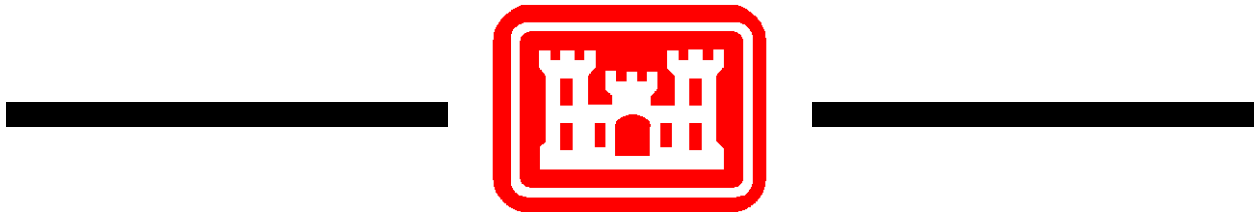


PUBLIC WORKS TECHNICAL BULLETIN 200-1-85
30 SEPTEMBER 2010

INSTALLATION WATER AUDIT GUIDELINES



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Public Works Technical Bulletin

30 September 2010

No. 200-1-85

FACILITIES ENGINEERING
ENVIRONMENTAL
INSTALLATION WATER AUDIT GUIDELINES

1. Purpose.

a. The purpose of this Public Works Technical Bulletin (PWTB) is to transmit information on how to conduct an Installation Water Audit using methods developed during the Army Installations Water Sustainability Assessment research project. This is intended to assist in addressing current requirements associated with references, below. Appendices include case studies for illustration along with instructions for using the model.

b. All PWTBs are available electronically (in Adobe® Acrobat® portable document format [PDF]) through the World Wide Web (WWW) at the National Institute of Building Sciences' Whole Building Design Guide web page, which is accessible through URL:

http://www.wbdg.org/ccb/browse_cat.php?o=31&c=215

2. Applicability. This PWTB applies to all U.S. Army facilities engineering activities.

3. References.(listed in hierarchical order of issuing agency)

a. *Energy Independence and Security Act of 2007.*

b. *Executive Order 13423, Strengthening Federal Environmental, Energy and Transportation Management, 29 January 2007.*

c. *Executive Order 13514, Federal Leadership in Environmental, Energy and Economic Performance*, 05 October 2009.

d. *The Army Energy Strategy for Installations*, 08 July 2003, and *Army Energy and Water Campaign Plan for Installations*, U.S. Department of the Army, 01 December 2007.

e. *ACSIM Memorandum DAIM-ZA*, 18 March 2003 and *Memorandum HQ IMCOM SFIM-OP-P*, 21 April 2004.

f. *Army Energy and Water Campaign Plan for Installations*, 01 December 2007.

g. *Army Installations Water Sustainability Assessment: An Evaluation of Vulnerability to Water Supply*. U.S. Army Corps of Engineers, Construction Engineering Research Laboratory. ERDC-CERL TR-09-38, September 2009.

4. Discussion.

a. Water issues impact Army installations and operations in many locations across the nation. Common concerns include the variability of water supply, the increased cost to purchase or produce water, water quality, habitat degradation, and water salinity. These issues have prompted a new focus on conserving water resources to meet current and potential future needs such as Army transformation. The high concentration of Army installations in regions affected by water supply issues (i.e., the arid Southwest and the drought-stricken Southeast) highlights the need to be able to quickly prepare water demand estimates using established methods.

b. Water efficiency requirements for Army facilities are found in the *Energy Independence and Security Act of 2007* (EISA 2007), *Executive Order 13423* (EO 13423), and *Executive Order 13514* (EO 13514). Section 432 of *EISA 2007* establishes a framework for facility project management and benchmarking. Under this new requirement, Federal agencies must identify all "covered facilities" that constitute at least 75 percent of the agency's facility energy/water use. Each facility water manager is responsible for completing comprehensive energy/water evaluations of 25 percent of these covered facilities each year, implementing all identified water efficiency measures, and following up on implemented measures by measuring and verifying water savings. *EO 13423* further requires a reduction of water consumption intensity of 2 percent annually through the end of Fiscal Year 2015, relative to a baseline of fiscal year 2007 (FY07). *EO 13514* extends this requirement through 2020 for a

