit/Replacement activities:

- O&M: Effectively maintain and operate cooling towers and associated valves, strainers, monitors, and controllers based on manufacturer and Air Force guidelines. Ensure effective chemical treatment for scale and corrosion control, optimizing the cycles of concentration. Maintain accurate operation schedules.
- Retrofit/Replacement: Maintain an effective schedule for large cooling tower replacement. Implement water saving devices such as meters, conductivity monitors, automatic blowdown controls, and automatic chemical feed pumps.

BMP Credit Status: The following bullets summarize the Base's cooling tower management programs.

- O&M: The Base's 19 cooling towers appear to be in excellent condition. Site evaluations of several of the cooling towers showed the use of chemical feed and automatic blowdown to keep the cycles of concentration consistent.
- Retrofit/Replacement: The Base effectively replaces old cooling towers with new ones. The hospital cooling towers and Building 200 cooling towers were recently replaced.
- O&M: Evaporative coolers are used extensively on Base. Evaporative coolers increase industrial water demand but are energy efficient. The evaporative coolers used at Nellis AFB do not incorporate a bleed-off (blowdown) strategy as part of their design. This causes the operation of these evaporative coolers to be water-efficient but maintenance intensive due to high scaling potential of the evaporative cooler water without the bleed-off.

BMP Credit Earned: The Base can claim credit for BMP #8. The Base has an effective O&M program in place for cooling tower systems. Water and energy saving devices, such as chemical feed pumps and automatic blowdown control systems, have been implemented on the Base's cooling tower systems.

Next Steps: The Base has implemented the requirements necessary to claim credit for this BMP. Additional water savings could be achieved by removing the mineral hardness from the cooling tower makeup water through softening the water. This would allow the cooling towers to achieve higher cycles of concentration and further optimize water use. Projects identified for implementation in this WMP include optimization of water softeners and cycles of concentrations for the six cooling towers at the hospital and Bldg. 200. Upon completion of implementation of these projects, actual paybacks can be determined and if found suitable, these projects can be evaluated for all other remaining cooling towers on Base.

Exhibit 3-20 shows the projects and estimated savings, costs, and payback period for BMP #8.

EXHIBIT 3-20
Implementation Costs, Savings, and Payback for BMP #8
Nellis AFB WMP

BMP	Water, Estimated Annual Savings (kgal)	Wastewater, Estimated Annual Savings (kgal)	Estimated Annual Savings ($)	Estimated Implementation Costs ($)	Simple Payback Period (yrs)
Soften Makeup Water at Hospital Cooling Towers	1,379	1,379	1,089	3,570	3.3
Soften Makeup Water at Building 200 Cooling Towers	1,619	1,619	1,279	3,570	2.8

** The wastewater savings are shown but the disposal costs are not included because of the Base's fixed annual wastewater rate structure.*

The following assumptions were used to determine the water savings and simple payback period calculation listed in **Exhibit 3-20**:

- Increasing the cycles of concentration on cooling towers is a cost-effective procedure that may provide excellent water savings. The current range of cycles of concentration for Nellis AFB cooling towers ranges from 2.5 at the cooling towers located at Bldg. 200 to 4.5 at the hospital cooling towers. Softening the makeup water would further optimize water use in the cooling towers located at the hospital and Building 200 by allowing the cycles of concentration to be increased to 6 without increasing the scaling potential of the water. These two locations were chosen because both of these cooling towers have water softener systems adjacent to the cooling towers.
- The estimated costs associated with this project are identical for both the hospital and Building 200 cooling towers. The costs include minimal piping installation from the current water softener to the cooling tower makeup valve and are estimated at $1,000 for each location.
- The installation of a mineral hardness analyzer is also recommended for both locations to ensure softened water is continuously being delivered to the cooling towers. The estimated cost for this analyzer is $2,500 for each location based on estimate from an equipment vendor. The labor associated with adjusting the cooling tower controller is determined at 3 hours per controller at a rate of $23.30 per hour. The $23.30 per hour labor rate is based on a WG-05, step 5, including benefits and a 25 percent markup for G&A support.
  - ✓ $1,000 per location piping cost.
  - ✓ $2,500 per location equipment cost (HACH analyzer).
  - ✓ 3 hours x $23.30 per hour = $69.90 for each location
  - ✓ $1,000 + $2,500 + $69.90 for labor = $3,570 for each cooling location
- The formula for estimating the annual water savings that can be achieved by increasing the cycles of concentration from the current state to the future state is:

- ✓ % Load x Recirculation Rate x ΔT (temperature difference across the tower) x 1 % per 10° F x [(future cycles – current cycles)/((future cycles – 1) x (current cycles – 1))] x 60 min per hour x operation hours per year x 1 kgal per 1000 gallons

- Two of the three hospital cooling towers are operated year round; the third tower is only operated during the summer. This gives a combined load average of approximately 85%. The cooling towers currently operate at 4.5 cycles of concentration and the future cycles are projected at 6. The operational time of the hospital cooling towers is 8,760 hours per year based on 365 days per year of operation of the hospital. The temperature drop across the cooling tower is estimated at 10 °F. The recirculation rate of the hospital cooling towers is 3600 gpm.
  - ✓ [85 percent x 3600 gpm x 10 °F x 1 percent/10 °F] x [(6 – 4.5)/((6 – 1) x (4.5 – 1))] x [60 min per hour x 8,760 hours per year] x [1 kgal per 1000 gallons] = 1,379 kgal per year
  - ✓ 1,379 kgal per year water saved x $0.79 per kgal = $1,089 per year water cost savings
- The estimated simple payback period was calculated by dividing the estimated implementation cost by the estimated annual savings:
  - ✓ $3,570 implementation cost/$1,089 savings per year = 3.3 years until payback is achieved.
- The three cooling towers at building 200 are estimated to operate at 85 percent load 24 hours per day for 210 days per year. The current cycles of concentration is 2.5 and the future cycles is 6. The temperature drop across the cooling towers is estimated at 10 °F. The recirculation rate of the building 200 cooling towers is 1,350 gpm.
  - ✓ [85 percent x 1350 gpm x 10 °F x 1 percent/10 °F] x [(6 – 2.5)/((6 – 1) x (2.5 – 1))] x [60 min per hour x 5,040 hours per year] x [1 kgal per 1000 gallons] = 1,619 kgal per year
  - ✓ 1,619 kgal per year water saved x $0.79 per kgal = $1,279 per year water cost savings
- The estimated simple payback period was calculated by dividing the estimated implementation cost by the estimated annual savings:
  - ✓ $3,570 implementation cost/$1,279 savings per year = 2.8 years until payback is achieved.
- Savings do not include intrinsic chemical additive reductions that may arise from increasing the cycles of concentration.

3.4.9 Analysis of BMP #9: Miscellaneous High Water-Using Processes

BMP Description: High water using processes should be identified and assessed for potential water conservation opportunities. In addition to vehicle and aircraft washing facilities, high water uses can be found in maintenance facilities, kitchens, food preparation facilities, cleaning/laundry services, hospitals, and laboratories.

Basis for BMP Credit: Compliance with this BMP is based on implementing the following O&M and Retrofit/Replacement activities:

- O&M: Identify candidate high-water uses. Meter, or otherwise measure, the volume of water used in each of the high water using processes or facilities. Implement effective O&M guidelines for candidate processes.
- Retrofit/Replacement: Identify and evaluate the feasibility of water efficiency improvements for high water use processes. Redesign processes to implement improved materials or technologies to reduce water requirements. All new construction should implement efficient water use.

BMP Credit Status: The following bullets summarize the Base's O&M and Retrofit/Replacement activities for high water-using processes.

- O&M: No specific high water users were identified other than dining hall, aircraft wash racks, and water softeners used at the hospital. No secondary metering of potential high water use processes or facilities has been implemented.
- Retrofit/Replacement: There are no identified retrofit and replacement options being evaluated by high water using processes.

BMP Credit Earned: The Base cannot claim credit for BMP #9. The only high water use processes that have been identified include wash racks, dining hall and hospital softeners. High water users are not metered.

Next Steps: To achieve credit for this BMP, the Base should upgrade dining halls, and optimize water softeners. Additional savings could be achieved by doing a survey of high water users and implementing appropriate water conservation practices. The Base should also consider a survey to identify and meter high water use processes.

Exhibit 3-21 shows the projects and estimated savings, costs, and payback period for BMP #9.

EXHIBIT 3-21
Implementation Costs, Savings, and Payback for BMP #9
Nellis AFB WMP

BMP	Water, Estimated Annual Savings (kgal)	Wastewater, Estimated Annual Savings (kgal)	Estimated Annual Savings ($)	Estimated Implementation Costs ($)	Simple Payback Period (yrs)
Upgrade Dining Halls in Bldg. 1300, 567, 790, & 10206 with Pedal Valves, Compliant Fixtures, and Pulper	1,184	1,184*	$2,246	50,290	22.4
Optimize Main Hospital Softeners	1,982	1,982*	20,9844**	10,500	0.5
Optimize Hospital Steam Plant Softeners	378	378*	3,976**	10,500	2.6

** The wastewater savings are shown but the disposal costs are not included because of the Base's fixed annual wastewater rate structure*
*** The savings include salt savings associated with this process.*

- The following assumptions were used to determine the water savings and simple payback period calculation listed in Exhibit 3-21:
- Upgrade Dining Halls. Four dining facilities (Bldg. 1300, 567, 790, and 10206) were identified for retrofit/upgrade with low-flow fixtures, pedal valves, and pulping machines during the Base visit. Based on Real Property records, the total square footage of the four dining facilities is approximately 47,000 square feet. The cost and the associated savings were based on an FY2002 Phase 2 study performed for another Air Force installation. The implementation cost and resulting savings were estimated to be $1.07 per square foot and 0.0252 kgal water savings per square foot per year respectively. Energy savings of 0.0051 MMBTU per square foot were also estimated based on the study. Natural gas costs based on FY2001 - FY2003 average is $5.46 per MMBTU.
  - ✓ Implementation cost = 47,000 sf x $1.07 per sf = $50,290
  - ✓ Annual water savings = 47,000 sf x 0.0252 per sf = 1,184 kgal per year
  - ✓ Annual energy savings = 47,000 sf x 0.0051 MMBTU per sf = 240 MMBTU per year
  - ✓ Annual cost savings = (1,184 kgal water x $0.79 per kgal) + (240 MMBTU per year x $5.46 per MMBTU) = $2,246 per year
- The estimated simple payback period for upgrading the dining halls was calculated by dividing the estimated implementation cost by the estimated annual savings:
  - ✓ Payback period = $50,290/$2,246 per yr = 22.4 years
- Optimize Main Hospital Softeners. There are two sets of water softeners for the main hospital and the hospital steam plant. These softeners are not set at their optimal regeneration frequency, increasing excess regeneration water, salt use, and reducing the life span of the resin. The effectiveness of these softeners can be improved by adding a hardness analyzer that will initiate regeneration based on water hardness instead of water volume.
- The project costs to install a hardness analyzer and replace and install the face piping/control system for each softener system:
  - ✓ $2,500 for HACH hardness analyzer + $8,000 to replace softener face piping/control system = $10,500 project cost
- The average total hardness for the influent water at the hospital is 300 ppm. Both sets of softeners are the same size (36 inches x 72 inches), contain the same amount of ion exchange resin (27 cubic feet), with the same ion exchange capacity (30,000 grains per cubic foot), and each system has two vessels. One unit is in operation and the other in standby. Based on the size of the softener systems, each uses 1,666 gallons of water and 405 lbs of salt per regeneration. The only difference is the annual volume of water each system softens. The theoretical set point capacity for each system is estimated below. Typically, 90 percent of full capacity is used to estimate the theoretical throughput.
  - ✓ 27 cubic feet per vessel x 30,000 grains per cubic foot x 90% = 729,000 grains per vessel
- The concentration of hardness in the water determines the theoretical capacity of the softener as follows:

- ✓ (300 ppm total hardness/17.1 ppm per grain per gallon, conversion factor) x 1000 gal per kgal = 17,544 grains per kgal
- ✓ 729,000 grains per vessel capacity/17,544 grains per kgal = 41.5 kgal water capacity throughput per vessel (theoretical)

- Currently, the main hospital softeners treat approximately 27,950 kgal per year based on meter data for the hospital. The current water volume throughput set point of these softeners is 15 kgal before regeneration. This causes excess regeneration water and salt use as compared to the theoretical set point.
  - ✓ 27,950 kgal per year/15 kgal per regeneration = 1,863 annual regeneration (current)
  - ✓ 27,950 kgal per year/41.5 kgal per regeneration = 673 annual regeneration (theoretical)
  - ✓ 1,863 annual regeneration (current) - 673 annual regeneration (theoretical) = 1,190 excess regeneration per year
  - ✓ 1,190 excess regeneration per year x 1.666 kgal per regeneration = 1,982 kgal per year of potential water savings
  - ✓ 1,982 kgal per year x $0.79 per kgal = $1,566 per year water cost savings
  - ✓ 1,190 excess regeneration per year x 405 lbs salt per regeneration = 481,950 lbs per year of potential salt savings
  - ✓ 481,950 lbs salt per year x $0.04 per lb of salt = $19,278 per year salt cost savings
  - ✓ Total Savings = 19,278 per year salt cost savings + $1,566 per year water cost savings = $20,844 per year total savings
- The estimated simple payback period for the main hospital softener system was calculated by dividing the estimated implementation cost by the estimated annual savings:
  - ✓ Payback period = $10,500 project cost/$20,844 per year savings = 0.5 years
- Optimize Hospital Steam Plant Softeners. The softeners at the hospital steam plant are the same size as above and treat approximately 5,318 kgal per year of water for steam production. Currently, the water volume throughput, the set point, of these softeners is 15 kgal before regeneration. This causes excess regeneration water and salt use as compared to the theoretical set point.
  - ✓ 5,318 kgal per year/15 kgal per regeneration = 355 annual regeneration (current)
  - ✓ 5,318 kgal per year/41.5 kgal per regeneration = 128 annual regeneration (theoretical)
  - ✓ 355 annual regeneration (current) - 128 annual regeneration (theoretical) = 227 excess regeneration per year
  - ✓ 227 excess regeneration per year x 1.666 kgal per regeneration = 378 kgal per year of potential water savings
  - ✓ 378 kgal per year x $0.79 per kgal = $299 per year water cost savings
  - ✓ 227 excess regeneration per year x 405 lbs salt per regeneration = 91,935 lbs per year of potential salt savings

- ✓ 91,935 lbs salt per year x $0.04 per lb of salt = $3,677 per year salt cost savings
- ✓ Total Savings = 3,677 per year salt cost savings + $299 per year water cost savings = $3,976 per year total savings

- The estimated simple payback period for the hospital central plant softener system was calculated by dividing the estimated implementation cost by the estimated annual savings:
  - ✓ Payback period = $10,500 project cost/$3,976 per yr savings = 2.6 years

3.4.10 Analysis of BMP #10: Water Reuse and Recycling

BMP Description: Many facilities have water uses that can be met with non-potable water. For reuse/recycle considerations, wastewater from one process may be suitable for reuse. Examples are rinse waters from a car wash or laundry used for the next wash, or cooling tower bleed-off distributed for landscape irrigation. Wastewater that is treated to meet high standards at a treatment plant can be re-distributed for non-potable uses.

Basis for BMP Credit: Compliance with this BMP is based on implementing the following O&M and Retrofit/Replacement activities:

- Identify non-potable water sources and identify possible potable water using applications that could be switched. Implement the use of non-potable water sources where feasible.
- Evaluate and implement the feasible projects to recycle water.
- **BMP Credit Status:** The following bullets summarize the Base's O&M and Retrofit/Replacement activities for water reuse and recycling.
- The golf course receives a small portion of the total irrigation demand from fire hydrant flushing runoff, a groundwater clean up site, and water from a non-potable well source. The majority (more than 90 percent) of the irrigation demand is satisfied with potable water.
- The Base has evaluated constructing a WWTP facility that would then send the effluent water to the golf course ponds to meet the irrigation demand. However, this project does not meet the 10-year payback requirements set by the Air Force.

BMP Credit Earned: The Base cannot claim credit for BMP #10. The Base has evaluated constructing a WWTP and reusing the effluent to irrigate the golf course. However, this project did not provide an attractive economic payback. To gain credit for this BMP, the Base should consider irrigating the golf course with 100 percent non-potable water by renovating non-potable wells in Area II. The Base is evaluating the renovation of these wells. No additional projects were identified for this BMP.

3.4.11 Summary of BMP Investigation and Implementation Initiatives

The Base is successfully implementing BMP #s 4, 5, 6, 7, and 8. Water conservation initiatives were recommended for implementation to achieve credit for BMP #s 1, 2, 3, 9, and 10. Additional water savings projects were identified for BMP #s 4, 5, 6, 7, and 8.

The Base is currently meeting the BMP goal established by the Air Force of implementing four BMPs. Meeting the BMPs is defined as compliance with EO 13123 and the subsequent DOE guidance. To maintain compliance, the Base is required to review the status of each BMP after 2 years and implement any identified projects that become cost effective.

Exhibit 3-22 provides a ranked listing, based on simple payback period, of water conservation projects. The projects listed for BMP #s 1, 2, 3, 9, and 10 are to achieve compliance. Projects listed for BMP #s 4, 5, 6, and 8 are to potentially achieve additional water savings. The projects included in the table are based on the analysis performed in Section 3.4. According to the *Guidebook*, a payback must be less or equal to 10 years for a project to be considered feasible. Projects that had a simple payback period of more than 10 years were also included, as a more detailed life-cycle cost analysis may indicate the payback period is actually less than 10 years. These projects will require further study by the Base prior to warrant programming.

EXHIBIT 3-22
BMP Enhancement Projects, Ranked by Payback
Nellis AFB WMP

Rank	BMP Enhancement	Cost ($)	Annual Savings ($)	Payback (yrs)
1	#2 – Conduct AWWA leak detection survey in water distribution system	59,700	56,687	N/A *
2	#1 – Upgrade water conservation awareness program	6,160	5,186	N/A **
3	#9 – Optimize Main Hospital Softeners	10,500	209,844	0.5
4	#6 – Install RO as Makeup for Hospital Boilers	41,400	24,907	1.7
5	#9 – Optimize Hospital Steam Plant Softeners	10,500	3,976	2.6
6	#8 – Soften Makeup Water at Building 200 Cooling Towers	3,570	1,279	2.8
7	#8 – Soften Makeup Water at Hospital Cooling Towers	3,570	1,089	3.3
8	#3 – Implement Irrigation Scheduling on the main Base	60,000	7,978	7.5
9	#3 – Implement xeriscaping in 30 of the 42 irrigated acres on the Main Base	3,332,340	273,919	12.2
10	#5 – Update Remaining 10% of Faucets and Showerheads Basewide.	43,675	2,565	17.0***
11	#4 – Update Toilets and Urinals in Industrial and Commercial Facilities	303,360	2,654	116***

* No simple payback provided since estimated implementation costs are for the AWWA Leak detection survey only and do not include costs to repair leaks or replace water distribution system pipes

** No simple payback provided since estimated implementation costs and water savings vary from year to year.

*** Ongoing projects.

3.5 Step 5 – Implementation

3.5.1 Implementation Plan Overview

BMP selection was based on existing compliant practices which provided the greatest impact to water savings and provided economical projects to enhance each BMP. These selections may change upon completion of the Final WMP.

Nellis AFB has selected BMP #s 4, 5, 6, 7, and 8 for implementation per the *Guidebook*'s requirements and Air Force policy. The Base's current management practices and policies have already achieved compliance with the requirements of the EO and subsequent DOE guidance

for these BMPs. Additional projects and Retrofit/Replacement programs at the Base are identified in **Exhibit 3-24** for BMP #s 4, 5, and 7. To remain compliant, Nellis AFB will need to continue with the following items:

- Upgrade Toilets and Urinals in facilities not yet converted to low-flow fixtures.
- Upgrade Faucets and Showerheads in facilities not yet converted to low-flow fixtures.
- Replace water-cooled ice machines with air-cooled ice machines when retrofit/replacement is required.

Exhibit 3-23 summarizes the water consumption savings and simple payback analysis performed for these projects in Section 3.4. The projects are included for estimating purposes to assist the Base in budgeting to complete the initiatives in place. The table includes the estimate of additional water savings realized upon project completion.

EXHIBIT 3-23
Summary of BMP Analysis and Action Items for Implementation
Nellis AFB WMP

BMP	Water, Estimated Annual Savings (kgal)	Wastewater, Estimated Annual Savings (kgal)	Estimated Annual Savings ($)	Estimated Implementation Costs ($)	Simple Payback Period (yrs)
#4 – Update remaining 25 percent of Toilets and Urinals Basewide	3,360	3,360	2,654	307,166	116
#5 – Update Remaining 10 percent of Faucets and Showerheads Basewide	1,920	1920*	2,565	43,675	17.0
# 7 – Replace water-cooled Ice Machines with air-cooled Ice Machines	6,321	6,321	1,936	97,426	50.3

3.5.2 Funding for Implementation

There are numerous project funding options that can be used to accomplish water conservation projects. **Exhibit 3-24** summarizes the funding options the Base is currently using to implement the projects identified in Exhibit 3-23. Nellis AFB will consider other sources of funding to complete these projects by 2004-2005, if required. Currently, UESC funding is preferred at the Base.

EXHIBIT 3-24
Potential Funding Options to Support BMP Implementation
Nellis AFB WMP

BMP	ESPC	NAF	ECIP	UE SC	Housing Funds	O&M Funds
#4 – Update remaining 25% of Toilets and Urinals Basewide				✔		✔
#5 – Update Remaining 10% of Faucets and Showerheads Basewide				✔		✔

EXHIBIT 3-24
Potential Funding Options to Support BMP Implementation
Nellis AFB WMP

BMP	ESPC	NAF	ECIP	UE SC	Housing Funds	O&M Funds
#6 - Install RO as Makeup for Hospital Boilers	✔		✔	✔		✔
#7 - Replace water-cooled Ice Machines with air-cooled Ice Machines						✔
#8 – Soften Makeup Water at Building 200 Cooling Towers	✔			✔		✔
#8 - Soften Makeup Water at Hospital Cooling Towers	✔			✔		✔

3.6 Step 6 – Monitoring

To maintain compliance with EO 13123 and DOE FEMP implementation guidance, the cost effectiveness of Retrofit/Replacement options must be re-evaluated within the next 2 years. The deadline for this re-evaluation is established as November 2005. At that time, all BMP retrofit/replacement options should be re-evaluated to determine if economics have changed in such a manner as to make them favorable for implementation.

The Base Energy Manager is responsible for monitoring the results of water conservation BMPs that are implemented at Nellis AFB as part of the Energy Management Program. This will be accomplished by measuring water use for the 12-month period following final implementation of cost-effective BMPs, and comparing the water use to the FY 1999 through FY 2003 historic average. Both the number of kgals saved and the cost of water savings will be measured. The results of this monitoring program will be added as an appendix to this WMP.

SECTION 4

Conclusion

Nellis AFB has taken a proactive approach towards water conservation. The Base designs new construction with water-efficient landscape in mind. Native plants are also used throughout the Base to reduce irrigation demands. Most HVAC systems are well-maintained and use effective chemical treatment for optimum performance. The Base irrigation systems are monitored effectively.

Nellis AFB may currently claim credit for the following BMPs.

- BMP #4 – Toilets and Urinals
- BMP #5 – Faucets and Showerheads
- BMP #6 – Boiler/Steam Systems
- BMP #7 – Single Pass Cooling Systems
- BMP #8 – Cooling Tower Management

The Base may further expand its efforts to meet EO 13123 requirements by implementing the additional cost-effective projects identified in Section 3.4.

APPENDIX A

Draft WMP Review Comments and Responses Memo

CH2MHILL TELEPHONE CONVERSATION RECORD

Call To:	Barry Flynn, Civil Systems Engineer, Nellis AFB		
Phone No.:	(702) 652-3354	**Date:**	April 12, 2004
Call From:	Glen Huffman & Nanda Nanjundappa	**Time:**	8:30 AM
Message Taken By:	Glen Huffman		
Subject:	Draft Water Management Plan Review		

A teleconference review and comments session of the draft Water Management Plan (WMP) was conducted on April 12, 2004 with Barry Flynn, Civil Systems Engineer, Nellis AFB. The purpose of the call was to discuss comments from the Air Force internal review of the WMP and incorporate these comments as part of the final Water Management Plan for Nellis AFB. The meeting lasted approximately one hour.

The following comments were incorporated into the final WMP.

- Remove project to install an irrigation line from a non-potable water source in Area II to irrigate the Base golf courses. There is already an existing line.
- Change the unit price of xeriscaping from $3.00 per square foot. The Base provided a unit cost of $1.00 per square foot to remove turf and sprinkler systems and $0.70 to install rock type xeriscaping. An additional $0.85 per square foot, based on general requirements, inflation, contingency, SIOH, and design, was then added as part of the project costs to provide a simple payback analysis.
- As part of the WMP process, the Base selected the xeriscape project to have a 1391 prepared for.
- The Base agreed with the analysis for selection of BMPs 4, 5, 6, 7, and 8 as receiving credit for.
- An e-mail attached below addresses other comments made by Nellis AFB. These comments were addressed in the final WMP.

"-----Original Message-----
From: Flynn Barry J GS-11 99 CES/CEOE
[mailto:Barry.Flynn@nellis.af.mil]
Sent: Wednesday, April 21, 2004 9:20 AM
To: Huffman, Glen/SAN
Subject: RE: Nellis Draft Water Management Plan

Glen,

1. One other question in the Executive Summary, Exhibit ES-1 has Historic and Projected water use, how far out (years) is the projected consumption data?

2. On the first page (ES-1) of the Executive Summary, strike the first sentence of the last paragraph (Nellis AFB has satisfied the Air Forces goal of implementing at least four BMPs).

3. On the third page (ES-3) of the Executive Summary, add this to the last
paragraph:

... and on-going water conservation initiatives. Additional BMPs could be implemented to save even more water in the future. Of the five BMPs Nellis AFB has not been given credit for, BMPs two and three have the greatest potential savings, if funding is available.

The Executive Summary is where we need to advocate to the Wing Leadership what additional things we should try to do in the future.

Barry"

APPENDIX B

Orientation Meeting Minutes Memo

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CH2MHILL

27 November 2003

Mr. Michael Clawson
HQ AFCESA/CESC
139 Barnes Drive, Suite 1
Tyndall Air Force Base, FL 32403-5319

Subject: Contract F08637-98-D-6001-6056: Water Management Plans for HQ ACC Bases – Orientation Meeting Minutes for Site Visit to Nellis AFB

Dear Mr. Clawson:

CH2M HILL hereby submits minutes of the meeting for orientation and kick-off meeting held at Nellis AFB on November 12, 2003 for preparing the Water Management Plan under Delivery Order 6056. The site visit to Nellis AFB was conducted during November 12-14 by a team of CH2M HILL personnel to collect data for preparing the Water Management Plans and to evaluate Best Management Practices for water conservation efforts. During the site visit, the records for water usage data and other plans and reports available at the Base were reviewed including visits to the large water users and interview with the personnel responsible for managing the water system at Nellis AFB. We are currently in the process of data evaluation to prepare the Interim Status Report and draft Water Management Plan for Nellis AFB as per the schedule submitted in the Project Work Plan.

Please contact Matt Tyler or Nanda Nanjundappa in our San Antonio office with any questions on this deliverable by phone at 210-377-3081; fax 210-349-8944; or by e-mail at mtyler@ch2m.com or nnanjund@ch2m.com.

Sincerely,
CH2M HILL

Nanda K. Nanjundappa
Project Manager

Attch: Minutes of the Meeting

cc: Mr. Mark Turner, HQ ACC/CEOI
Mr. Ramesh Patel / Barry Flynn, 99 CES/CEOE

MEETING SUMMARY

CH2MHILL

Orientation Meeting - HQ ACC Water Management Plans, Nellis AFB, NV

ATTENDEES:

Mr Barry Flynn, 99 CES/CEOE
Mr Ramesh Patel, 99 CES/CEOE
Mr Charles Transley, 99 CES/CEOE
Mr Russ Collins, 99 CES/CEO.2
Ms Nancy Bethurem, HQ AWFC/JAV
Mr Charlie Varner, 99 CES
Mr Conrad Fenandez, 99 CES/CEOE
Davie Stieb
Mr Charles Rowland, 99 CES/CEO1
Mr Giuseppe 'Joe' Lepore, 99CES/CERR
Mr Mo Zamanian, 99 CES/CECS
Mr Tom (Pete) Marnach, 99SVS
Mr Nanda Nanjundappa/CH2MHILL
Mr Mike Eberbach/CH2M HILL
Mr Glen Huffman/CH2M HILL
Michael Eberbach

COPIES:

Mr Dale Green/CH2M HILL
Mr Matt Tyler/CH2M HILL
Mr Terry Schaumberg/CH2M HILL
Glen Lindgren/CH2M HILL

FROM: Mr Nanda Nanjundappa/CH2M HILL

DATE: December 10, 2003

The site visit to Nellis AFB for data collection was conducted during November 12 to 14, 2003. This site visit started with the project orientation meeting on Wednesday, November 12, 2004 at 8:00 AM in the Base CE Conference Room. The purpose of this orientation meeting was to provide an overview of the Water Management Plans project awarded to CH2M HILL for Headquarters Air Combat Command (HQ ACC) through Headquarters Air Force Civil Engineering Support Agency (HQ AFCESA) and schedule times for data collection and staff interviews. The scope of this project is to develop a Water Management Plan for each ACC installation and identify at least four Federal Energy Management Program's (FEMP) Best Management Practices (BMPs) for water conservation at the Base for those that have potential for implementation including getting the credit for BMPs through documentation of BMPs and projects already implemented at the Base.

Project Drivers

Executive Order (EO) 13123 serves as a driver for the project and requires a Water Management Plan to be developed for all Air Force installations. The Air Force goal is to have all the installations develop their water management plans by 2005. DOE guidance also outlines the compliance schedule goal with BMPs for federal installations starting 2002 till 2010 to meet at least four BMPs. Identification of BMPs for implementation and preparation of project documentation such as DD Form 1391s and information for Energy Service Company (ESCO) data packages are required as per the *Air Force Water Conservation Guidebook* to meet the water conservation requirements of Department of Energy's (DOE's) FEMP guidelines for EO 13123.

DOE's FEMP water conservation goals are not defined in terms of percentages of each BMPs completed or water consumption reduced. Instead, they require a written water

management plan and the implementation of at least four BMPs at each Air Force installation under current schedule.

The *Air Force Water Conservation Guidebook* published by HQ AFCESA in May 2002 is tailored for Air Force installations to meet the EO 13123 by following the DOE's FEMP guidelines. This *Guidebook* will be used to ensure a consistent Water Management Plan framework and to consistently follow the evaluation of BMPs for all ACC installations on this project.

The Orientation Meeting began in one of the conference rooms of the Civil Engineering Squadron Building at Nellis AFB at 8:00 a.m. Mr. Barry Flynn, designated POC for the Base introduced the CE and other staff from Nellis AFB at the meeting and discussed the purpose of site visit by CH2M HILL representatives.

Presentation

Nanda Nanjundappa/CH2M HILL introduced the CH2M HILL staff and presented an overview of the project and site visit objectives. The overview addressed the following items:

- Purpose and Goal
- Project Drivers
- Project Objectives
- Project Team
- Project Schedule
- Site Visit Agenda
- Next Steps

A copy of the presentation slides is attached to the minutes. CH2M HILL representatives met with Nellis AFB personnel Wednesday through Friday, November 12 to 14, 2003 to gather specific information on water use and conservation initiatives. Detailed notes from this site visit will be included in the Interim Status Report (ISR). A list of follow-up data gap identified after the site visit is attached to the minutes and will be addressed with the Base POC to complete the data gathering.

Site Visit/BMP Evaluation

CH2M HILL gathered data during the site visit to develop a Water Management Plan for Nellis AFB. CH2M HILL will document existing BMPs already implemented and will also evaluate other potential BMPs suitable for Nellis AFB. A Rough Order of Magnitude (ROM) cost analysis will be developed for these potential BMPs.

Interim Status Report

CH2M HILL will present initial BMP analyses and results from the site visit in an Interim Status Report (ISR). HQ ACC and Nellis AFB will use the information presented in the ISR to select four best applicable BMPs (from an economic and technical feasibility as well as implementation perspective) for Nellis AFB. For each of these four BMPs selected for

implementation, CH2M HILL will prepare a summary of projects along with an economic analysis to include in the Final Water Management Plan. This information will focus on supporting the Base's efforts to implement BMPs and to comply with Executive Order 13123 in a cost-effective manner. If Nellis has already implemented any of the BMPs, CH2M HILL will provide preliminary documentation to support the Base in claiming credit for BMPs already completed.

BMP Funding Methods and Documentation

For BMPs that need capital investment, CH2M HILL will prepare a DD Form 1391 and other appropriate documentation for Nellis AFB to use for programming the projects for funding. If a specific BMP is a good candidate for an Energy Savings Performance Contract (ESPC) or Utility Energy Services Contract (UESC), CH2M HILL will provide information that the Base can provide to an ESCO to develop Energy Conservation Measures. This will be included as part of the Final Water Management Plan submittal. This information will not replace a Phase 1 Audit, but will provide enough project description and energy data for the ESCO to assist them in their preparation of the Phase 1 Audit.

Project Approach

CH2M HILL will follow the *Air Force Water Conservation Guidebook's* step approach and methodology to develop Water Management Plan for each ACC installation. Each of these steps are discussed below:

Step 1:

- Collect data on water use and conservation efforts at each installation.
- Determine water consumption and cost based on historical data to calculate incremental cost of water.
- Identify key individuals at each installation to interview and understand how water system management is performing at each base.
- Evaluate design standards, programmed projects for repair and replacement (O&M, MILCON, ECIP), existing field surveys such as leaks and losses as well as back flow prevention, and review high water-use infrastructures for the installation.
- The information collected will be used in development of the water management plan and evaluation of suitable BMPs for each installation.

Step 2:

- Research and categorize current water use.
- If water use through metered data is not available for a particular process, best engineering estimates will be used to determine water consumption for the process.

Step 3:

- Calculate incremental water costs.

- Use historical data, utility bills, rate schedules and O&M costs to calculate incremental water costs.

Step 4:

- Identify and evaluate potential BMPs for the installation.
- CH2M HILL will prepare an ISR to include the preliminary analysis of BMPs.
- Air Force will select at least four BMPs from the BMPs analysis of the ISR.
- Prepare a draft Water Management Plan to include details of water systems and BMP analysis for each base.
- Assess the existing water conservation efforts and prepare ROM for potential BMPs for documentation.

CH2M HILL will help guide each ACC installation in prioritizing the potential BMPs suitable for implementation.

Step 5:

- Complete the final Water Management Plan to incorporate Air Force review comments and to select four BMPs for implementation.
- Develop an implementation plan for selected projects for BMPs to include economic analysis of the projects, documentation for funding and general project description and schedule.

Step 6:

This step is identified in the AF water conservation *Guidebook*. However, actual implementation and monitoring of the projects is not included in the scope of this project with CH2M HILL and will be carried out by the Air Force.

- Monitoring the program by reviewing completed projects for BMPs every two years.
- Monitoring should include provisions to measure results and procedures must be developed to accomplish a systematic review of water/sewer bills to identify changes in water use.
- Water Management Plan should be revised and updated to reflect the most current information of the water systems and use on Base.

Schedule and Deliverables

Activities	OPR	Due Date
Deliver Orientation Meeting Minutes for the site visit	CH2M HILL	Dec 05, 2003
Deliver Interim Status Report	CH2M HILL	Dec 05, 2003
Selection of 4 BMPs from the ISR for additional analysis	HQ AFCESA, HQ ACC & Nellis AFB	Dec 26, 2003
Deliver Draft Water Management Plan	CH2M HILL	Jan 16, 2004

Activities	OPR	Due Date
Air Force to provide comments on the Draft WMP	HQ AFCESA, HQ ACC & Nellis AFB	Feb 06, 2004
Deliver Final Water Management Plan	CH2M HILL	Mar 08, 2004

Summary of Site Visit and POCs Contacted

After the Orientation Meeting, CH2M HILL scheduled time with Nellis AFB's CE and other staff for follow-on meetings, interviews and visits to the water user systems. The following is a summary of activities.

November 12, 2004

- Multiple discussions with Barry Flynn and Ramesh Patel during the 3 day visit by CH2M HILL personnel.
- Glen Huffman and Mike Eberbach met with the Water Shop to collect data and background information for the Base's water distribution system.
- Nanda Nanjundappa met with Mr. Bill Fielder, Golf Course Superintendent (Sunrise Vista Golf Course) to gather information on golf course irrigation systems.
- Glen Huffman and Mike Eberbach visited Area II and met with Sgt Monroe (820 Red Horse Squadron.
- Glen Huffman and Mike Eberbach visited Mike O'Callaghen Hospital and met with Joe Webb, John Funderburk, TSgt Murand to gather water use data specific to the hospital operation.
- Nanda Nanjundappa met with Ms. Linda Slotsch, Chief of Base Housing Facilities to gather data and background information regarding housing.

November 13, 2004

- Nanda Nanjundappa met with John Roe, Environmental, and SSgt. Pamela Joe, BioEnvironmental to gather information regarding environmental constraints of the Base in regard to the water system, environmental water projects, and water quality reports.
- Glen Huffman and Mike Eberbach met with MSgt Augente, Consolidated Dormitory Manager to gather data and check three dorms for water compliant fixtures.
- Mike Eberbach and Glen Huffman visited the aircraft wash rack and met with TSgt Scott Sampson and personnel washing aircraft to determine water use at this location.
- Glen Huffman and Mike Eberbach visited the dining hall, bldg. 790, and met with dining manager to gather water use data and background information.
- Mike Eberbach and Glen Huffman visited the HVAC shop and met with TSgt Joseph Ingram, TSgt Blass, SSgt Wader, SAmn Patacsil as available to gather data and

background information as well as inspect a cooling tower, boiler and evaporative cooler location.

- Mike Eberbach and Glen Huffman visited the Interior Shop and met with TSgt Lance and TSgt Woolford to gather information regarding water fixture replacement and water compliant fixture use.

November 14, 2004

- Nanda Nanjundappa, Mike Eberbach, and Glen Huffman met with Major Gleason, Barry Flynn, Charles Transley, and Ramesh Patel as a debriefing meeting to discuss various water use subjects and for further clarification of Base's water distribution.
- Nanda Nanjundappa, Mike Eberbach, and Glen Huffman visited Irrigation shop, building 806, and met with SSgt Atkins to collect data associated with the Base wide irrigation systems.
- Nanda Nanjundappa, Mike Eberbach, and Glen Huffman met with Russ Collins on the way out from Nellis AFB for final visit comments.

Follow Up Data Requirements (Data Gaps)

The following are the action items still open after the site visit:

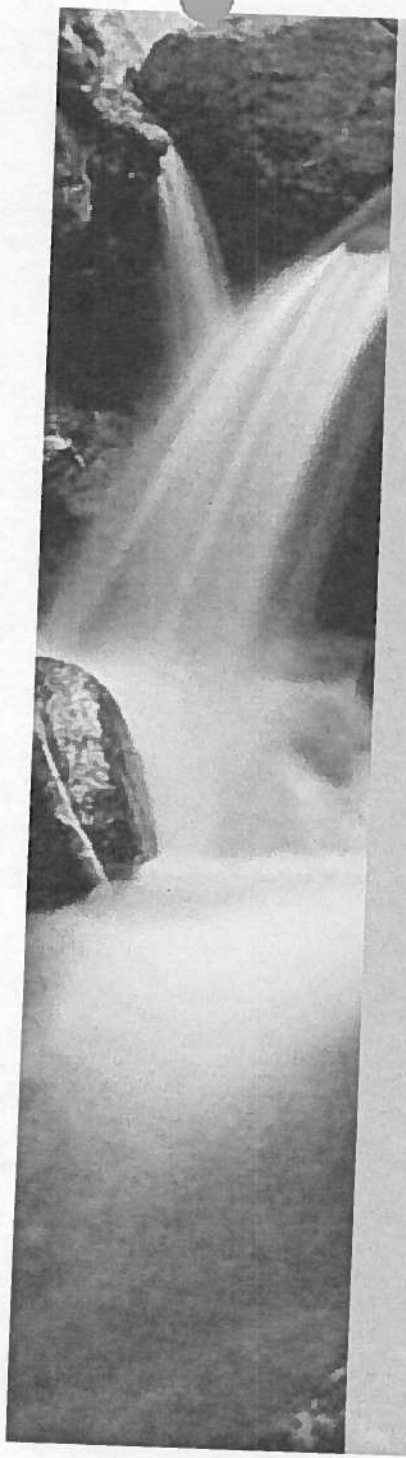
1. Who sets the water limit for NAFB?
2. A copy of the SNWA and NLV water contracts for the terms and agreements.
3. What plans are there for looping the water distribution system to reduce the dead ends and reduce line flushing requirements?
4. What percent of the water distribution valves have been replaced?
5. CEV- Does the lead bellow joints pose a potable water health concerns?
6. What are the number of traps in the hospital steam system and what number of traps are replaced every year?
7. What is the main hospital building water softener throughput (water) capacity in gallons set at before regeneration is sequenced?

Water Management Plans for HQ ACC Installations

Presented to:

Nellis AFB, NV

12 November 2003



Agenda

- Purpose and Goal
- Project Drivers
- Project Objectives
- Project Approach
- Project Team
- Project Schedule
- Site Visit Agenda
- Next Steps

Purpose and Goal

- Develop Water Management Plans for ACC Installations
  - Compliance with EO 13123
  - Credit for Prior Actions
- Identify Best Management Practices (BMPs) Projects
  - Guidance for Future Actions
- Prepare Project Documentation
  - 1391s
  - Preliminary Information for ESCO Data Packages

Project Drivers

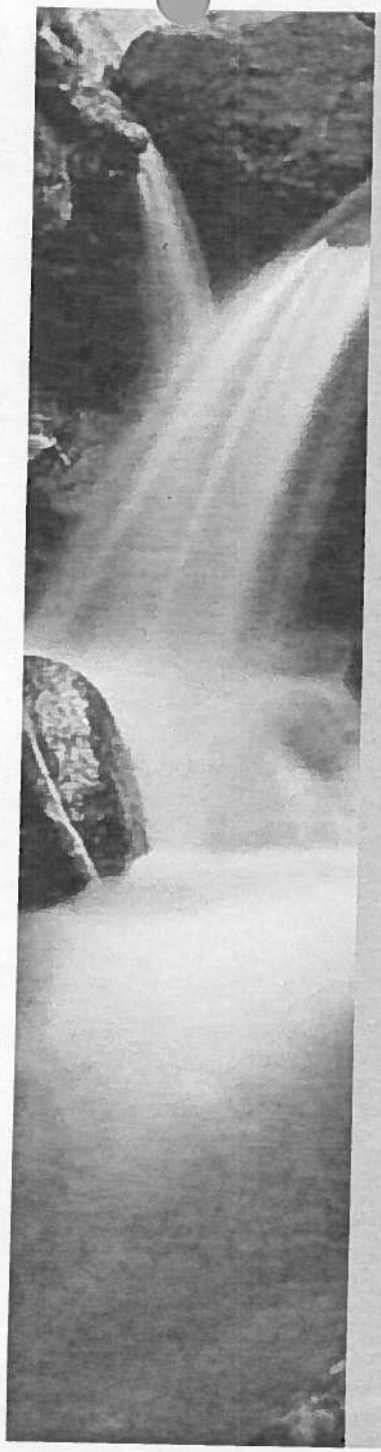
- Executive Order 13123
  - Establishes Water Conservation Goals
  - DOE (FEMP) guidance for implementing Executive Order 13123:
    - Develop a Water Management Plan
    - Implement at least four BMPs
- HQ AFCESA Water Conservation Guidebook
  - Step-by-Step Process
  - Ten Pre-defined BMPs

Project Objectives

- Develop Water Management Plan
  - Collect Relevant Data
  - Research and Categorize Water Use
  - Calculate Incremental Water Costs
  - Identify Potential BMP Projects
    - Document BMPs already accomplished
    - Select four most promising projects
    - Prepare economic analyses
    - Prepare implementation plans

Best Management Practices

- BMP #1 - Public Information and Education Program
- BMP#2 - Distribution System Audits, Leak Detection, and Repair
- BMP #3 - Water Efficient Landscaping
- BMP #4 - Toilets and Urinals
- BMP #5 - Faucets and Showerheads
- BMP #6 - Boiler/Steam Systems
- BMP #7 - Single Pass Cooling Systems
- BMP #8 - Cooling Tower Management
- BMP #9 - Miscellaneous High Water-Using Processes
- BMP #10 - Water Reuse and Recycling