total reduction in water consumption intensity of 26 percent. In addition, *EO 13514* requires implementation of water reuse strategies consistent with state law. The *Army Energy Strategy for Installations* sets the general direction in conservation of water resources while the *Army Energy and Water Campaign Plan for Installations* identifies tools, technologies, policies, management, and institutional requirements to achieve initiatives and approaches. A national policy was further interpreted by IMCOM and ACSIM in a memorandum that adopts the Department of Energy's 10 Best Management Practices (BMPs) for developing water management plans, increasing public awareness, and implementing conservation practices. In addition to developing water management plans, they must be reviewed and updated periodically. All of these policy documents are available through the ACSIM Web site:

http://army-energy.hqda.pentagon.mil/policies/water_con.asp

c. This PWTB provides an overview of the Installation Water Demand Tool that was developed as part of the Army Installations Water Sustainability Study. The installation water demand tool predicts the capacity, demand, and water supply requirements for an Army installation over a 30-year horizon. The Installation Water Demand Tool model will be housed on the following Web site which is expected to be available publicly in September 2010:

<http://water-management-toolbox.com>

d. Appendix A to this contains a description of the Installation Water Demand Tool.

e. Appendix B contains the Fort Bragg case study.

f. Appendix C contains the Fort Bliss case study.

g. Appendix D contains instructions on using the Installation Water Demand Tool.

h. Appendix E contains a list of acronyms and abbreviations used in this PWTB, paired with their spellouts.

i. Appendix F cites related ERDC-CERL publications.

5. Points of Contact. Headquarters, U.S. Army Corps of Engineers (HQUSACE) is the proponent for this document. The point of contact (POC) at HQUSACE is Mr. Malcolm E. McLeod, CEMP-CEP, 202-761-5696, or e-mail: Malcolm.E.Mcleod@usace.army.mil.

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APPENDIX A

Installation Water Demand Tool

Introduction

One of the key components of an effective water management programs is the identification of current water consumption and the projection of future water demand. Typically, this is accomplished by using data from individual building-level water meters. Although building meters are required by EISA 2007, complete metering is scheduled for completion in 2016.

The Installation Water Demand Tool comprises a model that enables the estimation of the end uses of water by using total installation water consumption as one input and preparation of water demand projections as another. The model works on the premise that there are three basic categories of water consumers on the installation, as listed here.

- residents
- commuters
- processes

The "residents" customer category (which can be combined depending on the availability of installation data) can be further broken down into the categories listed here.

- residential (family housing, unaccompanied personnel housing [UPH]/barracks, and transient/lodging facilities)
- dependent schools
- industrial and maintenance
- medical
- administrative and moderate users
- community and commercial (food and non-food related), storage, high water-use facilities, pools and vehicle wash facilities, irrigation and improved lands
- losses (leaks, line flushing, unaccounted uses)

The "commuters" population is represented by the square footage of the different types of buildings and their consumption factors. The "processes" category is represented by the irrigation loads, losses, and high water uses. There are also more unique consumers that should be evaluated for each installation. Examples of these unique consumers would be swimming pools, golf courses, and vehicle wash facilities.

The factors for the consuming sectors of the model were taken from Forecasting Urban Water Demand (Jennings and Jones 2008)

Sector demands then were developed based on typical water consumption values and are calibrated to the installation's footprint, population, and op-tempo.*

Drivers for Water Demand

The key drivers for the water model are listed here.

- installation's real property data
- installation's permanent population (barracks, multifamily, single family, and transient quarters)
- commuting population
- industrial tempo
- deployment tempo
- rainfall and evapotranspiration data
- planned construction

Water Use Data

Installation water use data is reported on a monthly basis by either the Directorate of Public Works or the utility contract operator. Data is available for the entire installation. Reimbursable customers are metered separately for billing purposes. This data is aggregated quarterly and entered into the Army Energy and Water Reporting System (AEWRS).

Initial per-capita water usage, typically about 69.3 gpcd,[†] applies to resident population (family housing, multifamily housing, and barracks). Indoor water usage for commuting population typically is 10 gpcd. Irrigation water usage is calculated as:

acreage X (summer evapotranspiration rate - 60 percent of summer precipitation rate).

The model assumes no restrictions on irrigation. The seasonal variation in installation consumption can also be used as a check on the irrigation rate.

An initial rough break-out by sector is 50-60 percent for residential, 25 percent for non-residential, and 10-15 percent for losses. These figures may need realignment based on the fact

*Op-tempo = "operational tempo," or how frequently a unit deploys or goes to the field.

[†]gallons per capita per day.

that many installations have a large population that commutes onto the installation, so the non-residential sectors may exceed the typical city's profile ratio for commercial/industrial/institutional buildings and usage. Irrigation may also be a much larger consumer than in a typical community due to large parade fields, commons, golf courses, etc.

Model Development and Testing

The steps in developing a water model are:

1. collect data on historical water use and drivers for water demand (10 years of monthly data and 20 years of annual data);
2. analyze key drivers and disaggregate data; develop and test model;
3. augment data if required (e.g., with individual building meter data);
4. test and calibrate model for several installations;
5. develop forecasts for the drivers (independent variables); and
6. develop water demand and consumption forecasts.

Model Results

The model was developed initially for application to Fort Bragg, NC, and Fort Bliss, TX. These installations are located in different sections of the United States, with significantly different climate zones – Fort Bragg in the Southeast (see Appendix B) and Fort Bliss in the Southwest (see Appendix C). Because of their different climates, the two installations have significantly different evapotranspiration rates for exterior use of water.

APPENDIX B
Fort Bragg Case Study

Establishing the Baseline

Fort Bragg was the location for initial testing of the Installation Water Demand Tool. The Fort Bragg/Fayetteville region has been subject to several localized droughts over the past decade. At the same time, population has increased both on and off post. The following discussion covers application and results of the Fort Bragg model.

Fort Bragg is a large U.S. Army Forces Command (FORSCOM) installation near Fayetteville, NC. The installation covers approximately 161,000 acres and is, by population, the largest U.S. Army installation. It is the home for the XVIII Airborne Corps and the 82nd Airborne Division. The installation experiences large shifts in the number of troops in residence due to military missions. The region surrounding Fort Bragg continues to grow in population, creating the need for an analysis of regional water sustainability. The Installation Water Demand Tool has been used to develop a projection of future water demand on post.

Figure B-1 shows Fort Bragg's historical water consumption, using monthly data. Over the past several years, consumption has dropped from an average of 8 million gallons per day (MGD) to about 5 MGD, partly as a result of the installation's water conservation program and partly due to a high level of deployments. Also note that the installation's recent consumption is trending back up. The average, from using the past 5 years of data, was 4.84 MGD. Considering this trend, a baseline of 5 MGD was used to calibrate the model.

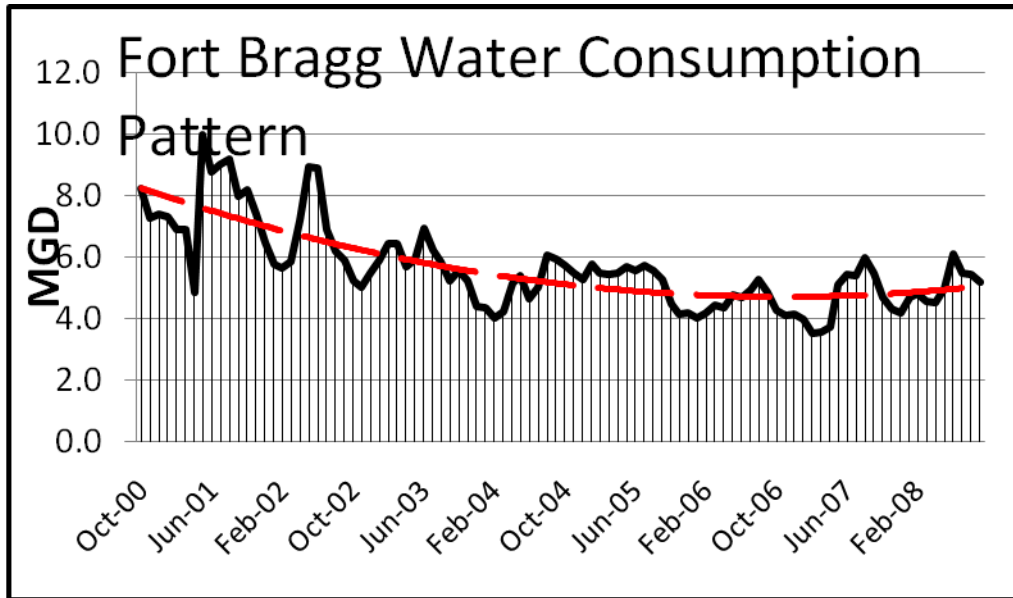


Figure B-1. Fort Bragg’s historical water consumption.

Projecting Fort Bragg Usage

Table B-1 lists the baseline population and input data used for Fort Bragg. Table B-2 lists the initial installation baseline projected consumption. The historical water use for Fort Bragg was obtained from the installations Directorate of Public Works. Note that this is an unconstrained baseline and assumes that improved lands are irrigated according to the typical evapotranspiration requirements of the area. This results in a projected baseline of about 5.38 MGD.