Project Approach

- 5-Step Process Flow Chart

Collect Required Background Data

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Investigate & Categorize Water Use

↓

Calculate Incremental Costs of Water & Sewage Disposal

↓

Investigate BMPs for Potential Implementation

↓

Prepare Implementation Plan

Step 1: Collect Data

- Objective:
  - Collect data on facilities, processes, historical consumption and cost
- Approach:
  - Develop and distribute data needs checklist
  - Pre-kickoff conference call
  - Kick-off/Orientation meeting at installation
  - Data review with installation personnel/team
  - Field survey & interviews with large water users

Step 2: Research/Categorize Current Water Use

- Objective:
  - Categorize water use in terms of housing, commercial, industrial, irrigation, and leaks and losses
- Approach:
  - Review real property records
  - Review Facilities/Equipment data
  - Evaluate DUERS data
  - Evaluate available meter data
  - Segregate the data to characterize

Step 3: Calculate Incremental Water Costs

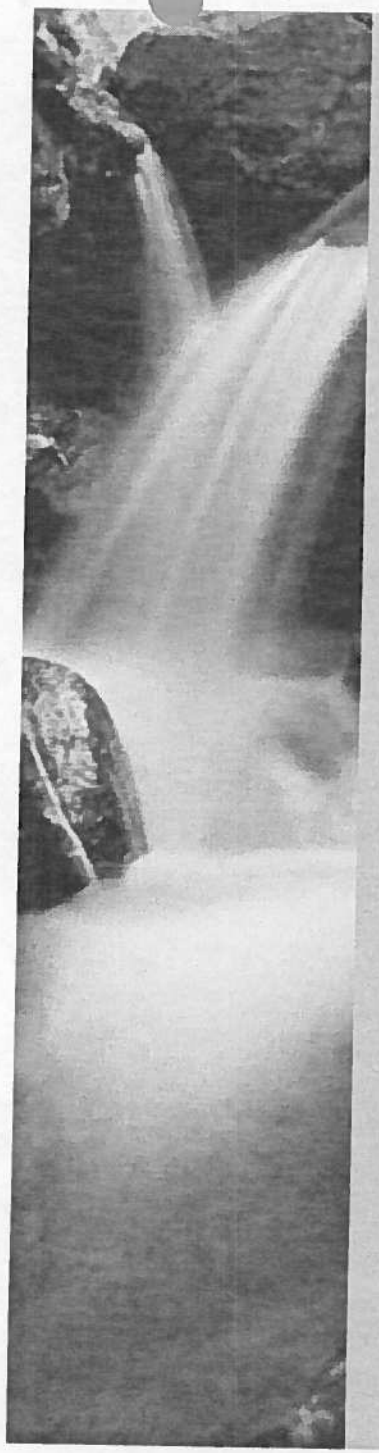
- Objective:
  - Calculate incremental cost of water based on historic data
- Approach:
  - Review past usage data and associated costs
  - Create a correlation for water usage by categories and true cost
  - True cost will be calculated based on utility bills, rate schedules, and O&M costs

Step 4: Identify & Evaluate BMPs

- Objective:
  - Identify all potential BMPs applicable to the installation
- Approach:
  - Identify potential BMPs during the site visits through observations and responses
  - Review data collected during the site visit & evaluate the suitability of each BMP
  - Credit for already implemented BMPs
  - Prepare a ROM for potential BMPs to include cost and savings by implementation

Step 5: Implement Selected BMPs

- Objective:
  - Develop implementation plan and schedule
- Approach:
  - Prepare detailed economic analyses for four selected BMPs
  - Prepare documentation for potential funding sources
  - Prepare a general project description and schedule for implementation



Project Team/Organization

Air Force Project Team:

HQ AFCESA Project Manager: Mike Clawson- AFCESA/CESC
HQ ACC Project Manager: Mark Turner - HQ ACC/CEOI
Nellis AFB/POC: Ramesh Patel - 99 CES/CEOE
Barry Flynn - 99 CES/CEOI
Other Base POCs as designated

CH2M HILL Project Team:

Program Manager: Matt Tyler
Project Manager: Nanda Nanjundappa
Senior Engineer: Mike Eberbach
Project Engineer: Glen Huffman

Schedule for Nellis AFB

Activity	Timeline
Kick Off / Orientation Meeting	12 Nov 2003
Site Visit for Data Collection	12–14 Nov 2003
Interim Status Report (ISR)	05 Dec 2003
Air Force Selects 4 BMPs from ISR	26 Dec 2003
Water Management Plan (WMP) DRAFT	16 Jan 2004
Air Force Review / Comments for WMP DRAFT	06 Feb 2004
FINAL Water Management Plan	08 Mar 2004

Site Visit Agenda

- Kick Off/Orientation Meeting
- Overview of Current Water Program
- Schedule Staff Meeting Times
- Review Data Collected (Checklist)
- Interview Staff (Questionnaire)
- Visit Large Water Users
- Review BMPs Actions/Projects Previously Implemented
- Out-brief with the Base POC

APPENDIX C

Final Interim Status Report

Notice

The purpose of this report is to assist the U.S. Air Force in the implementation of water conservation evaluations. This report is not an endorsement of any product. The views expressed herein are those of the contractor and do not necessarily reflect the official views of the publishing agency, the U.S. Air Force, or the Department of Defense.

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Acronyms and Abbreviations

ACC	Air Combat Command
AFB	Air Force Base
AFI	Air Force Instruction document
AWWA	American Water Works Association
BMP	Best Management Practice
CE	Civil Engineer
CRC	Colorado River Commission
DOE	Department of Energy
DUERS	Defense Utility Energy Reporting System
EC	evaporative cooler
EMCS	Energy Management Control System
ERU	Equivalent Residential Unit
ESPC	Energy Savings Performance Contract
FEMP	Federal Energy Management Program
FY	fiscal year
GIS	geographic information system
gpf	gallons per flush
HQ ACC	Headquarters for Air Combat Command
HQ AFCESA	Headquarters for Air Force Civil Engineering Support Agency
HVAC	heating, ventilation and air - conditioning
ISR	Interim Status Report
kgal	kilo (one thousand) gallons
MFH	Military Family Housing
MILCON	Military Construction
NOAA	National Oceanic and Atmospheric Administration
NLVWD	North Las Vegas Water District
NEPA	National Environmental Policy Act

POC	Point of Contact
POTW	Publicly Owned Treatment Works
ROM	rough order of magnitude
RWP	recurring work programs
SCADA	Supervisory Control and Data Acquisition
SNWA	Southern Nevada Water Authority
UESC	Utility Energy Services Contract
UPC	Unified Plumbing Code
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force

SECTION 1

Introduction

The purpose of this Interim Status Report (ISR) is to provide a preliminary evaluation of the current water system profile for Nellis Air Force Base (AFB) and to establish a framework for developing the Base's Water Management Plan. This ISR provides:

- A summary of site visit observations, data collection, and interviews with Base personnel conducted to date. This summary includes a list of the remaining data needs and unanswered questions needed to complete the Base's Water Management Plan.
- A preliminary assessment of the investigation/categorization of water use at the Base.
- A preliminary calculation/validation of the Base's incremental costs of water and sewage disposal.
- A preliminary assessment of the Base's water conservation activities related to the ten best management practices (BMPs) identified by the Department of Energy's (DOE) Federal Energy Management Program (FEMP).
- A preliminary evaluation of BMPs for which the Base may receive credit, based on activities already accomplished. It also identifies BMPs the Base may consider developing implementation plans for as a part of its water conservation program.

SECTION 2

Site Visit, Interviews, and Data Collection Summary

Site Visit

Representatives from CH2M HILL visited Nellis AFB from November 12 to 14, 2003 for data collection and project orientation with Base Civil Engineer (CE) staff. CH2M HILL's representatives included Nanda Nanjundappa, Mike Eberbach, and Glen Huffman. A summary of the tasks completed and personnel interviewed during the visit is provided in this section. A copy of the site visit notes is included in **Appendix A** of this report.

Site Visit Activities

A summary of activities follows.

November 12, 2003

CH2M HILL conducted an orientation meeting on November 12, 2003 at 8:00 AM. This meeting included an overview of the site visit schedule and an introduction of the DOE/FEMP Water Management Plan requirements for Nellis AFB personnel. CH2M HILL also discussed the roles and responsibilities of the team developing the Nellis Water Management Plan.

- Held multiple discussions with Barry Flynn (99th CES/CEOE) and Ramesh Patel (99th CES/CEOE) during the 3 day visit by CH2M HILL personnel.
- Glen Huffman and Mike Eberbach met with personnel from the Water Shop to collect data and background information for the Base's water distribution system.
- Nanda Nanjundappa met with Bill Fielder, Golf Course Superintendent (Sunrise Vista Golf Course), to gather information on golf course irrigation systems.
- Glen Huffman and Mike Eberbach visited Area II and met with Sgt Monroe (820 Red Horse Squadron).
- Glen Huffman and Mike Eberbach visited Mike O'Callaghen Hospital and met with Joe Webb, John Funderburk, and TSgt Murand to gather water use data specific to the hospital operation.
- Nanda Nanjundappa met with Linda Slotsch, Chief of Base Housing Facilities, to gather data and background information regarding housing.

November 13, 2003

- Nanda Nanjundappa met with John Roe (Environmental) and SSgt Pamela Joe (BioEnvironmental) to gather information regarding environmental constraints in regard to the water system, environmental water projects, and water quality reports.
- Glen Huffman and Mike Eberbach met with MSgt Augente (Consolidated Dormitory Manager) to gather data and check three dorms for water compliant fixtures.
- Mike Eberbach and Glen Huffman visited the aircraft wash rack and met with TSgt Scott Sampson and personnel washing aircraft to determine water use at this location.
- Glen Huffman and Mike Eberbach visited the dining hall (Bldg. 790) and met with the dining manager to gather water use data and background information.
- Mike Eberbach and Glen Huffman visited the HVAC shop and met with TSgt Joseph Ingram, TSgt Blass, SSgt Wader, SA Patacsil to gather data and background information as well as conduct site visitations to individual cooling tower, boiler, and evaporative cooler locations.
- Mike Eberbach and Glen Huffman visited the Interior Shop and met with TSgt Lance and TSgt Woolford to gather information regarding water fixture replacement and water compliant fixture use.

November 14, 2003

- Nanda Nanjundappa, Mike Eberbach, and Glen Huffman met with Major Gleason, Barry Flynn, Charles Trarsley, and Mr. Patel as a debriefing meeting to discuss various water use subjects and for further clarification of Base's water distribution.
- Nanda Nanjundappa, Mike Eberbach, and Glen Huffman visited the Irrigation shop, (Bldg. 806) and met with SSgt Atkins to collect data associated with the Base-wide irrigation systems.
- Nanda Nanjundappa, Mike Eberbach, and Glen Huffman debriefed Russ Collins.

Data Requirements

Several data gaps were identified during the implementation of this project. Follow-up with the Base POC and other personnel identified during the site visit will be required to obtain the missing information.

Data Needs

A copy of the Southern Nevada Water Authority (SNWA) and North Las Vegas Water District (NLVWD) water contracts for the terms and agreements.

Questions

1) What plans are there for looping the water distribution system to reduce the dead ends and reduce line flushing requirements?
2) What percent of the water distribution valves have been replaced?

SECTION 3

Preliminary Investigation and Categorization of Water Use

Nellis AFB obtains potable water from the Southern Nevada Water Authoriy (SNWA), the city of North Las Vegas Water District (NLVWD), and 10 on-Base waterwells. The distribution of the potable water is primarily from SNWA (approximately 48 percent) and on-Base wells (approximately 49 percent). The remainder (approximately 3 percent) is obtained from NLVWD. The water consumption from each source is monitorted to balance specific allocation requirements set forth by the Colorado River Commsion (CRC), for the SNWA water source, and the state of Nevada, for the on-Base water well sources.

Nellis AFB's average annual water consumption for FY 2000 through FY 2003 is 1,429,000 kgal based on data from DUERS reports. The total consumption was essentially constant during this period; however, DUERS data shows distinct differences in the main Base consumption versus the military family housing (MFH) consumption over the last 2 years (FY 2002 and FY 2003) as opposed to the previous 2 years (FY 2000 and FY 2001). Decreases in MFH water consumption have been offset by increases in the main Base water consumption. Based on water meter data for the last 2 years, it appears that all water supply sources were accounted for in the DUERS report during this time period. In reviewing the distinct water use differences in the DUERS data, the Base agrees that the most representative water use for the Base is for FY 2002 through FY 2003. The categorization analysis will be based on this timeframe.

This section provides a preliminary categorization of water use based on DUERS data, Monthly Water Consumption and Source Report, utility work sheets, and data collected during the site visit.

Category 1 - Housing Facilities

Category 1 accounts for approximately 4 percent of the overall Base water use.

There are currently 1,272 MFH units at Nellis AFB, representing 1.69 million square feet of housing area. The average annual MFH water usage for FY 2002 through FY 2003 has decreased approximately 261,000 kgal from the average FY 2000 through FY 2001 water use. This decrease can be attributed to the demolishion and construction/renovation of Base housing that was completed in FY 2001. The water consumption for this category was estimated using IWRAPS coefficients and removing both irrgation and leaks and losses which were then added to their corresponding cateogories.

Category 2 - Commercial Facilites

Category 2 accounts for approximately 19 percent of the overall Base water use.

Commercial facilities include administrative offices, the commissary, storage depots, cafeterias, health facilities, dormitories, visiting officer's quarters (VOQs), temporary living facilities (TLFs), security forces, and fire stations.

The water consumption for this category was estimated using cliamte-specific IWRAPS coefficients and the total area of commercial facilities. Based on the Nellis AFB Real Property Report, there is approximately 2.75 million square feet of commercial facilities.

Category 3 – Irrigation Water Use

Category 3 accounts for approximately 36 percent of the overall Base water use.

This category includes irrigation for the main Base, MFH, and the 36-hole golf course.

There are approximately 40 acres of landscaped areas that are irrigated on the main Base. The Base uses sprinkler systems and drip irrigation. The irrigation schedule is adjusted for winter and summer months. The Base has many desert xeriscaped areas with rocks and a few native plants. This design strategy is the basis for new construction, and conversion of other turf areas is also being considered.

Potable water is currently the primary source used to irrigate 249 acres of the 450 acre golf course. Other sources of irrigation include non-potable well #4 in Area II, water from a ground water remediation project adjacent to the golf course, and fire hydrant flush water from approximately 30 percent of the Base fire hydrants. The irrigation from well #4 in Area II has recently been put on-line and the net reduction of potable water use has not been fully realized. Meter data shows only a five month period with large fluctuations in consumption.

The Base MFH units are of mixed landscape design. The new Nellis Terrace units are desert xeriscaped with small areas of turf area. Old Nellis Terrace, Manch Manor, and Dunning Circle contain large areas of turf grasses.

Total Base irrigation includes main base, golf course, and MFH irrigation. The main Base irrigation was estimated by calcualtion of the frequency, flow, and number of sprinkler heads. Golf course irrigation was determined by meter data. The MFH irrigation was determined by using a summer minus winter average for based on the MFH DUERS data.

Category 4 - Leaks, Losses, and Unaccounted for Water

Category 4 accounts for approximately 35 percent of the overall Base water use.

The total water distribution system for Nellis AFB spans approximately 422 miles in which 186 miles of this includes the main ditribution piping. The distribution system is composed of approximately 55 percent polyvinyl chloride (PVC), 20 percent asbestos concrete (AC) and 25 percent cast iron (CI) pipes. Fifty percent of the PVC piping was replaced in 1985 to 1986 and the other five percent was replaced within the last 5 years.

To date, an AWWA leak detection survey has not been completed for the Base water distribution system. A valve survey has been conducted. Total Base leaks, losses, and unaccounted water was determined by mass balance from the other categories.

Category 5 - Industrial Facilities

Category 5 accounts for approximately 6 percent of the overall Base water use.

The Base has approximately 2.0 million square feet of industrial facilities based on the Nellis AFB Real Property Report. Industrial facilities include warehouses, maintenance areas, and administrave areas that support the facility operations. Although evaporative coolers are used for a majority of industrial facilities, the Base is moving towards more air cooled air conditioned facililties to reduce maintenance and operation cost. The water use for industrial facilities was determined using climate-specific IWRAPS coefficients.

SECTION 4

Incremental Preliminary Calculation of Water and Sewage Costs

Nellis AFB obtains potable water from two municipal sources and produces potable water from 10 on-Base wells. The SNWA and NLVWD supply approximately 51 percent of the total Base demand. The water source for the municipal suppliers is Lake Mead, which is replenished by the Colorado River.

NLVWD water use is minimized because the basic incremental rate for this water is over $2 per kgal which, is approximately four times the incremental rate of the SNWA source. The Base produced potable water has the lowest unit cost. A decision based on the incremental unit cost of water to optimize operating cost cannot be the sole factor in balancing the distribution from any particular source. Currently the entire Southern Nevada region is exceeding the Colorado River Commission limit of 300,000 acre-feet from Lake Mead. The region is using approximately 477,000 acre-feet and will need to reduce to the set limit while experiencing a high population growth rate. The incremental water rates will double over the next three years as a means to reduce water consumption for the area.

The Base averages 2,200 to 2,500 acre-feet annually, which is below the set limit. This could become a driver for the SNWA to renegotiate the 4,000 acre-foot limit set for Nellis AFB. The true value of the water, as an asset of sustainability for the Base, must be considered when deciding on potable water sources and operational costs. If the Base does not use the allocated SNWA water it could possibly loose the rights to that water. At the same time the Base must use a set limit of well water to retain their ground water permits through the state of Nevada.

Base personnel relayed to CH2M HILL that the municipal water suppliers will increase the incremental water rate by a factor of two during the next 3 years as a means to control water consumption in the Las Vegas area. For purposes of water savings calculations in this report, the average incremental rate based on FY 1998 through FY 2003 Utility Sales Rate Computation Worksheets will be multiplied by two, as the water rate is expected to double in the next 3 years. This equates to $1.14 per kgal.

Wastewater is discharged to Clark County Sanitation District, which is approximately 15 miles south of Nellis AFB. The average incremental wastewater rate for the Base is $2.17 per kgal as shown in the Utility Sales Rate Computation Worksheet. This rate is based on a fixed annual disposal cost and an estimated volume of sewage based on an Equivalent Residential Unit (ERU) for the Base. This rate was not used in project calculations because it is a fixed annual cost and will not change if water saving projects reduce the discharge from the Base.

Table 4.1 provides the potable water and wastewater rates for FY 1998 through FY 2003.

TABLE 4.1
Annual Water and Wastewater Rates

Fiscal Year	Incremental Water Rate per kgal	Incremental Wastewater Rate per kgal
FY 2003	$0.63	$1.93
FY 2002	$0.80	$2.33
FY 2001	$0.63	$2.51
FY 2000	$0.46	$2.08
FY 1999	$0.46	$2.08
Average	**$0.57**	**$2.17**
Future Rate	**$1.14**	**N/A**

Values from Nellis AFB Sales Rate Computation Worksheet

SECTION 5

BMP Evaluation

Results of the BMP Evaluation

CH2M HILL evaluated the Base's BMPs. The preliminary results of this evaluation indicate that Nellis AFB has successfully fulfilled the DOD goal of implementing four BMPs. Although additional analysis and calculations are required to validate these preliminary results, Nellis AFB has potentially achieved four of the ten BMPs.

Table 5.1 summarizes the initial assessment of the Base's water conservation activities for each BMP. The BMP evaluation process uses the *Air Force Water Conservation Guidebook* to address issues required to meet compliance to a given practice. Each BMP is addressed in more detail in Section 5.2.

TABLE 5.1
Summary of BMP Investigation for Nellis AFB

BMP	Description	Possible Claim for BMP (Yes or No)	Possible Future BMP (Yes or No)	Remarks
# 1	Public Information and Education Programs	No	Yes	Publish seasonal articles through Base newspaper. Use other media sources for water conservation topics. Train personnel on high water using equipment.
# 2	Distribution System Audits, Leak Detection and Repair	No	Yes	Perform AWWA leak detection.
# 3	Water Efficient Landscaping	No	Yes	Further develop desert xeriscaping on Main Base and MFH units with large turf areas.
# 4	Toilets and Urinals	Yes	*	75 % compliant on Main Base with most MFH units upgraded.
# 5	Faucets and Showerheads	Yes	*	90 % compliant fixtures in MFH and other areas.
# 6	Boiler and Steam Systems	Yes	*	Excellent O&M procedures with automatic chemical feed/blowdown control.
# 7	Single-Pass Cooling Equipment	No	Yes	Replace once through cooling ice machines with air-cooled units.
# 8	Cooling Tower Management	Yes	*	Excellent O&M procedures with automatic chemical feed/blowdown control.
# 9	Miscellaneous High Water Users	No	Yes	Upgrade dinning halls with water conservation/compliant fixtures. Optimize capacity of base water softeners.
# 10	Water Reuse and Recycling	No	Yes	Irrigate golf course and Base with recycled or non-potable water.

* The Base is eligible to receive credit for this BMP and is currently not required to take further action. Enhancements may be recommended to strengthen the Base's compliance with this BMP.

Evaluation of Individual BMPs

BMP #1, Public Information and Education Programs

Based on a preliminary evaluation, Nellis AFB cannot claim credit for BMP #1.

Although water restriction notices have been published in the Base newspaper (*Bullseye*) on an annual basis, the Base should publish articles regarding Base water use, conservation, or other water awareness articles on a regular basis. Additionally, the Base needs to further promote water conservation awareness through programmed facility manager training, surveys and sign and literature placement. Appendix B provides calculations for this BMP.

Additional Water Conservation Project Costs: $11,000

BMP #2, Distribution System Audits, Leak Detection, and Repair

Based on a preliminary evaluation, Nellis AFB cannot claim credit for BMP #2.

A majority of piping for MFH being replaced under new housing construction program. The Base maintains 702 fire hydrants which are flushed annually for 20 to 30 minutes. The replacement of the a majority of old valves has been programmed at a cost of $5 million.

An AWWA #M36 leak detection survey has not been performed for the Base water distribution system. The Base has conducted a valve survey and is funding GIS mapping of the potable water distribution system, which will give Base personnel a tool to identify distribution valves for maintenance and replacement. Appendix B provides calculations for this BMP.

Additional Water Conservation Project Costs: $63,300

BMP #3, Water Efficient Landscaping

Based on a preliminary evaluation, Nellis AFB cannot claim credit for BMP #3.

Nellis AFB has implemented water-efficient landscape design for a substantial portion of the Base. The new Nellis Terrace MFH units (350) are desert xeriscaped with limited turf areas for recreation in each tenants' individual yard. The older Nellis Terrace MFH units (329) have not been upgraded to this standard and are predominantly 100 percent turf. Manch Manor MFH units (593) are predominantly 100 percent turf as well. Further desert xeriscape in the MFH areas and on the Main base would provide compliance of this BMP.

Ideas concerning the best approach for a water-efficient 36-hole golf course have been talked about but there is not currently an action plan for xeriscaping the golf course. Ideas such as artificial turf, island fairways, and others have been contemplated. Appendix B provides calculations for this BMP.

Additional water conservation project cost: $6,098,428

BMP #4, Toilets and Urinals

Based on a preliminary evaluation, Nellis AFB can claim credit for BMP #4.

There is an effective recurring work program through the Interior Shop to maintain Base toilets and replace non-compliant toilets and urinals with compliant fixtures as they break. The Base and MFH units have been upgraded to approximately 75 percent compliant fixtures.

The additional water conservation project identified involved updating the remaining 25 percent of non-compliant fixtures to new compliance standards. This analysis evaluates this project for MFH and the Base industrial and commercial facilities. Appendix B provides calculations for this BMP.

Additional Water Conservation Project Costs: $695,863

BMP #5, Faucets and Showerheads

Based on a preliminary evaluation, Nellis AFB can claim credit for BMP #5.

There is an effective recurring work program for faucet and showerhead maintenance through the Base Interior Shop. A project for 500 showerheads was awarded through Environmental in October 2003 for Base dormitories. Approximately 90 percent of the faucets and showerheads are compliant Base-wide.

Two additional water conservation projects were identified. One project involves updating the remaining 10 percent of non-compliant fixtures to new compliance standards. This analysis evaluates this project for MFH and the Base industrial and commercial facilities. The second project is the installation of Metlund® Hot Water Demand Systems. These systems reduce water and energy losses occurring from the waiting period for the faucet or shower to become the desired temperature. The system recirculates the water back through the cold water line when a sensor initiates a small pump under the sink. Appendix B provides calculations for this BMP.

Additional Water Conservation Project Costs: $520,647

BMP #6, Boiler/Steam Systems

Based on a preliminary evaluation, Nellis AFB can claim credit for BMP #6.

The Base boiler and steam systems have excellent control systems in place controlling boiler blowdown and chemical feed. Base personnel keep accurate maintenance and operation records of the boiler systems. A site visit and review of the hospital boilers revealed the boilers are in good condition and properly maintained. There are no apparent steam trap problems with the hospital stream system.

A water and energy saving project was identified for the hospital boilers. This project involves using reverse osmosis (RO) to generate high purity water for the hospital steam plant. RO would allow the boiler to operate at an optimal 1 percent blowdown rate. Appendix B provides calculations for this BMP.

Additional Water Conservation Project Costs: $41,400

BMP #7, Single-Pass Cooling Equipment

Based on a preliminary evaluation, Nellis AFB cannot claim credit for BMP #7.

There are approximately 14 ice machines on Base that use once-through cooling as their heat sink. A potential conservation project that evaluates the use of air-cooled ice machines will be included in the Draft Water Management Plan.

Water Conservation Project Costs: See Draft Water Management Plan

BMP #8, Cooling Tower Management

Based on a preliminary evaluation, Nellis AFB can claim credit for BMP #8.

The Base has approximately 20 cooling towers. An evaluation of the hospital and building 200 cooling towers indicated that the systems were being properly maintained. Both cooling tower systems utilized conductivity analyzers to initiate blowdown and chemical feed through a controller. The hospital cooling tower system utilized pH control as well to further increase the cycles of concentration. Two identical projects were identified for the hospital and building 200 cooling tower systems. These projects identified the water savings associated with softening the makeup water to achieve 6 cycles of concentration. Appendix B provides calculations for this BMP.

Additional Water Conservation Project Costs: $204,206

BMP #9, Miscellaneous High Water-Using Processes

Based on a preliminary evaluation, Nellis AFB cannot claim credit for BMP #9.

There are a few high-water using processes on Base. Some of these include the water softeners at the hospital, the aircraft wash rack, and the dinning halls.

There are six dining halls on Base totaling approximately 101,000 square feet, with one of these in the hospital. Projects identified for the dinning halls include upgrading the sinks with pedal valves and compliant fixtures as well as adding pulper machines to the garbage disposals that will help recycle garbage disposal water.

Another project identified involves optimization of the water softeners at the main hospital and the steam plant adjacent to the hospital to reduce on the frequency of regeneration water and salt losses. This project will allow for efficient water use in the operation of the softening equipment. This project includes installing a hardness analyzer that will sequence regeneration when a desired residual of hardness is detected.

Another project identified under this BMP is the use of 5 gpm pressure washers at the wash racks. The increased pressure with reduced flow leads to significant savings as compared to the current hose and nozzle. Appendix B provides calculations for this BMP.

Additional Water Conservation Project Costs: $130,866

BMP #10, Water Reuse and Recycling

Based on a preliminary evaluation, Nellis AFB cannot claim credit for BMP #10.

Although Nellis AFB currently reclaims water for 30 percent of the total fire hydrant flushing water on Base, groundwater remediation recovery water, and the use of non-potable wellwater from well # 4 in Area II for the golf course, this does not represent a substantial amount of potable water savings.

Potential projects include construction of a WWTP and consolidation of a non-potable wellwater distribution system to irrigate the golf course and the Main Base. An additional project for consideration is to reclaim water losses from hospital fire system testing. Appendix B provides calculations for this BMP.

Further analysis will be evaluated in the Draft Water Management Plan.

SECTION 6

Rough Order of Magnitude Cost for BMPs

This section provides a summary of the Rough Order of Magnitude (ROM) cost estimates for the BMPs evaluated. For the purpose of this report, the 2-year average of FY 2002 through FY 2003 water consumption is used in the calculations. The cost summary includes the following factors:

- facilities identified for the projects in specific BMP;
- project cost for the projects identified under each BMP;
- quantity of water saved by these projects;
- dollar amount savings by implementing a specific BMP project; and
- simple payback.

The ROMs presented in **Table 6.1** are based on the data collected during the site visit. **Appendix B** provides ROM calculations for all the BMPs. However, there were some engineering assumptions made based on the standard water usage and cost in estimating these values. Payback periods for the proposed BMP improvement projects are influenced by the rates the Base expects to pay for water in the next three years: $1.14 per kgal for potable water. The wastewater incremental rate was not used in any pertaining calculations because the Base pays a flat rate and reduction in discharge will not reduce the sewer fee charged to the Base.

TABLE 6.1
Summary of ROM Cost Estimate for BMPs

#	Best Management Practices (BMPs)	Facility	Project Cost ($)	Annual Water Saved (kgal)	Annual Energy Saved (MMBTU or MWh)	Annual Dollar Savings ($)	Simple Payback (yrs)
1	**Public Information & Education Programs**						
	Upgrade awareness program	Base wide, MFH	11,000	14,690	N/A	16,747	N/A
2	**Distr. System Audits, Leak Detect & Repair**						
	Conduct AWWA leak detection survey (and immediately repair any leaks discovered)*	Base wide	63,300	367,250	N/A	418,665	N/A
3	**Water Efficient Landscape**						
	Water-efficient landscaping in MFH & Main Base	MFH	6,098,428	95,000	N/A	108,300	56.3
4	**Toilets and Urinals**						
	Upgrade 25 % toilets & urinals- industrial & commercial	Main Base	303,360	3,318	N/A	3,783	80.2
	Upgrade 25 % toilets and urinals- MFH	MFH	392,503	2,958	N/A	3,372	116.4

TABLE 6.1
Summary of ROM Cost Estimate for BMPs

#	Best Management Practices (BMPs)	Facility	Project Cost ($)	Annual Water Saved (kgal)	Annual Energy Saved (MMBTU or MWh)	Annual Dollar Savings ($)	Simple Payback (yrs)
5	**Faucets and Showerheads**						
	Upgrade 10 % faucets & showerheads-industrial & commercial	Main Base	43,134	1,896	190 MMBTU	3,198	13.5
	Upgrade 10% faucets & showerheads - MFH	MFH	70,473	6,591	N/A	7,514	9.4
	Install Metlund® Hot Water Demand System	MFH	407,040	8,522	395 MWh	41,315	9.9
6	**Boiler/Steam Systems**						
	Use RO as makeup source for Hospital Boiler	Hospital	41,400	1,465	3,282 MMBTU	24,070	1.7
7	**Single-Pass Cooling Systems**						
	Evaluation of air-cooled ice machines	Hospital/Dinning Halls	Future		N/A		
8	**Cooling Tower Systems**						
	Increase CT COC from 4.5 to 6	Hospital	3,500	1,241	N/A	1,415	2.5
	Increase CT COC from 2.5 to 6	Bldg. 200	3,500	1,715	N/A	1,955	1.8
9	**Misc. High Water-Using Processes**						
	Dinning Hall Upgrades- pedal valves, fixtures, pulping machine for garbage disposal	Base wide/Hospital	107,616	2,545	515 MMBTU	5,713	18.8
	Optimize Hospital Water Softener Regeneration Frequency	Main Hospital	10,500	716	N/A	7,785*	1.3
	Optimize Hospital Water Softener Regeneration Frequency	Hospital Boiler Room	10,500	350	N/A	3,711*	2.8
	Low Flow Pressure Washers	Aircraft Wash Rack	2,250	702	N/A	800	2.8
10	**Water Reuse and Recycling**						
	Total		**7,568,504**	**508,959**		**648,343**	

* These projects include regeneration salt (brine) savings.

APPENDIX A

Site Visit Notes

November 12-14, 2003

CH2MHILL Attendees: Nanda Nanjundappa
Mike Eberbach
Glen Huffman

Nellis AFB Personnel: Barry Flynn, Civil Systems Engineer, primary POC
Nellis AFB personnel are listed in the sections in which their comments are included.

Notes from the site visit to Nellis Air Force Base follow.

Background

Reference, Orientation Meeting

1. What is the overview of the water management program? The Base provides information to CH2MHILL through the collection of Base documented water data and discussions with the different engineering operation support groups to analyze water use. CH2MHILL uses the provided information to understand each source of water and categorize the water.

2. Barry Flynn asked if Nellis AFB could receive compliance for more than four BMPs. CH2MHILL answered that all Bases are encouraged to achieve more than four BMPs.

3. Does CH2MHILL plan to break down rates for individual projects or provide NAFB a blended rate. A blended rate is considered but will also look at specific projects to consider project specific rates. NAFB requested these be separate to gauge rate cost. However blended rate will also help the Base see the big picture.

4. Nancy Bethurem requested CH2MHILL to provide more than simple payback and further explain the actual value of the water. This would be difficult to do based on time considerations.

5. Mr. Collins thought two rates for each supplier would be more helpful in considering water conservation projects. Charles Transley liked a single blended rate to project overview of water consumption.

6. Nancy Bethurem asked what is the overall goal of the Water Management Plan? Nanda Nanjundappa explained that the Water Management Plan focuses on how the Base receives, uses, disposes, and recycles the supplied water as it relates to water conservation. The plan will look at both current supply and demand and projected water supply and demand.

7. Nancy Bethurem mentioned that the Base uses two basic water rates one for main Base and one for the golf course. She also stated that the Base is reviewing a sustainability plan that would stabilize well water by relying more on municipal water and conservation.

8. Nancy Bethurem mentioned that water conservation analysis becomes skewed when the value of water is not considered. Simple payback does not consider the local value of water.
9. Ross Collins asked whether electric utility rates were incorporated into water project analysis. Michael Eberbach answered that it depended on the project and amount of energy savings that can be included with each project.
10. There are no industrial areas surrounding Nellis AFB.

Major Gleason, Barry Flynn, Charles Transley, Mr. Patel, CH2MHILL.

11. Legally, no O&M funds can be used for golf course upgrades. Funded through services to recoup money. Possible funding through Base capital account for appropriation provided that the project can show a payback, 20 years to re-capitalized.
12. Southern Nevada has been under a drought alert for three years. The Lake Mead level has dropped at least 37 feet in this time period.
13. Major Gleason does not anticipate increase in CRC use but expects Indian Spring area to increase in water use.
14. Barry Flynn expects Base water increase especially if BRAC occurs, F22 increasing, Joint Strike Fighter being added. Missions will grow. Expects a 10 percent increase.
15. Indian Springs is expected to increase, currently they have a water shortage. They rely completely on well water.
16. The sewer rates cannot be used to calculate simple payback for water saving projects. Since wastewater is based on equivalent residential units (ERUs). Reduced wastewater will not lower bill.
17. New F22 Hangar (approx. 10,000 sf) is designed with air conditioning in lieu of evaporative coolers. High-energy use but reduced water.
18. The Base is not directly impacted by city drought emergency requirements. No enforcement of city regulations for water restrictions, limited enforcement for housing residents.
19. No current energy policy.
20. Russ Collins would like the report to show funding sources and provide 1391's as noted in our briefing. This will depend on project data.

Ramesh Patel

21. Base is broadly divided into there areas called Area I, Area II and Area III. These areas have the missions as follows:
22. Area I is the main Base and supports 99th Squadron missions.
23. Area II is located to the East and Southeast side of the main Base. Some of the facilities in this area include a weapons storage area (About 50 persons), Federal Prison (Non-DoD facility, about 550 persons), Explosive Ordinance Detonation (EOD) facilities (about 30 persons), and Red Horse Facility (2 separate units – 558th and 820th with a total of about 200 persons) for mostly weapons maintenance mission.

24. Area III is located to the Northwest side of the main Base. Some of the facilities in this area includes Hospital (200 beds in the main hospital and about 150 beds in clinics with a total of about 500 persons in the facility), DRMO with three facilities (about 20 persons), Security Police (about 5-10 persons), PLCC (Security Forces mission – about 120 persons with three bldgs. Each of about 50,000 sq ft), Family camp grounds for about 150 spots (Average of 30-50 camps at any given time). POL facilities with 5 storage tanks (about 3-4 persons), and Air Force Reserves with 2 facilities of 20,000 and 40,000 sq ft in area (about 200 persons mostly weekend activities).

25. There is also a DOE owned facility at the Base called East side area located between Area I and Area II. Base maintains this facility including water supply and power. This facility is approximately 200,000 square feet in area.

26. Base currently has a permit for water supply from Lake Mead source up to 4,000 acre-feet per year. However, Base is only using about 2,200- 2,400 acre-feet per year on average.

Water Overview

Robert Carranza, MSgt Randall Adams, MSgt James Kelley, John Maish, Joe O'Malley

1. Lake Mead is the source of water for Nellis AFB supply from the city. Water to Lake Mead comes from Colorado River.

2. NAFB has two municipal suppliers, Southern Nevada Water Authority (SNWA) and North Las Vegas (NLV), and 10 on-site wells.

3. Nancy Bethurem mentioned that the Base would like to maximize water allocation from the Colorado River Commission (CRC) benchmark and reduce well water use. The CRC benchmark for the Base is 4,000 acre-feet. Currently, the Base water use is between 2,200 and 2,500 acre-feet.

4. Currently, the Southern Nevada area is under a drought alert condition and is expected to go to a drought emergency level by February 2004. The Base is not affected directly by this issuance but needs to consider water conservation actions.

5. A new Federal court decision has reaffirmed the existing CRC limits. Under this decision is the requirement that regions using more than their allocation reduce their consumption to meet the set limits within 5 years. Currently, the Southern Nevada region is using approximately 477,000 acre-feet and will need to reduce to the set limit of 300,000 acre-feet. During this same time the growth rates in the Las Vegas area are estimated at an additional 5,000 people/day. This may become a driver for the city to renegotiate the 4,000 acre-foot limit set for NAFB.

6. Russ Collins stated, that instead of the city setting limits, Southern Nevada Water Authority will increase rates (anticipating rates to double within 3 years) and that this is the cities way of driving water conservation. Rates will be broken down into a tier system with rates set by use limits. NAFB rates are based on large user rate which will simply be adjusted upward on a yearly basis.

MSgt Griggs, SSgt Rodriguez, TSgt Murand, Charlie Varner, Exterior Shop: 702 652 4247.

7. There are ten (10) wells reported by the water shop: 1, 2, 4 CR, 6, 7, 8, 11, 12, 13, 14. The meters on these wells are checked and logged every day. The data is used to report DUERS Base water use.

8. The Base pumps out approximately 687,000 Kgal of water annually from the ten (10) wells.
9. Water pressure ranges from 35 to 70 psi. There are no customer complaints regarding water pressure. There are few to issues regarding water particles or color. Chlorine levels are kept in the correct ranges (except at the numerous dead ends) and there are no issues with biological contamination.
10. The City of North Las Vegas Water District (NLVWD) supply connection (10" PVC) is from the East side.
11. The Southern Nevada Water Authority supply connects in a vault in Freedom Park as a ductile iron 24" line where it is split into a 12" and an 8" line for Base use.
12. Meters and vaults not owned by the Base. Meters are hand read monthly by the Base for Base consumption data and DUERS reporting. The meters are maintained by the supplier.
13. Hospital has a back-up connection provided by North Las Vegas.
14. Wells are in okay shape. A copy of the well depth is available.
15. There are twenty-four (24) reimbursable customers that are metered, these are hand read monthly. These meters will be installed with electronic reading controls by JCI.
16. The contact for the Indian Springs bombing range is Greg Bordles (702) 652-0160.
17. The Base water towers include. 1721 (300 Kgal), 561 (500 Kgal), Manch (100 Kgal), Area 2 (100 Kgal). Above ground storage tanks: 491 Base (500 Kgal), 562 (200 Kgal), 1725 (2.3 MM gal), Area 3 (3 MM gal), Area 2 (300 Kgal).
18. Dust control is needed for construction areas.

Joe Webb, John Funderburk, TSgt Murand Mike O'Callaghen Hospital

19. Hospital potable water pipe is asbestos cement.

John Roe, Environmental and SSgt. Pamela Joe, BioEnvironmental Environmental Compliance (Water Systems) and Bio-Environmental Engineering (BEE)

20. Satellite locations (Off-Base) such as Indian Springs and Talopa, are located about 60 miles from the main Base. These units/facilities have their independent source of water from wells in the area. Chlorination is the only treatment for the water at these locations.
21. These satellite locations are operated and maintained by contractor (Dynacorp). Contractor's POC for this operation is Larry Cook (702) 652-0463. Nellis main Base has not included the water use data for these locations on their DUERS report or any other Base water use reports.
22. CNLV (City of North Las Vegas) buys water from SNWA (Southern Nevada Water District) and supply water through their own distribution network to their customers. Source of water to SNWA is from Lower Colorado River.
23. Water analysis for the Base potable water supply is conducted by SNWA. They collect water samples for analysis and submit a copy of the analysis report to the Base. Bio Environmental Engineering on Base maintains these records along with the CCR (Consumer Confidence Report). Copies of this report for the past 2-3 years were obtained during the visit.

24. New EPA rules that was published in 2002 which will be in effect by 2006 will have limitations of arsenic in drinking water to be not more than 10 ppb. This will have some implications on the water quality at the Base from the well water sources.

25. There is a project planned for arsenic removal treatment system for potable water supply for the Base from well water sources. This project is estimated to be about $2.7M which is likely to start construction by 2005. Well #s 1, 6 and 7 in Area 1 have arsenic levels in excess of 10 ppb. Treatment units mainly include adsorption technology. (Project # WZVS046100).

26. Checked for a copy of the Drought Management Plan but was not available. However, John mentioned CE might have a copy of the Emergency Preparedness Plan that may include drought management or contingency plan for water scarcity.

Major Gleason, Barry Flynn, Charles Transley, Mr. Patel, CH2MHILL.

27. The Base needs to operate wells in order to keep permits, must be operated over a 5-year average. There are no new wells expected.

28. Water pumping and permit limit data was provided for few wells on Base in Area I. Annual well water quantity in acre-feet from the aquifer source in Area 1 of the Base is as follows;

Well #	Actual	Permit
1	94	155
2	172	226
6	217	120
7	88	120
8	82	170
11	-	-
Total	53	791

Barry Flynn

29. There are two water sources of supply from the City. One of the sources is from the City of North Las Vegas (CNLV) and other source is from Southern Nevada Water Authority (SNWA). Water source for both these authorities comes from Colorado River.

30. There are four (4) overhead (elevated) water tanks and five (5) ground level water tanks on Base for storage and distribution.

31. Generally, there have not been many complaints about the adequate water pressure in the distribution network.

Monitoring

Reference: Tom DeMartino and Bill Casiere, JCI technicians, ext. 6744/41

1. Visited EMCS hub.

2. CI has been contracted to operate EMCS system.

3. All new EMCS equipment shall be JCI/Metasys equipment.

4. Most of the field equipment is Metasys Centaurus equipment for HVAC control. There is also some Siemens and Honeywell (Delta) equipment.
5. Water pumps are wireless Centaurus controls for pump operation. No electronic flow meters but this has been discussed with branch manager, Buddy Wells.
6. Well operation is controlled by electronic level gauges that operate water pumps if tank level is too low.

Wastewater

Reference: John Roe, Environmental and SSgt. Pamela Joe, BioEnvironmental

1. Wastewater from the Base is currently discharged into the sanitary sewer lines of Clark County sanitation district which is being treated by a POTW located approximately 15-16 miles southeast of the Base.

Reference: Major Gleason, Barry Flynn, Charles Transley, Mr. Patel, CH2MHILL

2. The concept of a wastewater plant has been considered but is too costly to consider. The sewage from the Base flows to Clark County Sanitation District (CCSD) for wastewater treatment. The city has no incentive to reclaim Base wastewater.
3. The Indian Springs satellite Base utilizes a settling, which was described to be a lower cost alternative for the site. A system like this could be installed but water quality is probably not good enough for golf course watering.

Category 1 – Housing

1. MFH privatization is being contracted out. Even if a contract is completed within a year, Russ Collins estimates that it will take an additional 3-5 years to complete. Thus housing recommendations and water projects should be considered.

Reference: Ms. Linda Slotsch, Chief of Base Housing Facilities

2. Currently housing privatization efforts are in progress and the request for proposal (RFP) has been solicited. Proposed schedule for housing privatization is included in the fact sheet, a copy of this fact sheet is obtained for reference.
3. Housing units are located in three separate areas. Theses are Manch Manor, Nellis Terrace (Old and New) and Dunning Circle. See attached Fact sheet that provides location area map of these communities.
4. Old Nellis Terrace housing units were built in 1950's. New Nellis Terrace housing units were built between 1996 through 2002. Nellis Terrace has much smaller yards and landscape areas compared to Manch Manor housing area. Most of the yards in Nellis Terrace are covered with gravel and boulders for the yard.
5. Eventually all the units on main Base are planned to be demolished except 4 houses designated for 2 for GOQ's (general officers quarters) and 2 for SOQs (senior officers quarters).
6. Currently, about 1,278 housing units exist for Base family housing. A list of inventory of these housing units which includes number of units and size of each of these units is provided in the fact sheet for housing privatization.