Table B-1. Fort Bragg population and infrastructure data.

Type	Baseline
Housing Units	5,580
Military Stationed	47,435
Transient Population	2,451
Dependents	72,101
Civilian Workforce	16,290
Deployment Factor: Family Housing	0.84
Deployment Factor: Barracks	0.67
Industrial/Maintenance Factor	1.00
Storage Growth Factor	1.00
High Water Use Facilities Factor	1.00
Irrigated Land Factor	1.00
ET (Moisture Deficit)	16.66
Losses Factor	0.10

Table B-2. Initial installation baseline projected consumption.

Using Sector	MGD (annual average)	Number	Units	Consumption (gpud)
Family Housing	1.367	23,250	Occupants	70
Barracks	0.858	18,284	Spaces	70
Dependent Schools	0.102	6,812	Students	15
Medical	0.165	133	Buildings	1,236
Industrial and Maintenance	0.321	459	Buildings	700
Transient Housing/Lodging	0.190	1,267	Spaces	150
Administrative/Moderate Users	1.271	1,056	Buildings	1,204
Community and Commercial: Non- food related (indoor)	0.109	173	Buildings	629
Community and Commercial (food-related)	0.040	44	Buildings	906
Storage	0.012	1,188	Buildings	10
High Water Use Facilities	0.025	49	Buildings	500
Irrigated/Improved Land	0.332	446	Acres	
Pools, Wash Racks, etc	0.100			
Losses	0.489			
Total	5.380			

Actual demand will fluctuate based on season and can be as much as 80% -100% higher during peak irrigation times. The number listed is an annualized demand. The model is then adjusted for increase or decrease in consumption in the various sectors based on expected changes (growth or reduction) in the various inputs. The installation population is adjusted for future changes, the various consuming sectors are adjusted based on planned construction, and the mobility factors are adjusted based on the expected rates of deployment. The baseline projection makes no assumptions about water conservation projects or implementation of best management practices (BMPs).

Figure B-2 shows the 30-year projection for Fort Bragg. The model projects that the installation will increase its baseline water consumption about 0.5 MGD in the future due to several force transformation initiatives. Figure B-2 also provides a modified projection based on implementation of the water-saving requirements of Executive Order (EO) 13423, which requires a 2 percent reduction per year from FY08-FY15. Implementing water efficiency BMPs would result in a long-term reduction of consumption to an annual average of about 5.2 MGD. Here again, it is assumed irrigation requirements are met.

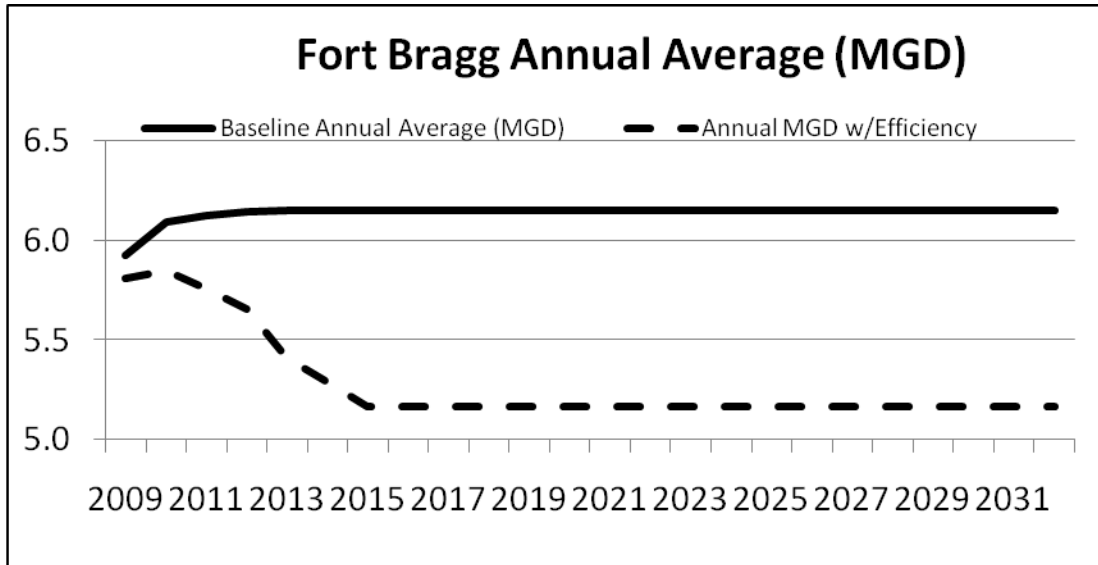


Figure B-2. Projected Fort Bragg water consumption.