7. Fact sheet also provides a synopsis of plan for the future development of military family housing for the Base.
8. Information for future plans on demolition, renovation and building of new units are all included in the fact sheet for housing privatization. A copy of the solicitation for RFP for housing privatization is published on the web site at www.pscmhc.com
9. A summary of demolition and new units for construction plan is discussed in the attached Fact Sheet.
10. Housing Community Plan has been recently updated in 2002-03 for the Base and is available for managing the Base Housing program. An electronic copy of this plan was not readily available; however, a copy (CD) will be mailed to us by Linda Slotsch during next week (11/22/2003).

Category 2 – Commercial

Reference: Sgt Monroe (820 Red Horse Squadron) Area II

1. Military and federal prison personnel use the dining hall. It is maintained by the prison.

Reference: Joe Webb, John Funderburk, TSgt Murand Mike O'Callaghen Hospital

2. The Hospital has installed a new atomized mean fog system in lieu of old steam generator. Uses an R.O. Supply air temperature is important, too cold and the atomized water will condense.
3. The hospital is expanding by 9000 SF.
4. Hot wells for food trays require daily water.
5. Met with MSgt Bochard for dining hall visit at building 709 (ext. 6744)

Category 3 – Irrigation

Reference: Mr. Bill Fielder, Golf Course Superintendent (Sunrise Vista Golf Course)

1. Golf course at Nellis AFB was primarily started in 1950's as a 9-hole course, which was upgraded to an 18-hole course in early 1960's. These are now called as Eagle and Falcon courses.
2. There was one more 9-hole course added in 1995 which is named as Raptor and the last course added was in 2000 which is named as Thunderbird.
3. Total area of this entire golf course is about 450 acres of which irrigated area is approximately 249 acres.
4. Sources of water used for golf course irrigation include well water (Well #4 from Area II and few other wells in Area I) and groundwater recovery water from the remediation project. Well #4 in the Area II has high lead and arsenic content that is not suitable for potable supply. Well #4 in the Area II is locates on the federal land and hence there are no water restrictions on the water drawn.
5. Well # 2, 3 and 5 in Area II are currently not in production and needs development if needed to be used for future water pumping. Area I has well #s 1, 2, 4, 6, 7, 8, 11, 12, 13, and

14. Water from well #s 6, 7, 11, 12, 13, and 14 are all used for golf course besides potable supply. (See the attached wells chart for reference).

6. Currently no water from the city source is used for golf course irrigation.

7. There are about six employees including 3 persons for field activities (turf maintenance) and 3 for general maintenance of the course.

8. Three pump houses are located on this golf course. One of the pump houses is located in the Eagle-Falcon course, and one each are located in Thunderbird and Raptor course.

9. Three pumps are located in the Eagle-Falcon course with each pump having a capacity of 75 HP @ a rate of 2,500 gpm. Two pumps are installed in each of the pump houses located in Raptor and Thunderbird courses with each pump having a capacity of 75 HP.

10. All these are centrifugal pumps with variable frequency drives which helps in keeping the pressure and flow-rate at a constant required level at all the times. These pumps are all connected to the computer system that is centrally controlled for flow and pressure in the system. Each of these pumps are attached to a small jockey pump to build and maintain the pressure that is required in the system.

11. Size of the main water lines vary from about 2" to 10" in diameter. Laterals are about 1.5" to 1/25" in diameter.

12. Irrigation system for Eagle-Falcon course was upgraded last time about ten (10) years ago.

13. Raptor and Thunderbird irrigation system have the original system that was built 8 and 3 years ago respectively.

14. Sprinkler heads are located at a spacing of about 65 feet apart and have a flow-rate of 45 gpm. Aprons and roughs are also irrigated the same way as greens on this course.

15. Golf course pays approximately $0.38 per K Gal to CE. This is the most recent data Based on the blend rate that CE uses.

16. An estimated 1,400 acre-feet of water is used for golf course annually to irrigate the entire 36-hole course.

17. There are totally six ponds located in the golf course area of which three are used for irrigation water storage purpose and the remaining three ponds for aesthetics. There are no fish in any of these ponds.

18. Actual size of these irrigation ponds was not available. However, the average depth of water in these ponds is estimated to be about 7 feet at the center. The pond in the Eagle-Falcon course is called duck pond and is estimated to be about 4-acres in area. Each of the pond in Raptor and Thunderbird course are approximately 2-acre in area.

19. Three other ponds located on this golf course for aesthetics are . The pond in Raptor is called Arrow-head lake and is about 3 acres in area. Pond in Falcon course is about 3/4th of an acre. Other pond in Thunderbird is about 2-acres in area.

20. Sulfur burners are continuously used in summer to lower the pH of irrigation ponds.

21. During other seasons these are used only during the week days.

22. Algaecide is used for non-irrigation ponds at least twice a year.

Reference: Major Gleason, Barry Flynn, Charles Transley, Mr. Patel, CH2MHILL.

23. Project to add Southern Nevada water supply to duck pond as an alternative to well number 11 & 12.

24. General Discussions- Currently there is wintertime restrictions for water use in the area, especially for watering lawns and irrigation of yards.

Category 4 – Leaks, Losses and Unaccounted for Water

1. There are 698 fire hydrants, which are flushed every year for 20-30 minutes. This helps clean out dead ends where water becomes stagnant. The flushing requirement is every 3 years but the Base chooses to flush the hydrants annually to remove the stagnant water in dead ends. The water shop estimates that 30% of this water goes to the 'Duck Pond' through the drainage system.

2. Area II uses a 5000-gallon tank to control dust, 8/year.

3. The fire pump is in fair condition has a minor pump seal leak. It is tested every Tuesday, 1,000 gpm x 10 minutes.

4. No problems with debris in lines creating fixture problems except when there is a line break.

Category 5 – Industrial

1. There is a host agreement between the base and the 820th Red Horse Squadron.

2. There are approximately 25 buildings under Red Horse control. Approximately 10 are maintenance areas.

3. There are three 400-ton chillers of which two are being replaced with 350 and 550 ton centrifugal units.

BMP #1 – Public Information and Education Program

Reference: Ms. Linda Slotsch, Chief of Base Housing Facilities

1. Water restrictions are enforced once a week with the concept of watering odd numbered houses on odd dates of the month and even numbered houses on even dates.

2. There are three housing inspectors currently available to perform rounds of the housing area to ensure the housing policy and rules are followed by the residents.

3. Watering restrictions are communicated to the residents through the handouts provided along with the move-in package for new residents.

4. Base newspaper *"Bullseye"* also publishes articles on housing watering restrictions. Some of the articles including watering restrictions and yards landscape awareness for the housing areas for water conservation are provided by the Base housing office to the Public Affairs to publish in the Base newspaper.

5. Similar awareness messages are also published to the Base residents through the TV channel available for communicating the Base news.

Reference: Interior Shop, TSgt Lance, TSgt Woolford, ext. 2740

6. Customer service reports leaks and maintenance problems to shop, DSW prepared and repair and replacement performed. Approximately 200 calls per month in the summer and 120 calls per month in the winter.

Reference: MSgt Griggs, SSgt Rodriguez, TSgt Murand, Charlie Varner, Exterior Shop: 702 652 4264

7. The customer service center operates 24/7 and water shop receives calls for leaks and losses.

BMP #2 – Distribution Systems Audits, Leak Detection and Repair

Reference: Ramesh Patel

1. Most of the water distribution system (piping) on Base is about 50-60 years old. However, nearly half of the water piping was replaced in 1985-86 to C900 pipe (PVC). After this replacement, there have been no major projects for replacements of any water distribution pipelines.

2. General condition of the pipeline is not too bad based on the number of breaks reported to the water maintenance shop. However, leak detection survey needs to be done to estimate the true leaks and losses in the water transmission system.

3. Area II water distribution system has mostly Cast Iron (CI) piping. Area III has a combination of some CI piping along with some asbestos-cement piping.

4. Most of the water distribution piping in the housing area has C900 (PVC) piping.

Reference: MSgt Griggs, SSgt Rodriguez, TSgt Murand, Charlie Varner, Exterior Shop: 702 652 4246

5. A SCADA or EMCS system is not used for metering/totalizing well water only to control operation. Johnson Control (JCI) has a large contract to update controls but not for well water metering. One of the issues restricting this possibility is that the well controls utilize a RF pulse signal and that retrieving data by pulse RF will cause the existing system to crash.

6. There is approximately 186 miles of potable water main piping and 422 miles of total water piping. The ten (10) well meters are approximately 2 years old and have not been calibrated (not an issue yet) since installation. Read daily for monthly report. Shop to provide electronic copy or hard copy if not available.

7. Valves are operating okay but there are many problems with old valves and need to be replaced. A valve survey has been completed (what % of Base valves) and the water shop performs RWP for exercising valves.

8. There is a lot of asbestos cement piping as well as old lead bellow joints. These joints may be an environmental concern and may have the potential for funding. Each joint is spaced 13 feet apart. Ductile iron represents approximately 25 percent of Base piping.

9. Replaced Area 2 valves. Submitted a 332 to replace main Base valves. The approximate cost is $5MM.

10. The valve issue creates problems for detected leaks since the Base cannot isolate water to leaking areas.

11. According to the shop, approximately 5% of potable water lines have been replaced in the last 5 years when including Nellis Terrace residential area. Other areas include north enclave of Base and CE/800 area.

12. No AWWA leak detection survey has recently been done (Mr. Patel thinks one was done through Mike Clawson. Need to check).

13. As far as the shop knows, no new areas have been programmed for funding. The shop provided the following areas recommended for repair and replacement: 1) Swabb St. (2000 ft, 10 " line), valve replacement at Tyndal St (50 valves), valve replacement at flight line (50 valves), north end of the runway (600 ft, 10" line), Rickenbacher and Washington area (800 ft).

14. GIS is funded and being implemented.

BMP #3 – Water Efficient Landscaping

1. Barry Flynn acknowledged that Nellis AFB was not doing as good as areas in the city of Las Vegas in promoting Xeriscaping. Base has many opportunities to improve landscaping.

Reference: John Roe, Environmental and SSgt. Pamela Joe, Bio-Environmental

2. Most of the landscaping grass on Base is both fescue and Bermuda grass. Xeriscaping and drought resistant landscaping would be a viable alternative to save water for the future based on the discussions.

3. Gary Faron, CECF (Phone: 652-8437 or 236-3515 Cell) is the POC for Landscape design/architecture on Base.

4. Most dorms had irrigated landscape. Two (2) dorms have been converted to Xeriscape. Would like to see Xeriscape installed at all dorms but this will take time (maybe through 2010, funding issues). MSgt Augente had the Wing Commander inspect Xeriscape landscape. Slowly proceeding.

Reference: Major Gleason, Barry Flynn, Charles Transley, Mr. Patel, CH2MHILL.

5. Options for the conserving water at the golf course include, narrowing fairways, artificial turf, desert patches, reduce number of ponds.

6. One of the potential areas on Base for water conservation is by reducing the irrigation water use for Base landscaping in general areas and to adopt drought tolerant landscaping suitable for the Base.

Reference: General Discussions

7. There is lot of turf and lawn all over the Base. Not necessarily all this grass is drought resistant and hence this needs to be looked into very keenly for water conservation efforts.

8. Watering for all this irrigation on Base other than golf course uses water from the city water source and sometimes blended with the well water on Base.

9. A centralized computer control system (connected with radios) for irrigation watering on Base for all landscape areas similar to golf course system would be very helpful in water conservation effort.

10. Area 2 has four non-potable wells with high arsenic levels. One of the wells is used for the golf course. The others are not used

Reference: Mr. Bill Fielder, Golf Course Superintendent (Sunrise Vista Golf Course)

11. Soil enhancements are carried out on a regular basis to increase moisture holding capacity and reduce water usage. Soil aeration is done for the golf course on an average of twice a year for greens; once a year for tees; and once a year for fairways.

12. Soil amendments are done by adding soil organics, mulch and wetting agents (Reduces surface tension to penetrate water/moisture into the soil faster) on an average of ten times annually.

13. Watering for greens, tees and fairways are all done at an average of about 20-30 minutes. However, this may vary depending on the weather conditions and controlled accordingly by the computerized centrally controlled system.

14. Weather data is used to control the watering schedule at this course. Toro® Site Pro Central Control System computer program (software) with Osmac is used for watering on this course. Osmac is the handheld radio system connected to the computer system through which the field controls are handled.

15. All the water supply to the golf course is metered and the records for the metering data is maintained by CE and water shop.

16. Based on this estimate, an average of 5.62 acre-feet of water is used per acre considering 249 acres of the course is irrigated. About 7.5 acre-feet per acre is the average water usage for the golf courses in the Las Vegas area.

17. Las Vegas valley has about 40 golf courses in the area. The new rule that is likely to come into effect in the near future will restrict all the golf courses in the Las Vegas area to use not more than 6.5 acre-feet/acre of water for irrigation.

18. Water supply to these ponds is handled by Base CE and golf course personnel control the water supply from these ponds to the golf course for further irrigation. However, there are no level controls currently installed for these ponds and pumps are turned off manually by visual observation of water level in these ponds. Quite often, the water from these ponds is likely to overflow the surplus water into the nearby ditch/channel, which flows into a creek outside the Base. This can be immediately stopped by installing a level controller with cut-off valve for pumping water from the well.

19. Hospital irrigation is accomplished using a 7.5 hp pump, 1 ½ pipe lines, automated timers to 25 stations, 8-10 minutes per station.

20. Watering the housing units is the responsibility of the corresponding unit residents. Common areas such as ball fields, parks and picnic areas are watered and maintained by the Base grounds maintenance department.

Reference: SSgt Atkins, Irrigation Shop, BLDG 806

21. All sprinklers are on timers. Xeriscaping on drip systems. Areas irrigated include: Freedom Park, OC Club, NCO Club, dorms, runners World, F.P. soccer field and sports pavilion.

22. Water is not metered. Summer average, every day, twice a day, 20 minutes, winter: 3 times/week for ten minutes. No rain sensors. No watering 11am – 7pm. Average line size is 1".

23. Emitters have an average flow rate of 7 gpm. Approximately 1000 emitters.

24. Only irrigation leaks occur from construction or customer breakage.

25. Overall good maintenance. There seven civil service personnel and three military personnel. No labor problems. Repair soft spots quickly.

26. Approximately 20 percent of landscape area is xeriscaped. There are approximately 40 acres of turf area irrigated. There is also a large number of water using hardwoods.

27. New artificial turf not yet considered.

28. Dust control used for new construction as required for air quality. 5,000 gallon truck used daily for dust control from well water. Airstrip areas have been treated to harden ground, breaking up.

BMP #4 – Toilets and Urinals

Reference: Interior Shop *TSgt Lance, TSgt Woolford, ext. 2738*

1. Approximately 75 percent of toilets and urinals are compliant. Flushometers are all low-flow Balance of toilets and urinals are replaced as needed.

2. No waterless urinals, too much maintenance.

3. Autoflush and hand wash sensors are used at Freedom Park, OC and NCO clubs and approximately 10 other facilities. Reliability of autoflush systems similar to manual flushometers but are more expensive.

4. Need additional funding for repairs, no training or personnel needs requested.

5. MFH units are maintained by contractor, Nellis Terrace compliant, Manch Manor likely compliant.

6. Sgt Monroe (820 Red Horse Squadron) Area II- All fixtures are low-flow.

7. Inspected three Dormitory buildings, all had low-flow fixtures. Eight washing machines per 72 man dorm older dorms have 12 washing machines, all use top loading units. A total of 90 washing machines are estimated to be in use at the dorms. (Kenmore model # 110.26292693, 65% of all washing machines are new).

BMP #5: Faucets and Showerheads

1. All fixtures are low-flow.

2. Inspected three (3) dormitories and all inspected had low-flow fixtures. Eight washing machines per 72 man dorm older dorms have 12 washing machines, all use top loading units. A total of 90 washing machines are estimated to be in use at the dorms (Kenmore model # 110.26292693). Approximately 65 percent of all washing machines are new.

3. Autoflush and hand wash sensors are used at Freedom Park, OC and NCO clubs and approximately 10 other facilities. Reliability of autoflush systems similar to manual flushometers but are more expensive.
4. About 500 units of low-flow showerheads were purchased by Environmental in October 2003 at about $46K to install in the dormitory units. However, this will not cover all the dorm units. (Project # RKMF056101).
5. Approximately 90% of Base wide faucets and showerheads are compliant.
6. Cost of 2.0 gpm showerhead is $6.00
7. About 500 low-flow showerheads have been purchased recently to replace the existing ones as retrofit in the dorms for water conservation. Environmental has funded this project.

BMP #6 – Boiler and Steam Systems

Reference: Joe Webb, John Funderburk, TSgt Murand, Mike O'Callaghen Hospital

1. The three (3) 250 hp boilers are operated as a lead/lag/standby. Boiler steam is approximately 90 psig
2. Centralized control system monitors all 3 boilers for conductivity, chemical feed and metering.
3. Three 250 hp boilers are operated at the energy plant. Boiler water is softened. Steam system is 10 years old in fair to good condition. Maintenance includes inspecting and replacing traps at least every year.
4. Hospital is looking into decentralizing the steam system.
5. Sgt Monroe (820 Red Horse Squadron), Area II- The area does not use boilers just hot air furnaces.

BMP #7 – Single-Pass Cooling System

1. 14 water cooled, single pass, filtered ice machines. Possible project to replace some ice machines with air-cooled versions (need to look at space requirements) most of the ice machines are 10 years old.
2. A vacuum pump system is also operated with a single pass cooling system. Cooling water is used for pump seals.
3. The large ice machines produce 606 lbs/day of ice. The heavy use machines operate at full capacity. Cooling water is approximately 100 F and drains at a rate of 20 oz/16.5 seconds (4.5 gpm) with an intermittent flow depending on compressor cooling demands. Ice is produced 24 hours a day. The smaller units produce an estimated 50 to 100 lbs/day. Ice machines use filters and must be cleaned of condenser scale. Filters are changed every 2 months.

BMP # 8 - Cooling Tower Management

1. The hospital chillers and cooling towers utilize a conductivity control system with chemical feed and auto blowdown.

2. The cooling tower consists of a three-cell system with common header for pump suction. Two pumps (1,200 GPM) for year round and a third pump for summer operation.
3. There are approximately 250 evaporative coolers with an average flow rate of 10,000-20,000 cfm. The evaporative coolers do not use drip lines or drain pumps. Pads are replaced at least 2 per year. Approximately 50 units are replaced each year. Purchased silver/copper ion filters to reduce scale build-up not effective. No water softening. Water analysis indicates varying hardness depending on well site.
4. There is a question on why there are no drain lines. Researched issue, no answer.
5. SSgt Wader is in charge of cooling tower maintenance. Scale problem due to water quality problems has impacted HVAC replacement. Approximately 20% of cooling towers have been replaced with air cooled systems.
6. Everything under 100 tons is air-cooled.
7. Changed chemical supplier to Chem Search.
8. Visited building 200. New pump stations at cooling towers includes conductivity monitors, auto blow down, 3 chemicals, inhibitor, de-scaling, and biocide. Service is excellent by Chem Search, provides weekly water analysis and inspection. Scale problems have reduced significantly with new supplier. Hardness was measured at 200 at make-up and 900 at tower. Boiler softener not being used.
9. Replaced 42 pot feeders, replaced 35 of 70 existing pot feeders.
10. HVAC shop logs maintenance and chemical service of each cooling tower.
11. Did not check HVAC RWP record. Handled by Chuck Barnet.
12. Extremely heavy scale on pads. Could not see any drain lines, two overfill valves. No drain pumps. SSgt Blas had no problems in installing drain pumps, some concern over installation time. Main issue was whether it was permitted to drain water, may be seen by Base personnel as a water waste. Mike Eberbach explained that the CH2MHILL would research further this issue before making recommendation.
13. Russ Collins did not see an environmental problem with draining evaporative coolers, would like to consider draining to plants for irrigation.

Sgt Monroe (820 Red Horse Squadron), Area II

14. Minor HVAC repairs done by Red Horse personnel, higher cost repairs done be Base.
15. The evaporative cooler pads are replaced four (4) times a year and are checked monthly as part of an RWP process. Water quality is poor due to high hardness content.
16. There are approximately 25 evaporative coolers with an estimated capacity of 21,000 cfm.
17. The hospital cooling towers are on an acid treatment program with 3 chemicals (inhibitor, two biocides) used. Similar treatment for the chiller loop. Chem Treat is the supplier.

BMP #9 – Miscellaneous High Water Users

1. Hospital dining hall operates from 5 am to 7pm assume water use for garbage disposals at 6 hours, 356 days/yr.
2. The dining hall uses two garbage disposals, which operate with water, assume 6 hours of operation.
3. Two softeners hospital boiler room, 25 cu ft each. Set at 15,000, 11,500 gallons to backwash.
4. The aircraft wash rack has two bays. TSgt Sampson estimated 2.5 aircraft/day is the typical washing rate. An average of 30 to 45 minutes of water running per wash. Water is not metered or recycled. There are three 1" water lines. Aircraft washers have complained that the soap is not foaming properly. The soap is changing to Type II. The soap is injected into a pressure tank. The solenoid switch is not working properly, probably scaled up.
5. The water is sprayed onto the plane using 'garden' spray nozzle and an open end hose for rinse. Operation is water intensive. Interested in high-pressure wash equipment but are concerned that the pressure will strip decals.
6. There is one wash rack used 15 times/month on average in Area 2 in conjunction with the 820th Red Horse Squadron. The water is treated through an oil water separator.
7. All water influent to the hospital is softened. The water softener has 27 cubic feet of resin with 30,000 grains per cubic foot.

BMP #10 – Water Reuse and Recycling

1. Groundwater (GW) recovery system as part of the remediation project (clean-up of JP-8 fuel from POL storage tanks) is in place since 1990-91. This system was installed for pump and treat has a flow rate of about 15 gpm, operated about 8 hours a day for 5 days a week. This amounts to an average of approximately 7,200 gallons/day of groundwater recovery that is being pumped for irrigation use for golf course. Bernd Schmidt (Phone: 652-2882) is the POC for additional information on this remediation project.
2. GW treatment plant includes unit operations such as oil water separator, coagulation and precipitation followed by granular activated column. There is no chlorination included in this treatment at present.
3. Treated GW is collected into a sump and pumped into the golf course for irrigation. Piping for this pumping system is PVC of 6"-8" in diameter. Length of piping from GW recovery plant to the golf course is about 5-6 miles.
4. It is likely that this GW treatment and recovery system may shut down in the next 5 years based on the monitoring of concentrations of contaminants of concern (COCs), meeting the limits set by the regulatory agency.

References

List of contacts identified by Ramesh Patel and Barry Flynn – Primary POC's for the Base are as follows:

Water Shop – Charlie Varner, (702) 652-5856 charlie.varner@nellis.af.mil and TSgt. Murand, (702) 652-5856

Base Utilities – Charles L Transley, (702) 652-7790 charles.trarslet@nellis.af.mil and Conrad Fernandez, (702) 652-7786 conrad.fernandez@nellis.af.mil

Environmental Compliance (Water Systems) – John Roe, (702) 652-2072 john.roe@nellis.af.mil

Bioenvironmental (Water Quality) – SSgt Pamela Joe, Phone: (702) 653-3316 pamela.joe@nellis.af.mil

Base Housing – Linda Slotsch, Chief of Housing Facilities, Phone: (702) 652-4207 (office), (702) 249-3081 (Cell) linda.slotsch@nellis.af.mil

Dorms Manager – MSgt Steven Augente, (702) 652-3270 (Office), (702) 249-2463 (Cell) steven.augente@nellis.af.mil

HVAC Systems – MSgt Brian Jones, (702) 652-3315/8145/5605

Designs – Mo Zamanian (HVAC only), (702) 652-4745 mo.zamanian@nellis.af.mil

Golf Course – Bill Fielder, (702) 652-6907, bill.fielder@nellis.af.mil

Programs and Planning – Stanley Fueller, (702) 652-8451 stanley.fueller@nellis.af.mil

Real Property – Giuseppe (Joe) Lepore, Realty Officer, (702) 652-6822 cheryl.cordray@ellsworth.af.mil

Irrigation Systems – SSgt Clint Atkins, (702) 652-3107 clint.atkins@nellis.af.mil

Aircraft Washracks and Flightline Operations – TSgt Scott Sampson, (702) 652-2397/3361 scott.sampson@nellis.af.mil

Public Affairs – Mr. Mike Estrada, (702) 652-2750 mike.estrada@nellis.af.mil

APPENDIX B

BMP Selection Calculations (ROM)

BMP 1 - Public Awareness

Upgrade Awareness Programs

Water Savings: 14,690 kgal per yr

1,469,000 kgal per year X .01

Water Cost Savings: $16,747

14,690 kgal X $1.14 per kgal of potable water
Note: Sewer rates were not incorporated because Nellis AFB pays a flat rate.

Cost: $11,000 per year

200 hours of labor per year X ($45 per hour + $10 per labor hour for material cost)

Payback: N/A

The payback is not applicable since the public awareness program is an annual reoccurring cost. It is reasonable that the annual cost would decrease with each year after the program is set in place.

Data Reference:

Assuming a GS-11 step 5 salary, including benefits and a 25 percent markup for general and administrative (G&A) support, the estimated labor cost is $45.00 per hour. Non-labor costs were estimated at $10 per labor hour.

The one-percent savings is based on laboratory studies from the Florida Solar Energy Center.

BMP 2 - Distribution System Audits, Leak Detection & Repair

AWWA Leak Detection Survey of Water Distribution System

Water Savings: 367,250 kgal per yr

1,469,000 kgal per year X (0.35 current leaks & losses - 0.10 considered a tight system)

Water Cost Savings: $418,665 per yr

367,250 kgal X $1.14/kgal

Cost of Survey: $63,300

422 miles x $150 per mile

** Cost does not include expenses incurred in repairing leaks or replacing lines. It is assumed Base personnel will repair any leaks discovered during leak detection survey.*

Payback: N/A

A payback cannot be determined until the quantity and magnitude of leaks are identified and the repair and replacement costs are identified.

Data Reference:

- *422 miles of main and sub distribution lines at Nellis AFB*
- *$150 per mile for leak detection survey, based on Air Force Water Conservation Guidebook recommended estimate*

BMP 3 – Water Efficient Landscaping

Desert xeriscape Main Base and MFH Areas.

The water savings realized through this project are based on installing desert xeriscaping on 50% of the area (estimated 70 acres) currently being irrigated on Main Base and MFH.

Water Savings: 95,000 kgal per yr

123,000 kgal per year current irrigation – 28,000 kgal per year with desert xeriscape irrigation

Water Cost Savings: $108,300 per yr

95,000 kgal per year X $1.14 per kgal

Costs: $6,098,428

$ 4 per sq ft for xeriscape X 35 acres X 43560.2 sq ft per acre

Payback: 56.3 years

$6,098,428 costs/$108,300 per year savings

Data Reference:

- *Current housing and Main Base irrigation is estimated at 123,000 kgal per year.*

BMP 4 - Toilets and Urinals

Upgrade Toilets and Urinals in Commercial and Industrial Facilities

75 percent of the Base toilets and urinals have been upgraded. The water savings are based on 25 percent of the total area of the commercial and industrial facilities. The Base has approximately 4.74 million square feet of industrial and commercial facilities as determined by the Nellis AFB Real Property Report.

Water Savings: 3,318 kgal per yr

4,740,000 sq ft X 0.25 X 0.0028 kgal per sq ft water saved

Water Cost Savings: $3,783 per yr

3,318 kgal per year x $1.14 per kgal
Note: Sewer rates were not incorporated because Nellis AFB pays a flat rate.

Costs: $303,360

4,740,000 sq ft X 0.25 X $0.256 per sq ft for upgrades

Payback: 80.2 years

$303,360 costs/$3,783 per year savings

Data Reference:

- *0.0028 kgal per sq ft water saved is based on an analysis of water conservation projects from a phase II ESCO report.*
- *$0.256 per sq ft for upgrades is based on an analysis of water conservation projects from a phase II ESCO report.*

Upgrade Toilets in MFH Units

75-percent of the MFH toilets have been upgraded. The water savings are based on 25-percent of the total area of the MFH units. The MFH units have approximately 1.69 million square feet of area as determined by the Nellis AFB Real Property Report.

Water Savings: 2,958 kgal per yr

1,690,000 sq ft X 0.25 X 0.0070 kgal per sq ft water saved

Water Cost Savings: $3,372 per yr

2,958 kgal per year X $1.14 per kgal
Note: Sewer rates were not incorporated because Nellis AFB pays a flat rate.

Costs: $392,503

1,690,000 sq ft X 0.25 X 0.929 per sq ft for upgrades

Payback: 116.4 years

$392,503 costs/$3,372 per year savings

Data Reference:

- *0.0070 kgal per sq ft water saved is based on 5.1 flushes per day per person from the AF Water Conservation Guidebook and upgrading from a 4.0 gpf toilet to a 1.6 gpf toilet with an average of 3.25 persons living in a 2,000 sq ft MFH unit.*
- *$0.929 per sq ft for upgrade cost is based on the cost to replace two toilets in a 2,000 sq ft MFH unit.*

BMP 5 - Faucets and Showerheads

Upgrade Faucets & Showerheads in Industrial & Commercial Facilities

90 percent of the faucets and showerheads have been upgraded in industrial and commercial areas. The water savings are based on 10 percent of the total area of the industrial and commercial areas. The industrial and commercial areas have approximately 4.74 million square feet of area as determined by the Nellis AFB Real Property Report.

Water Savings: 1,896 kgal per yr

4,740,000 sq ft X 0.10 X 0.004 kgal per sq ft water saved

Water Cost Savings: $2,161 per yr

1,896 kgal per year x $1.14 per kgal
Note: Sewer rates were not incorporated because Nellis AFB pays a flat rate.

Energy Savings: 190 MMBTU per yr

4,740,000 sq ft X 0.10 X 0.0004 MMBTU per sq ft energy saved

Energy Cost Savings: $1,037 per yr

190 MMBTU per year x $5.46 per MMBTU

Total Savings: $3,198 per yr

$2,161 per year + $1,037 per year

Costs: $43,134

4,740,000 sq ft X 0.10 X $0.091 per sq ft for upgrades

Payback: 13.5 years

$43,134 costs/$3,198 per year savings

Data Reference:

- *0.004 kgal per sq ft water saved is based on an analysis of water conservation projects from a phase II ESCO report.*
- *0.0004 MMBTU per sq ft energy saved is based on an analysis of water conservation projects from a phase II ESCO report.*
- *$0.091 per sq ft for upgrades is based on an analysis of water conservation projects from a phase II ESCO report.*
- *$5.46 per MMBTU is the energy rate for Nellis AFB based on 1026 BTU per cubic feet of natural gas and $5.60 per 1000 cubic feet of natural gas.*

Upgrade Faucets & Showerheads MFH Units

90 percent of the MFH units have upgraded faucets and showerheads. The water savings are based on 10 percent of the total area of the MFH units. The MFH units have approximately 1.69 million square feet of area as determined by the Nellis AFB Real Property Report.

Water Savings: 6,591 kgal per yr

1,690,000 sq ft X 0.10 X 0.039 kgal per sq ft water saved

Water Cost Savings: $7,514 per yr

6,591 kgal per year X $1.14 per kgal
Note: Sewer rates were not incorporated because Nellis AFB pays a flat rate.

Costs: $70,473

1,690,000 sq ft X 0.10 X 0.417 per sq ft for upgrades

Payback: 9.4 years

$70,473 costs/$7,514 per year savings

Data Reference:

- *0.039 kgal per sq ft water saved is based on 8.1 minutes per day per person (AF Water Conservation Guidebook) of faucet use time and 10 minutes per day per person of shower use time. The unit savings rate also incorporates upgrading faucets from a 2.7 gpm to 0.5 gpm flow and upgrading showerheads from a 2.0 gpm to a 1.5 gpm flow with an average of 3.25 persons living in a 2,000 sq ft MFH unit.*
- *$0.417 per sq ft for upgrade cost is based on the cost to replace two showerheads and three faucets in a 2,000 sq ft MFH unit.*

Install Hot Water Demand System in MFH Units

Water Savings: 8,522 kgal per yr

20 gal per day X 335 days X 1272 units/1000 gal per kgal

Water Cost Savings: $9,715 per yr

8,522 X $1.14 per kgal
Note: Sewer rates were not incorporated because Nellis AFB pays a flat rate.

Energy Savings: 395 MWh per yr

158 BTU per gal saved X 8,522 kgal saved X 1,000 gal per kgal/3413 BTU per kWh/1000 kWh per MWh

Energy Cost Savings: $31,600 per yr

$0.08 per kWh X 1000 kWh per MWh X 395 MWh

Total Savings: $41,315 per yr

$31,600 per year energy savings + $9,715 per year water savings

Costs: $407,040

$320 per unit x 1272 housing units

Payback: 9.9 years

$407,040 costs/$41,315 per year savings

Data Reference:

- *Estimated 20 gallons per day water savings derived from use of hot water demand device (reference: www.gothotwater.com)*
- *Hot water demand device will be used an estimated 335 days per year*
- *Hot water demand device cost $320, which includes device, shipping and installation*
- *Hot water demand device saves heat that would go down the drain at an estimated 200 BTUs (British Thermal Units) per gallon of water saved.*
- *Cost per kWh is $0.08, based on Nellis utility sales rate computation worksheet (6 year average FY 1998 through FY 2003)*
- *The energy saved, 158 BTU's per gallon of water saved, is estimated by the average hot water use temperature, 100 degrees Fahrenheit, and the initial water temperature, 70 degrees Fahrenheit. The average temperature is 100 + 70/2 = 85 degrees Fahrenheit. The average temperature is used to account for the BTUs lost from the water at 70 and 100 degrees Fahrenheit. The 85-degree Fahrenheit water has 442 BTU per gallon. The potable water source is estimated to average 66 degrees Fahrenheit, having an enthalpy of 284 BTU per gallon. The energy loss is determined by the difference in enthalpy of the water loss from the faucet or shower to that of the potable water source (442 – 284 BTU per gal = 158 BTU per gallon of energy lost).*
- *Current base housing units: 1272*
- *3,414 is the number of BTUs per watt-hour.*

BMP 6 - Boiler/Steam Systems

High Purity Reverse Osmosis (RO) Water used for Hospital Boiler Makeup

The payback for this project occur as a result of installing a reverse osmosis unit capable of 20 gpm. The calculations are based on 13,800 lbs per hour of 90-psig steam produced with 10 percent blowdown. The RO will produce high purity water that will allow the boiler to increase its cycles of concentration from 10 to 100 thus reducing the boiler blowdown from 10 percent to 1 percent. One-percent blowdown is the minimum recommended by ASME. Intrinsic chemical savings will also be realized by reducing the boiler blowdown. They are not included here but generally approximate 50 percent of the current cost. Another benefit is minimal condensate piping corrosion (with a reduction in neutralizing amines use) resulting from reduction in the carbonate and bicarbonate alkalinity in the boiler makeup water.

Water Savings: 1,465 kgal per yr

Savings based on the mass and energy balance of the system.

Water Cost Savings: $1,670 per yr

1,465 X $1.14 per kgal
Note: Sewer rates were not incorporated because Nellis AFB pays a flat rate.

Energy Savings: 3,282 MMBTU per yr

Savings based on the mass and energy balance of the system.

Energy Cost Savings: $22,400 per yr

3,282 MMBTU per year X $5.46 per MMBTU/0.80 boiler efficiency

The boiler efficiency takes into account the additional fuel required to produce the equivalent amount of steam energy.

Total Savings: $24,070 per yr

$22,400 per year energy savings + $1,670 per year water savings

Costs: $41,400

20 gpm RO unit X $2,070 per gpm installed cost

Payback: 1.7 years

$41,400 cost/$24,070 savings per year

BMP 7 - Single-Pass Cooling Systems

Evaluation of air cooled versus the current water-cooled units will be evaluated further in the Draft Water Management Plan.

BMP 8 - Cooling Tower Systems

Cooling Tower Cycles of Concentration Optimization

Hospital Cooling Towers- Increase Cycles of Concentration form 4.5 to 6

Water Savings: 1,241 kgal per yr

The following calculation determines the difference (savings) in makeup water requirements for the cooling towers based on the current (4.5) and future (6) cycles of concentration. This project involves using softened water as the makeup source for the cooling towers. The evaporation rate will not change; the blowdown rate will be reduced in turn causing the makeup rate to be reduced.

[0.85 X 3600 gpm X 0.9 X 10 °F/1000]X [(6 – 4.5)/[(6-1) X (4.5-1)]])
X 60 min per hour X 8,760 hr per year X 1 kgal per 1000 gal)

The above calculation is based on the recirculation rate of two of the three cooling towers operating at 100 percent of cooling capacity and the third operating only in the summer months to get an effective load of 0.85. A temperature drop of 10 °F is assumed for this estimate. Evaporative water losses are also based on 1 percent loss of the recirculation rate for every 10 °F temperature drop (0.01 per 10 °F or 1/1000 as seen in the above formula) across the tower. The last part of the calculation is based on the difference (current vs. future) of the cycles of concentration. Then annualizing the water savings by the operational frequency hours give the total potential water savings.

Water Cost Savings: $1,415 per yr

1,241 kgal per year X $1.14 per kgal
Note: Sewer rates were not incorporated because Nellis AFB pays a flat rate.

Costs: $3,500

$2,500 HACH hardness analyzer + $1,000 installed piping from softener

Payback: 2.5 years

$3,500 cost/$1,415 savings per year

Data Reference:

- *3,600 gpm is the total recirculation rate of the cooling tower as noted on the cooling tower air permit.*
- *8,760 is the operational hours as shown on the air permit for the cooling tower.*

Building 200 Cooling Towers - Increase Cycles of Concentration form 2.5 to 6

The cooling tower in building 200 has a softener system adjacent to the tower which makes this project very attractive. This cooling tower is currently operating at 2.5 cycles of concentration and with softened makeup water can achieve 6 cycles of concentration.

Water Savings: 1,715 kgal per yr

[1 X 1350 gpm X 0.9 X 10 °F/1000]X [(6 – 2.5)/[(6-1) X (2.5-1)]]) X 60 min per hour X 5,040 hr per year X 1 kgal per 1000 gal)

Water Cost Savings: $1,955 per yr

1,715 kgal per year X $1.14 per kgal
Note: Sewer rates were not incorporated because Nellis AFB pays a flat rate.

Costs: $3,500

$2,500 HACH hardness analyzer + $1,000 installed piping from softener

Payback: 1.8 years

$3,500 cost/$1,955 savings per year

Data Reference:

- *1,350 gpm is the total recirculation rate of the cooling tower as noted on the cooling tower air permit.*
- *5,040 is the operational hours as shown on the air permit for the cooling tower*

BMP 9 - Misc. High Water-Using Processes

Upgrade Dining Hall with Pedal Valves, Compliant Fixtures, & Pulper

Water Savings: 2,545 kgal per yr

101,000 sq ft X 0.0252 kgal per sq ft

101,000 is the area of 6 Base dinning facilities

Water Cost Savings: $2,901 per yr

2,545 X $1.14 per kgal
Note: Sewer rates were not incorporated because Nellis AFB pays a flat rate.

Energy Savings: 515 MMBTU per yr

101,000 sq ft X 0.0051 kgal per sq ft

Energy Cost Savings: $2,812 per yr

515 MMBTU per year X $5.46 per MMBTU

Total Savings: $5,713 per yr

$2,812 per year energy savings + $2,901 per year water savings

Upgrade Costs: $107,616

101,000 sq ft X $1.0655 per sq ft
Includes the upgrade of foot pedals for sinks, water compliant fixtures, and a pulping machine for the garbage disposal

Payback: 18.8 years

$107,616 cost/$5,713 savings per year

Data Reference:

- *0.0252 kgal per sq ft water saved is based on an analysis of water conservation projects for a dinning facility from a phase II ESCO report.*
- *0.0051 MMBTU per sq ft energy saved is based on an analysis of water conservation projects for a dinning facility from a phase II ESCO report.*
- *$1.0655 per sq ft for upgrades is based on an analysis of water conservation projects for a dinning facility from a phase II ESCO report.*
- *$5.46 per MMBTU is the energy rate for Nellis AFB based on 1026 BTU per cubic feet of natural gas and $5.60 per 1000 cubic feet of natural gas.*

Water Softener Optimization

This project involves optimization of the softener regeneration frequency to conserve water and salt usage at two locations associated with the hospital, the main hospital mechanical room and in the boiler room adjacent to the hospital. The throughput capacity is based on the capacity of the ion exchange resin within the softener and the average total hardness of the water. The current throughput capacity is set well below optimal conditions. This causes the softener to regenerate 2.8 times more than required. A total hardness analyzer was incorporated, to initiate regeneration at a predetermined total hardness residual to ensure optimal capacity, as part of the project cost. This was included because the total hardness of the Nellis AFB water supply varies as to the water sources used at any given time.

Main Hospital Softener

Regeneration Water Savings: 716 kgal per yr

1,114 kgal per year current regeneration – 398 kgal per year future optimal regeneration
1,114 kgal per year is based on the current, 15,000 gallons, water-volume throughput set point before regeneration is automatically initiated by the controller. 398 kgal per year of regeneration water is at the optimal set point of 41,553 gallons based on 300 ppm of total hardness in the influent water, 27 cubic feet of ion exchange resin, and 27,000 grains of capacity per cubic foot of resin.

Water Cost Savings: $816 per yr

716 kgal per year X $1.14 per kgal
Note: Sewer rates were not incorporated because Nellis AFB pays a flat rate.

Salt Savings: $6,969 per yr

$.04 per lb of salt X 405 lbs of salt per regeneration X [(2.8 excess regeneration multiplier X 239 optimal softener regenerations per year) - 239 optimal softener regenerations per year]

Total Savings: $7,785 per yr

$6,969 per year salt savings + $816 per year water savings

Optimization Costs: $10,500 per yr

$2,500 HACH hardness analyzer + $8,000 replace softener face piping and control system

Payback: 1.3 years

$10,500 cost/$7,785 savings per year

Data Reference:

- *239 regenerations per year is based on the optimal set point.*
- *2.8 is the number of excess regenerations due to the current throughput set point.*
- *405 lbs of salt per regeneration is based on the 15 lbs of salt per cubic foot of resin to regenerate.*
- *$0.04 per pound is an average salt cost for water softener salt.*

Boiler Room Softener Adjacent to Hospital

Regeneration Water Savings: 350 kgal per yr

569 kgal per year current regeneration – 219 kgal per year future optimal regeneration
569 kgal per year is based on the current, 15,000 gallons, water-volume throughput set point before regeneration is automatically initiated by the controller. 219 kgal per year of regeneration water is at the optimal set point of 38,476 gallons based on 300 ppm of total hardness in the influent water, 25 cubic feet of ion exchange resin, and 27,000 grains of capacity per cubic foot of resin.

Water Cost Savings: $399 per yr

350 kgal per year X $1.14 per kgal
Note: Sewer rates were not incorporated because Nellis AFB pays a flat rate.

Salt Savings: $3,312 per yr

$.04 per lb of salt X 375 lbs of salt per regeneration X [(2.6 excess regeneration multiplier X 138 optimal softener regenerations per year) - 138 optimal softener regenerations per year]

Total Savings: $3,711/yr

$3,312 per year salt savings + $399 per year water savings

Optimization Costs: $10,500/yr

$2,500 HACH hardness analyzer + $8,000 replace softener face piping and control system

Payback: 2.8 years

$10,500 cost/$3,711 savings per year

Data Reference:

- *138 regenerations per year is based on the optimal set point.*
- *2.6 is the number of excess regenerations due to the low throughput set point.*
- *375 lbs of salt per regeneration is based on the 15 lbs of salt per cubic foot of resin to regenerate.*
- *$0.04 per pound is an average salt cost for water softener salt.*

Aircraft Wash Racks- Pressure Washer @ 1,500 psi and 5 gpm

Water Savings: 702 kgal/yr

2.5 aircraft per day X 45 min of water use per aircraft X 260 day per year X (29 gpm – 5 gpm) X 1 kgal per 1000 gal

Water Cost Savings: $800/yr

702 X $1.14 per kgal
Note: Sewer rates were not incorporated because Nellis AFB pays a flat rate.

Project Cost: $2,250

3 pressure washers X $750 per pressure washer

Payback: 2.8 years

$2,250 cost/$800 savings per year

Data Reference:

- *29 gpm is the estimated current flow rate based on the ¾" line and nozzle*
- *5 gpm is the flow from the pressure washer*

BMP 10 – Water Reuse and Recycle

Installation of WWTP and Irrigate Golf Course with WWTP Effluent

Potential Water Savings: 399,000 kgal/yr

399,000 kgal per year based on meter data

Potential Water Cost Savings: Reduce Base potable water consumption by 27%

339,000 kgal per year of golf course irrigation water/1,469,000 kgal total base water consumption based on DUERS data

Costs:

Further analysis will be included in the Draft Water Management Plan.

Payback: N/A

This would reduce the Base's environmental footprint by approximately 1,040 acre-feet per year in water drawn from the ground wells or Lake Mead.

APPENDIX D

Photographs

PHOTO 1
Aircraft Washrack Hose Use

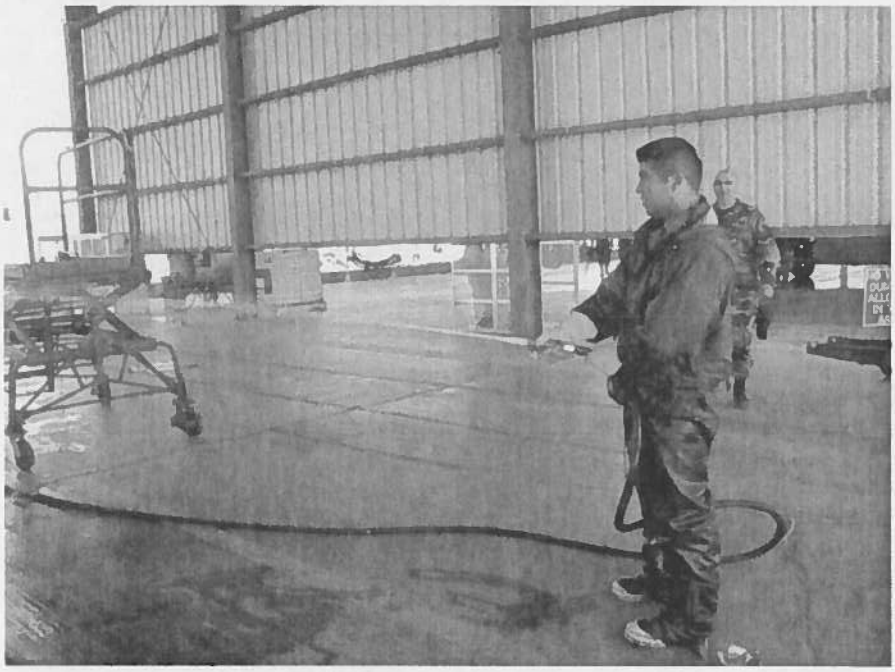

PHOTO 2
Building 200 Cooling Tower Chemical Feed and Blowdown Control

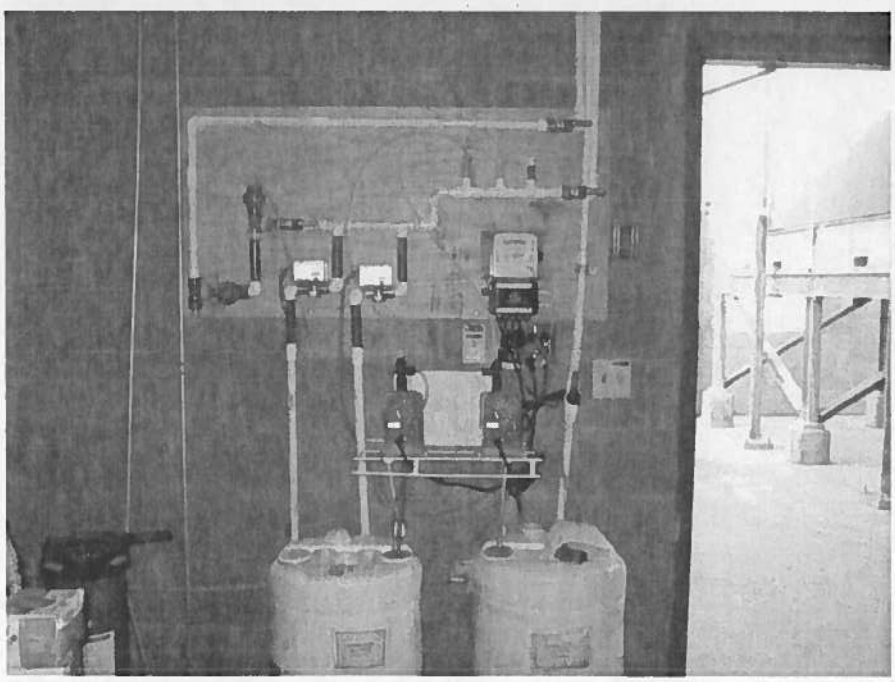

PHOTO 3
Golf Course Irrigation Pond Middle Pond

PHOTO 4
New Nellis Terrace MFH Water-Efficient Landscaping

PHOTO 5
SNWA Supply Vault in Freedom Park

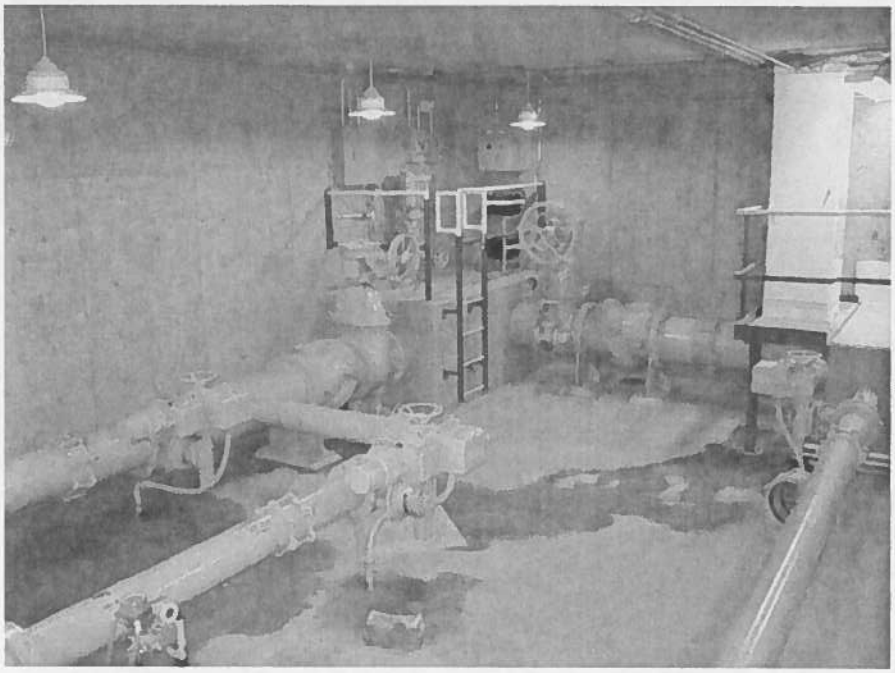

PHOTO 6
Well # 11

APPENDIX E

BMP Evaluation Memo and Matrix

Water Management Plan: BMP Selection Process

ATTENDEES: Nanda Nanjundappa, Jarah Redwine, Dave Stieb, Michael Eberbach

COPIES: Angela Curtis, Glen Huffman, Eva Urbatsch

DATE: December 20, 2003

Overview

This memorandum reviews the process of issuing credit to bases for meeting BMPs.

The AFCESA Water Management Guideline provides valuable assistance to bases developing water management plans. The Guidelines provide lists of operation and maintenance and retrofit and replacement criteria necessary for bases to receive BMP credit. However, many of these criteria do not provide direct quantitative water savings and must be evaluated based on site inspections and interviews with base personnel. Other issues must also be considered in these evaluations, including partial implementation of BMP criteria and the magnitude of potential water savings from different programs.

BMP Selection Tool

In order to standardize BMP compliance analysis, a decision analysis tool was developed. The decision analysis tool analyzes each BMP based on the guideline criteria, priority value, and score submitted by the auditor. A final score is then calculated for each BMP. A score of 70 percent or greater (or 80 percent or greater for BMP # 1) indicates the base is BMP compliant for that practice.

Criteria

Each BMP lists specific criteria, as noted in the *AFCESA Water Management Guidebook*. Criteria are typically engineering and utility shop initiatives that promote water conservation through operation and management and retrofit and replacement activities.

Priority Value

Every criteria has an assigned priority value. The priority value is the weighted importance for a given BMP, and is based on water savings potential and the estimated level of effort (both in cost and person-hours) to implement the given criteria. For example, the priority value of a faucet flow restrictor is greater than the priority value assigned to adding a hand wash sensor. Both of these measures provide water savings but a flow restictor is less costly and requires little maintenance.

Score

The score provided to each criteria is scaled from 1 to 5 and is determined by analyzing water conservation activities obtained from Base information, site inspections, and interviews with Base personnel. The score scale is defined in Table 1.

TABLE 1
Criteria Scoring for BMP Analysis
Water Management Plans: BMP Selection Process

Score	Description
5 (Pass)	Indicates a specific criterion has been completely (100 percent) implemented. There are no current retrofits or replacement projects, and future projects are planned and programmed. Provides outstanding operation and maintenance (implements a proactive RWP and follows equipment manufacturer and Air Force standards). Receives maximum water savings from implementation.
4 (Pass)	Indicates most tasks of a specific criterion have been implemented. Additional retrofits or replacement tasks may be ongoing and are estimated to be 70 percent completed. Future projects are planned and programmed. Provides excellent operation and maintenance (no RWP deficiencies and follows equipment manufacturer and Air Force standards). Receives significant water savings (future enhancements may increase water savings).
3.5 (Pass)	Indicates a majority of the tasks of a specific criterion have been adequately (or 50 percent) implemented. Additional retrofits or replacement tasks are funded. Future projects are planned or may be programmed. Provides sufficient operation and maintenance (no RWP deficiencies and may or may not follow all of the equipment manufacturer and Air Force standards). Receives adequate water savings (future tasks and enhancements are expected to increase water savings).
3 (Fail)	Indicates limited tasks (less than 50 percent) of a specific criterion have been implemented. Additional retrofits or replacement tasks are planned. Future projects may be programmed but are not yet funded. Provides mostly sufficient operation and maintenance (may have minor RWP deficiencies and may or may not follow all equipment manufacturer and Air Force standards). Limited water savings (future tasks and enhancements are expected to increase water savings).
2 (Fail)	Indicates limited tasks (under 25 percent) of a specific criterion have been implemented. Additional retrofits or replacement tasks have not been considered. Provides limited operation and maintenance (some RWP deficiencies exist and does not follow all equipment manufacturer and Air Force standards). Limited to no water savings (future tasks and enhancements would significantly increase water savings).

TABLE 1
Criteria Scoring for BMP Analysis
Water Management Plans: BMP Selection Process

1 (Fail)	Indicates no tasks (0 percent) of a specific criterion have been implemented or considered. Additional retrofits or replacement tasks have not been considered. Neglected operation and maintenance (numerous RWP deficiencies and not following equipment manufacturer and Air Force standards). Water waste visible (future tasks and enhancements would significantly increase water savings).

Final Score

A final score is then calculated for each BMP. A score of 70 percent or greater (or 80 percent or greater for BMP # 1) indicates the base is in compliance with the BMP.

The final score is calculated by summing the total percentage of all the criteria of a given BMP. A perfect score would be 100 percent.

Criteria percentage are calculated by multiplying priority value by the auditor score (priority value x score).

Conclusion

The BMP Selection Tool noted below provides Guidance to subjectively analyze and standardize the analysis process. However, final scores are not provided in the water management plan and are not designed to provided definite compliance decisions.

FEMP/DOE BMPs were developed to provide government agencies flexibility in implementing water conservation measures. Adjustments for economic, technical, and/or mission specific issues need to be considered which may allow or disallow BMP credit.

WATER CONSERVATION BEST MANAGEMENT PRACTICES
NELLIS AFB

	BMP Selection Process	Score*	Priority Value	Perfect Score	Maximum Score	Actual Score	Passing Min.	Passing Score	Percent	Claim BMP?	Remarks
	BMP # 1 - Public Information & Education Programs										
	3.1.1 Internal Options										
1	Does CE (Energy Mgr., CEV, CEH, others) provide water information to Public Affairs for quarterly publishing?	2	0.033	5	0.165	0.066	0.800	0.132	40%		Not quarterly, occasional articles published, WQ report
2	Is water conservation coordinated through Energy Management?	1	0.033	5	0.165	0.033	0.800	0.132	20%		CEV,CEO, PA need to improve com
3	Are instructions provided on newly installed water saving technology?	2	0.033	5	0.165	0.066	0.800	0.132	40%		Some HVAC shop training
4	Are regular training meetings held to promote water conservation?	2	0.033	5	0.165	0.066	0.800	0.132	40%		Limited CE training
	3.1.2 External Options										
5	Does the local utility provide water conservation assistance?	3	0.033	5	0.165	0.099	0.800	0.132	60%		Significant municipal water information, limited use
6	Are all media channels considered to promote water conservation (signage, web sites, email, brochures, TV, townhall meetings)?	2	0.033	5	0.165	0.066	0.800	0.132	40%		MFH brochures limited use of other media options
	3.1.3 Air Force Implementation Measures										
7	Does CE (Energy Mgr., CEV, CEH, others) provide water information to Public Affairs for publishing (quarterly)?	2	0.268	5	1.340	0.536	0.800	1.072	40%		Not quarterly, occasional article, WQ report
8	Are the installation's water use facts and conservation results distributed and displayed for public notification?	2	0.267	5	1.335	0.534	0.800	1.068	40%		Provided to housing residents, other areas limited
9	Is there a hot line to report water leaks or conservation ideas?	3.5	0.267	5	1.335	0.935	0.800	1.068	70%		Service call center acceptable, needs more emphasis
	ASSESSMENT SCORE (Passing score is 80%)				**5.000**	**2.401**	**0.800**	**4.000**	**48%**	**NO**	
	BMP # 2 - Distribution System Audits, Leak Detection, and Repair (Passing score: 70%)										
	3.2.1 O&M Options										
1	Has the installation performed a full-scale audit and leak detection survey, consistent with Manual of Supply Practices, AWWA # M36?	2	0.300	5	1.500	0.600	0.700	1.050	40%		AWWA Leak survey not scheduled, valve survey, GIS funding

WATER CONSERVATION BEST MANAGEMENT PRACTICES
NELLIS AFB

	BMP Selection Process	Score*	Priority Value	Perfect Score	Maximum Score	Actual Score	Passing Min.	Passing Score	Percent	Claim BMP?	Remarks
	3.2.2 Retrofit/Replacement Options										
2	Does the installation effectively retrofit/replace pipes when leaks are found?	4	0.350	5	1.750	1.400	0.700	1.225	80%		Good water management personnel, valves, hydrants use effective rwp
3	Has the installation recently replaced (5yrs), installing or programming the replacement of poor condition piping?	2	0.350	5	1.750	0.700	0.700	1.225	40%		5% replaced, MFH programmed
	ASSESSMENT SCORE (Passing score is 70%)				**5.000**	**2.700**	**0.700**	**3.500**	**54%**	**NO**	
	BMP # 3 - Water Efficient Landscaping										
	3.3.1 O&M Options										
1	Irrigation schedules	3.5	0.150	5	0.750	0.525	0.700	0.525	70%		Residents irrigation scheduled, common area on timers
2	Monitor and inspect irrigation effectiveness	3.5	0.150	5	0.750	0.525	0.700	0.525	70%		Effective monitoring
3	Hot line to report problems and leaks	3.5	0.150	5	0.750	0.525	0.700	0.525	70%		Service call center acceptable, needs more emphasis
	3.3.2 Retrofit/Replacement Options										
4	Rain sensors, automatic irrigation's systems	3.5	0.150	5	0.750	0.525	0.700	0.525	70%		Golf course good, common areas automated
5	Are controllers properly used?	3.5	0.150	5	0.750	0.525	0.700	0.525	70%		Effective O&M
6	Water-wise landscape, emphasizing native turf and plants	2	0.150	5	0.750	0.300	0.700	0.525	40%		20% of turf water wise landscaping
	3.3.3 Additional Assistance										
7	USAF Landscape Design Guide	3	0.050	5	0.250	0.150	0.700	0.175	60%		Developed good landscape guide, not emphasized
8	Xeriscape and LEED guidelines considered	2	0.050	5	0.250	0.100	0.700	0.175	40%		20% of turf water wise/xeriscaping
	ASSESSMENT SCORE (Passing score is 70%)				**5.000**	**3.175**	**0.700**	**3.500**	**64%**	**NO**	
	BMP # 4 - Toilets and Urinals										
	3.4.1 O&M Options										
1	Is the installation's maintenance program properly maintaining toilets and urinals (effective RWP, correct parts replaced)?	3.5	0.400	5	2.000	1.400	0.700	1.400	70%		Good O&M

WATER CONSERVATION BEST MANAGEMENT PRACTICES
NELLIS AFB

	BMP Selection Process	Score*	Priority Value	Perfect Score	Maximum Score	Actual Score	Passing Min.	Passing Score	Percent	Claim BMP?	Remarks
	3.4.2 Retrofit Options										
2	Are effective water saving devices added (timers, sensors)?	3	0.050	5	0.250	0.150	0.700	0.175	60%		10 facilites using autoflush toilets, limited
	3.4.3 Replacement Options										
3	Have toilets and urinals been replaced to meet 1997 guidelines? (50% compliance = passing, 3.5, 70% = 4)	4	0.500	5	2.500	2.000	0.700	1.750	80%		75% compliant, Most MFH compliant
4	Have waterless urinals been considered?	1	0.050	5	0.250	0.050	0.700	0.175	20%		None
	ASSESSMENT SCORE (Passing score is 70%)				**5.000**	**3.600**	**0.700**	**3.500**	**72%**	**YES**	
	BMP # 5 - Faucets and Showerheads										
	3.5.1 O&M Options										
1	Is the installation's maintenance program properly maintaining faucets and showerheads (effective RWP, correct parts replaced)?	3.5	0.300	5	1.500	1.050	0.700	1.050	70%		Good O&M
2	Are problems reported to fix leaks?	3.5	0.100	5	0.500	0.350	0.700	0.350	70%		Yes, service line, response good
3	Is systems pressure properly tested?	3.5	0.050	5	0.250	0.175	0.700	0.175	70%		No problems, Base managing issue
4	Are effective water saving devices added (timers, sensors)?	3	0.050	5	0.250	0.150	0.700	0.175	60%		10 facilites using hand wash sensors, limited
	3.5.2 Retrofit/Replacement Options										
5	Are flow restrictors used?	4	0.225	5	1.125	0.900	0.700	0.788	80%		Compliant in most homes and dorms
6	Are the 2.5 gpm standards for faucets and showerheads being met? (50% compliance = passing, 3.5, 70% = 4)	4	0.225	5	1.125	0.900	0.700	0.788	80%		90% compliant in most homes and dorms
7	Are faucet aerators being used (except hospitals)?	4	0.050	5	0.250	0.200	0.700	0.175	80%		Compliant in most homes and dorms
	ASSESSMENT SCORE (Passing score is 70%)				**5.000**	**3.725**	**0.700**	**3.500**	**75%**	**YES**	
	BMP # 6 - Boiler/Steam Systems										
	3.6.1 O&M Options										
1	Does the installation effectively maintain large boilers and associated traps, valves, receivers and pipes complying with manufacturer and Air Force standards?	3.5	0.300	5	1.500	1.050	0.700	1.050	70%		Hospital boilers, O&M good

WATER CONSERVATION BEST MANAGEMENT PRACTICES
NELLIS AFB

	BMP Selection Process	Score*	Priority Value	Perfect Score	Maximum Score	Actual Score	Passing Min.	Passing Score	Percent	Claim BMP?	Remarks
2	Does the installation maintain an effective chemical treatment program that optimizes the cycles of concentration to reduce make-up water including the use of conductivity monitors and chemical feed pumps?	3.5	0.300	5	1.500	1.050	0.700	1.050	70%		Auto chemical feed pumps, metered
3	Does the installation maintain accurate operation schedules?	3.5	0.150	5	0.750	0.525	0.700	0.525	70%		Schedule maintained
	3.6.2 Retrofit/Replacement Options										
4	Does the installation program the replacement of large boilers (>1MBH)?	3.5	0.150	5	0.750	0.525	0.700	0.525	70%		No 5 yr plan, limited need, hospital considering replacing steam system
5	Has the installation identified, evaluated and installed water/energy saving devices such as auto blowdown, meters?	3.5	0.100	5	0.500	0.350	0.700	0.350	70%		Auto chemical feed pumps, softener used
	ASSESSMENT SCORE (Passing score is 70%)			5	**5.000**	**3.500**	**0.700**	**3.500**	**70%**	**YES**	
	BMP # 7 - Single-Pass Cooling Equipment										
	3.7.1 O&M Options										
1	Does the installation identify and list single-pass cooling system?	1	0.166	5	0.830	0.166	0.700	0.581	20%		Limited application, (14) ice machines
2	Is water effectively controlled in single-pass cooling systems?	1	0.167	5	0.835	0.167	0.700	0.585	20%		Significant water lost
3	Are single-pass cooling systems properly maintained?	3.5	0.167	5	0.835	0.585	0.700	0.585	70%		Maintained, filtered
	3.7.2 Retrofit/Replacement Options										
4	Does the installation program the replacement of large single-pass cooling systems?	1	0.100	5	0.500	0.100	0.700	0.350	20%		No
5	Are closed loop systems considered?	1	0.100	5	0.500	0.100	0.700	0.350	20%		No
6	Is single-pass effluent reused?	1	0.100	5	0.500	0.100	0.700	0.350	20%		No
7	Is recycled water considered?	1	0.100	5	0.500	0.100	0.700	0.350	20%		No
8	Is multi-pass replacement considered?	1	0.100	5	0.500	0.100	0.700	0.350	20%		Med vac water cooled, estimate use 200 gpd
	ASSESSMENT SCORE (Passing score is 70%)				**5.000**	**1.418**	**0.700**	**3.500**	**28%**	**NO**	

WATER CONSERVATION BEST MANAGEMENT PRACTICES
NELLIS AFB

	BMP Selection Process	Score*	Priority Value	Perfect Score	Maximum Score	Actual Score	Passing Min.	Passing Score	Percent	Claim BMP?	Remarks
	BMP # 8 - Cooling Tower Management										
	3.8.1 O&M Options										
1	Does the installation effectively maintain large cooling towers, complying with manufacturer and Air Force standards?	3	0.300	5	1.500	0.900	0.700	1.050	60%		Cooling towers maintained, evap coolers poor
2	Does the installation maintain an effective chemical treatment program that optimizes the cycles of concentration to reduce make-up water including the use of conductivity monitors and chemical feed pumps?	4	0.300	5	1.500	1.200	0.700	1.050	80%		Poor water quality, good chem service
3	Does the installation maintain accurate operation schedules?	4	0.150	5	0.750	0.600	0.700	0.525	80%		EMCS control
	3.8.2 Retrofit/Replacement Options										
4	Does the installation program the replacement of large cooling tower?	3.5	0.100	5	0.500	0.350	0.700	0.350	70%		Evap coolers, cooling towers replaced as required
5	Has the installation indentified, evaluated, and installed water/energy saving devices, such as auto blowdown, meters?	3.5	0.150	5	0.750	0.525	0.700	0.525	70%		Auto blow down, softener being added to increase COC, ion filters added to evap coolers limited success
	ASSESSMENT SCORE (Passing score is 70%)				**5.000**	**3.575**	**0.700**	**3.500**	**72%**	**YES**	
	BMP # 9 - Misc. High Water-Using Processes										
	3.9.1 O&M Options										
1	Are high water-using processes metered?	2	0.200	5	1.000	0.400	0.700	0.700	40%		Dining halls not metered, limited application
2	Does the installation effectively maintain high water-using processes?	3	0.600	5	3.000	1.800	0.700	2.100	60%		Aircraft wash rack can be improved, dining halls well managed
	3.9.2 Retrofit/Replacement Options										
3	Are high water-using processes evaluated for efficiency improvements?	3	0.200	5	1.000	0.600	0.700	0.700	60%		Dining halls need water upgrades, aircraft needs upgrades
	ASSESSMENT SCORE (Passing score is 70%)				**5.000**	**2.800**	**0.700**	**3.500**	**56%**	**NO**	

WATER CONSERVATION BEST MANAGEMENT PRACTICES
NELLIS AFB

	BMP Selection Process	Score*	Priority Value	Perfect Score	Maximum Score	Actual Score	Passing Min.	Passing Score	Percent	Claim BMP?	Remarks
	BMP # 10 - Water Reuse and Recycling										
	3.10.1 On-site Water Recycling										
1	Is on-site water recycled?	3	0.050	5	0.250	0.150	0.700	0.175	60%		Some well water treatment for golf course
	3.10.2 Water Reuse										
2	Is reclaimed water used for golf course, landscapes, firefighting training, power plants, cooling towers?	2	0.500	5	2.500	1.000	0.700	1.750	40%		Considered, too expensive
	3.10.3 Gray Water										
3	Are Air Force limited gray water applications considered?	3	0.050	5	0.250	0.150	0.700	0.175	60%		Add pulping machines at dining halls
	3.10.4 Other Non-Potable Sources										
4	Are other non-potable sources used or considered (surface and well water)?	3	0.400	5	2.000	1.200	0.700	1.400	60%		Base considering CR optimizing and well sustainability issues
	ASSESSMENT SCORE (Passing score is 70%)				**5.000**	**2.500**	**0.700**	**3.500**	**50%**	**NO**	

APPENDIX F

Criteria for Evaluation of BMP #1

Water Management Plan: Criteria for Evaluation of BMP #1 - Public Information & Education Programs

ATTENDEES: Nanda Nanjundappa, Jarah Redwine, Dave Stieb, Michael Eberbach

COPIES: Angela Curtis

DATE: December 20, 2003

Overview

The objective of this memorandum is to categorize specific tasks for BMP #1 - Public Information & Education Programs.

BMP #1 Criteria

Specific water conservation awareness classification and criteria are noted below:

1) Base implemented programs that meet the required guidelines and are currently being used by the Base for water conservation;
2) Base required programs necessary to receive credit for BMP # 1; and
3) Base enhancements that consider time limitations and are included as options to improve water awareness.

The total hours necessary to accomplish both required programs and enhancements were estimated at 224 hours annually. This assumes that the water conservation POC will dedicate approximately 10 percent, or 4.5 hours per week, (for 50 weeks) of his/her time promoting energy awareness. Water savings estimates were based on energy awareness studies conducted by the Florida Solar Energy Center showing education involving water awareness conservation result in a 4 percent savings. The following calculation uses a more conservative approach of 1 percent and proportions this to the entire BMP criteria.

TABLE 1
Water Awareness Criteria
Water Management Plans for ACC Bases

Description	Water Savings (% of total base consumption)	Installation hours/cost (hours/$)
Seasonal news articles	0.1	32/1,760
Update energy policy	0.1	24/1,320
Promote service call center	0.1	8/440

TABLE 1
Water Awareness Criteria
Water Management Plans for ACC Bases

Facility manager training	0.2	16/880
Surveys	0.2	40/2,200
Sign placement/literature distribution	0.1	8/440
Electronic media promotion	0.1	24/1,320
Awards and recognition	0.05	48/2,640
Public events promotion	0.05	24/1,320
Total	**1.0**	**224/12,320**

Implementation costs were estimated assuming a GS-11 step 5 salary, including benefits and a 25 percent markup for general and administrative (G&A) support. The estimated labor cost is $45.00 per hour. Non-labor costs were estimated to be $10 per labor hour. These charges are based on previous utility privatization estimates for documentation materials and miscellaneous expenses.

Seasonal News Articles Coordinated through CE (Required)

CEOE, environmental (CEV) and Public Affairs may all participate in publishing water conservation articles. Seasonal articles are a necessary tool in promoting water conservation awareness, providing water use information and informing personnel of utility service issues.

Maintenance engineering (CEOE) through their water conservation POC is responsible for ensuring that news articles are published. They should actively coordinate with the other groups to reduce article conflicts and distribute the task of preparing new articles.

Further future consideration should be given to developing an energy and water conservation data base that would allow CE to choose from a list of already produced articles and quickly customize the chosen article to reflect the current situation.

Implementation: 32 hours (4 articles x 8 hours) x $45 per hour + 32 hrs x $10 per hour = $1,760.

Water savings: 0.2 percent x overall water consumption

Update Energy Policy to Include Water Conservation Guidelines (Required)

The Basewide energy policy should provide an overview of EO 13123, set yearly energy reduction goals, describe energy management programs, and establish energy conservation guidelines for Base personnel and facilities. The Basewide energy policy should also contain water conservation guidelines clearly defining irrigation schedules for commercial facilities and Base residences, discussing drought standards, and describing the responsibilities of Base personnel.

A Basewide water conservation AFI or updated water management plan could take the place of this requirement.

Maintenance engineering (CEOE) through their water conservation POC should standardize guidelines based on discussions with the housing contractor and local utilities. Once incorporated into the energy policy, the revised AFI should be submitted to the Commander for signature.

Implementation: 24 hours x $45 per hour + 24 hours x $10 per hr = $1,320

Water savings: 0.1 percent x overall water consumption.

Promote Service Call Center for Water Conservation (Required)

Air Force installations should promote the service center as a communication channel to notify CE and/or utility shops of maintenance repair problems, report public water leaks or offer suggestions to improve service or maintenance.

Maintenance engineering (CEOE) through their water conservation POC should promote the service call news articles, public events, and/or other media channels.

Implementation: 8 hrs x $45 per hour + 8 hours x $10 per hour = $440

Water savings: 0.1 percent x overall water consumption.

Scheduled Facility Managers Training (Required)

CEOE and the utility shop supervisor normally coordinate quarterly facility manager training seminars to educate new military personnel to duties and responsibilities of facility maintenance. This training includes updates concerning new technologies and services.

The water conservation POC should coordinate with the shop supervisor and CEOE to include a 15 minute oral presentation on energy and water conservation. This typically involves the preparation of one to three Power Point slides. The water conservation POC may also need to update Base facility manager training handbooks to incorporate water conservation issues and procedures.

Implementation: 16 hours (4 times per year x 4 hours) x $45 per hour + 16 hours x $10 per hour = $880

Water savings: 0.2 percent x overall water consumption.

Surveys (Required)

A weekly site inspection of large water using facilities should be conducted as often as necessary to maintain informed of current Base conditions.

The water conservation POC should schedule inspections which may include visiting dormitories, dining halls, golf courses, and large mechanical rooms. This is different from Water Shop inspection.

Implementation: 40 hours (25 inspections x 1.6 hours) x $45 per hour + 40 hrs x $10 per hour = $2,200

Water savings: 0.2 percent x overall water consumption

Sign Placement/Literature Distribution (Required)

Display signs and posters in large water-using facilities and public areas. Develop and publish Base specific water conservation facts and service information on flyers and brochures to be distributed to existing and new residents in Base housing.

The water conservation POC should prepare a list of large water users and coordinate placement of signs and posters in public areas for improved exposure. The water conservation POC should also meet with the CEH representative and housing manager (often a contractor) to provide water conservation literature as needed.

Implementation: 8 hours x $45 per hour + 8 hours x $10 per hour = $440

Water savings: 0.1 percent x overall water consumption

Electronic Media Promotion Via Web Sites, Emails, and TV (Enhancement)

Many Base web sites allow CEOE to place a web page addressing energy and water conservation. Another option is to send out electronic flyers to Base personnel informing them of drought conditions, water saving ideas or upcoming events. Some Bases also have a community cable channel within which they can promote water conservation programs.

CEOE through the water conservation POC should coordinate the development (if necessary) and updating of a water conservation web page. This should include water conservation information, promote water conservation programs, and present water use data.

Electronic flyers can be produced by CEOE as a word document and sent to PA for modification into an electronic flyer. A similar procedure for cable TV slides can also be considered.

Implementation: 24 hours (updated twice per year x 4 hours + two flyers x 8 hours) x $45 per hour + 24 hours x $10 per hour = $1,320

Water savings: 0.1 percent x overall water consumption

Awards and Recognition (Enhancement)

The DOE/FEMP issues awards for exemplary water conservation programs and tasks. An installation may elect to recognize water conservation activities completed by individual personnel to help reduce water consumption on Base.

The DOE/FEMP awards require preparation time and must be coordinated through the BCE and up the chain of command to the Base Commander. Base award recognition requires the establishment of procedures for recognition and Basewide promotion.

Implementation: 48 hours (one award per year x 40 hours + recognition promotion 8 hours) x $45 per hour + 48 hours x $10 per hour = $2,640

Water savings: 0.1 percent x overall water consumption

Public Events Promotion (Enhancement)

Public events include Basewide townhall meetings, visiting the on-Base school, and supporting local utility conservation events and rebates. For instance, October is energy conservation month which can be used as an option for also promoting water conservation.

The water conservation POC should coordinate with Wing HQ to be included with other speakers in the townhall meeting. This may include an oral presentation or one to three slides to be used by the Commander. These slides may require review and editing by the BCE and other group commanders which will take time, coordination, and preparation.

Other preparation includes preparing a site booth, obtaining literature and scheduling visits to Base schools.

Implementation: 24 hours (3 times per year x 8 hrs) x $45 per hour + 24 hours x $10 per hour = $1,320

Water savings: 0.05 percent x overall water consumption

APPENDIX G

1391 Form

1. COMPONENT	FY 2006 MILITARY CONSTRUCTION PROJECT DATA (computer generated)	2. DATE
AIR FORCE		20040630

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
NELLIS AIR FORCE BASE, NV	MAIN BASE TURF REPLACEMENT WITH

5. PROGRAM	6. CATEGORY	7. PROJECT NUMBER	8. PROJECT COST ($000)
			3,100

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
REPLACE 30 ACRES OF TURF GRASS AREAS WITH DESERT XERISCAPE	LS			2,644
SUBTOTAL				2,644
CONTINGENCY (10%)				264
TOTAL CONTRACT COST				2,908
SUPERVISION, INSPECTION, AND OVERHEAD				166
TOTAL REQUEST				3,074
TOTAL REQUEST (ROUNDED)				3,100

10. Description of Proposed Construction: Replace 30 acres of the 42 acres containing turf landscaped areas of the Main Base with water efficient xeriscape.

11. REQUIREMENT: As Required
PROJECT: Provides water savings by significantly reducing the amount of water used for irrigating the Main Base turf areas. This project reduces the base maintenance cost required to maintain the Main Base turf grass areas. It significantly improves the quality of life for military personnel by reducing the amount of facility landscape maintenance required to be performed by off-duty military personnel. The project demonstrates environmental stewardship by Nellis AFB to take the initiative in the Las Vegas area to reduce the amount of water being removed from local water sources. This project also assists Nellis AFB in meeting necessary aquifer/water restrictions that are likely to be in effect for the foreseeable future.

REQUIREMENT: Executive Order 13123 (Jun 99) mandates continued energy and water reduction for federal installations. This project will also help the Base to meet the U.S. Department of Energy (DOE) requirements by reducing potable water usage through the implementation of life cycle, cost effective projects. The project is specifically related to Best Management Practice #3 of the Federal Energy Management Program (FEMP) Best Management Practices (BMPs).

CURRENT SITUATION: The Base currently irrigates 42 acres of turf grass areas that consume approximately 75 million gallons of water per year. Xeriscaping 30 of the 42 acres will save approximately 39 million gallons of purchased water every year. The required maintenance of the 42 acres of turf grass area is estimated at $472,000 annually. Xeriscaping 30 of the 42 acres would save approximately $243,000 per year of maintenance costs. Also the entire Las Vegas area is exceeding the alotment of water allocated for the area by the Colorado River Commission. This may cause future water restrictions to the Las Vegas area and Nellis AFB.

IMPACT IF NOT PROVIDED: Without implementation of this project, the Air Force will be impeded from meeting its reduction goals required by Public Law, which may result in unfavorable audits by DOD. With future year utility account budgets being based on project reductions in water and energy consumption, the overall O&M budget will be negatively impacted by utility account shortfalls if the projected reductions are not realized. Additionally, the Air Force requirement to improve the quality of life will be hindered. The Air Force may loose the opportunity of taking stewardship to conserve natural resources, including water if this project is not implemented.

ADDITIONAL INFORMATION: An economic analysis was performed on this project, and the simple payback is 12.2 years. The annual water savings is 75,002 kgal with a water cost savings of $30,919. There is also approximately $243,000 per year in maintence cost avoidance. The total water usage reduction and maintenance savings are $273,919 annually. The Air Force POCs are: Mr. Mike Clawson, AF Water Manager, 850-283-6362, Mr. Mark Turner, ACC Water Manager, 757-764-2876, and Mr. Barry Flynn, Nellis Civil Systems Engineer, 702-652-3354.

- Implementing xeriscaping on the main Base involves the transition from standard grass and floral landscaping to water-efficient landscaping. The main Base is estimated to have 42 acres of irrigated turf grass areas. Project costs and savings were estimated assuming 30 of the 42 acres currently being irrigated are converted to desert xeriscaping. The estimated cost to convert the landscaping to water-efficient landscaping is $1.70 per square foot based on information provided by Nellis AFB and information published by the Arizona Multi-housing Association. General requirements, inflation, contingency, SIOH, and design cost adds another $0.85 per square foot. The effective installed cost is $2.55 per square foot.

- 30 acres x 43,560 sf per acre sf x $2.55 per sf = $3,332,340 to transition 30 acres of sprinkler-irrigated landscaping to water-efficient desert landscaping.

Water savings were estimated by calculating the difference between the current irrigation requirement for the landscaped area and the expected irrigation requirement for the same area after it is xeriscaped. Based on industry published water requirements, that incorporate climate, plant density, and plant species, a xeriscaped or water-efficient landscape crop coefficient of 0.3 is used.

The estimated current irrigation demand of the 42 acres on the main Base was determined as follows:

274 days per year of irrigation x (0.25 inches irrigation required per day - 0.01 daily average rainfall during the irrigation period) x 43,560 sf per acre x 42 acres turf grass area x 7.481 gallons per cubic foot/(12 inches per foot x 1,000 gallons per kgal) = 75,002 kgal per year.

Conversion of 30 acres to desert xeriscaping and 12 acres of irrigated turf grass area significantly reduces the water consumption as follows:

Remaining 12 acres of turf:

274 days per year of irrigation x (0.25 inches irrigation required per day - 0.01 daily average rainfall during the irrigation period) x 43,560 sf per acre x 12 acres turf area x 7.481 gallons per cubic foot/(12 inches per foot x 1,000 gallons per kgal) = 21,429 kgal per year.

Xeriscape 30 acres:

274 days per year of irrigation x [(0.25 inches irrigation required per day x 0.3 water-efficient crop coefficient) - 0.01 daily average rainfall during the irrigation period] x 43,560 sf per acre x 30 acres xeriscaped area x 7.481 gallons per cubic foot/(12 inches per foot x 1,000 gallons per kgal) =
= 14,509 kgal per year.

Projected Consolidated Water Savings Per Year

21,429 kgal per year for 12 acres turf grass area + 14,509 kgal per year for 30 acres xeriscaped area = 35,938 kgal per year based on future irrigation demand.

- The annual water savings is estimated by the difference between the current 42 acres of irrigated area and the conversion to 30 acres of xeriscaped area and 12 acres of irrigated area.
- 75,076 kgal per year current - 35,938 kgal per year with xeriscaping = 39,138 kgal per year of water savings.
- 39,138 kgal per year water savings x $0.79 per kgal water = $30,919 per year of water cost savings.

Additional savings can also be attributed to reduced required maintenance costs of the irrigated areas from mowing, pruning, seeding, and fertilization. The maintenance savings associated with conversion to water-efficient landscaping is based on published information provided by the Arizona Multi-housing Association (AMA). The AMA information provides estimated maintenance costs for lush, traditional landscape with lots of turf and water-type plants at $1,300 to $2,600 per acre per month and a moderately-maintained desert landscape with selective pruning at $500 to $900 per acre per month. Through discussion with the Base POC, a cost of $2,500 per acre per month was used as the most accurate cost basis for the current maintenance costs. A future maintenance cost of $700 per acre per month for moderately maintained desert landscape was used as the cost basis for the 30 acres of xeriscaped area and $2,500 per acre per month for the remaining 12 acres of turf areas that remain. The Base utilizes correctional facility population and off-duty enlisted personnel to maintain approximately 50 percent of the areas being considered by this project. This effectively reduces the maintenance costs for each category by one-half. A nine-month (Nellis AFB primary irrigation season) maintenance performance period was used as the basis to estimate the future maintenance costs.

- The current estimated maintenance costs are:
- 42 acres x $2,500 per acre per month x 50% (non-paid labor) x 9 months per year = $472,500 per year of current upkeep and maintenance costs.
- The water efficient desert landscape estimated maintenance costs are:
- (12 acres x $2,500 per acre per month + 30 acres x $700 per acre per month) x 50% (non-paid labor) x 9 months per year = $229,500 per year of future upkeep and maintenance costs.
- The water efficient desert landscape estimated savings in maintenance costs are:
- $472,500 per year of current maintenance costs - $229,500 per year in future maintenance costs = $243,000 per year in cost savings.
- The total water cost and maintenance savings are:
- $30,919 per year of water cost savings + $243,000 per year maintenance cost savings = $273,919 per year total savings.
- The estimated simple payback period was calculated by dividing the implementation cost by the estimated annual savings:
- $3,332,340 implementation cost/$273,919 savings = 12.2 year simple payback.

3. Savings Verification Plan: The savings that will be realized as a result of this project will be verified as follows:

   a. The future irrigation water use will be compared to the historic water use by Nellis AFB to validate monthly water savings.

4. Closure Statement: This installation is not being considered for closure or realignment.

APPENDIX H

Hospital RO Water Savings Calculation

Hospital Central Steam Plant RO Operating Costs

Nellis AFB

Category	Current NaZ Operation	NaZ/RO Operation	Units
Annual steam produced	120,888,000	120,888,000	pounds/year
Boiler cycles of concentration	10.0	100.0	cycles
Blowdown rate	10.00%	1.00%	percent
Annual feedwater	17,002,532	15,456,847	gallons/year
Annual condensate volume	11,391,696	11,391,696	gallons/year
Annual make up volume to boilers	5,318,008	3,852,992	gallons/year
GPM rate of make up to the boilers	10.12	7.33	gpm
Annual makeup to boiler pretreatment	5,318,008	5,137,323	gallons/year
Annual blowdown volume	1,700,253	154,568	gallons/year
Average gpm rate to the pretreatment	10.12	9.77	gpm
RO Percent Reject	n/a	25.0%	
RO reject volume	n/a	1,284,331	gallons/year
RO reject flowrate	n/a	2.4	gpm
RO reject to sewer cost of operation	n/a	n/a	$/year
Is reuse of the RO reject feasible? (Yes or No)	n/a	Yes	
Peak estimate R.O. flow rate	n/a	10.00	gpm
HP of RO pump	n/a	5	hp
RO electrical cost of operation	n/a	$1,916.22	$/year
Annual water/sewer softener regen cost	$198	$191	$/year
Annual water softener salt usage	48,895	47,234	pounds/year
Annual water softener salt cost	$1,956	$1,889	$/year
Annual caustic cost	n/a	n/a	$/year
Annual blowdown sewer discharge cost	$0	$0	$/year
Make up water cost	$4,201	$3,044	$/year
Annual makeup water enthalpy required	11,915	8,633	MM BTU's/year
Fuel Cost, Natural Gas	$5.46	$5.46	$/MCF
Plant energy value	$7.80	$7.80	$/MM BTU's
Makeup water energy cost	$92,938	$67,335	$/year
Steam energy cost	$835,025	$835,025	$/year
Boiler chemical treatment cost	$0	$0	$/year
Total annual operating cost	$934,318	$909,401	$/year
Operating cost per 1000 pounds steam	$7.73	$7.52	$/1000 lb steam
Savings compared to current cost:		***$24,917***	$/year

Operational Savings Summary	Current	NaZ/RO	Units
Change in make up volume	0	1,465,016	gallons/year
Pretreatment make up water savings	$0	$1,157	$/year
Change in blowdown volume	0	1,545,685	gallons/year
Blowdown sewer savings	$0	$0	$/year
Change in makeup energy required	0	3,282	MM BTU's/year
Makeup water energy savings	$0	$25,603	$/year
RO reject volume	n/a	1,284,331	gallons/year
RO reject cost of operation	n/a	n/a	$/year
Water softener regen water/sewer savings	$0	$7	$/year
Water softener salt savings	$0	$66	$/year
Caustic cost	n/a	n/a	$/year
Chemical treatment savings	$0	$0	$/year
Electrical cost of operation	$0	($1,916)	$/year
Total annual savings:	**$0**	***$24,917***	