APPENDIX C
Fort Bliss Case Study

Establishing the Baseline

Fort Bliss was the second demonstration site for testing the Installation Water Demand Tool. The Fort Bliss/El Paso/Juarez region receives less than 10 in. of precipitation per year. This area also has the challenge of dealing with not only differing state laws but also international compacts that govern water rights. Fort Bliss is experiencing rapid growth in military population and the El Paso/Juarez region is also growing. The following discussion covers application and results of the Fort Bliss model.

Fort Bliss covers 1.1 million acres of land stretching across the far western tip of Texas and north into New Mexico. Projections indicate that Fort Bliss will triple in population size by 2013. The adjacent El Paso metropolitan region is also experiencing rapid growth, as is the adjacent region across the international border in Mexico. Rapid population growth, coupled with a desert climate regime, creates the need for an analysis of regional water sustainability. The Installation Water Demand Tool was used to develop a projection of future water demand on post.

Figure C-1 shows Fort Bliss' historical annual water consumption (data obtained from AEWRS). Consumption has fallen over the past several years, from an average of 5 MGD to about 4 MGD. Also, note that the installation's consumption trend is somewhat erratic due to incomplete data availability at the time of this analysis and is probably weather dependent. The average using the past eight years of data was 4.4 MGD, which is fairly high for an installation of this size, but is an indicator of the demand due to climate factors. This average was used as the baseline for calibrating the model.

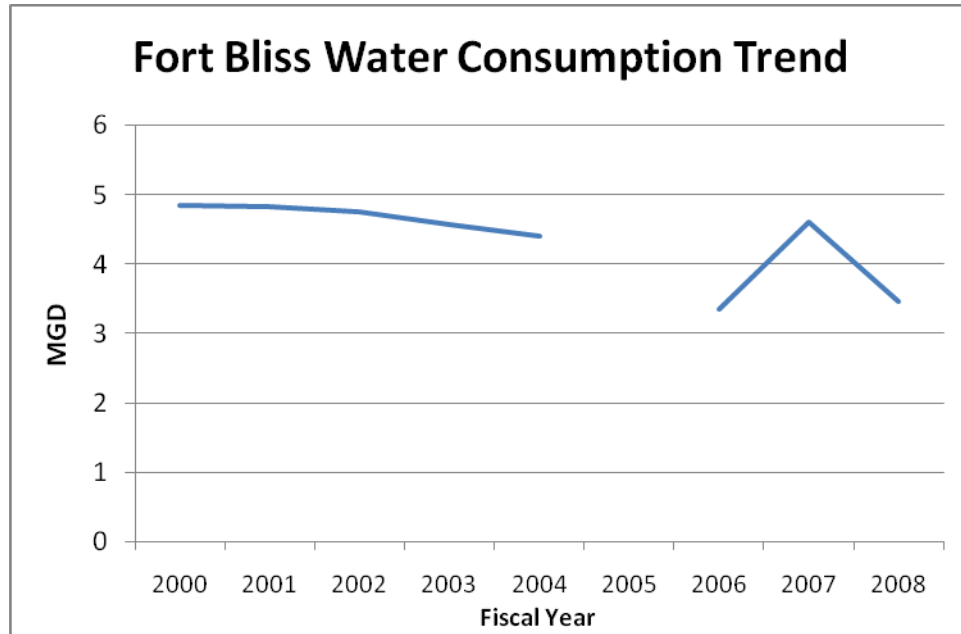


Figure C-1. Fort Bliss: historical water consumption.

Projecting Fort Bliss Usage

Table C-1 lists the baseline population and input data used for Fort Bliss (data obtained from AEWRs). Ideally, monthly data from the installation DPW would be used to create this graphic. Table C-2 lists the initial installation baseline projected consumption, by category. Note that this is an unconstrained baseline and assumes that improved lands are irrigated according to the typical evapotranspiration requirements of the area. This results in a projected baseline of about 4.95 MGD. Actual demand will fluctuate based on season and can be as much as 80%-100% higher during peak irrigation times. The number listed is an annualized demand.

Table C-1. Fort Bliss population data.

Type	Baseline
Housing Units	3.052
Military Stationed	9,330
Transient Population	2,132
Dependents	15,330
Civilian Workforce	3,621
Deployment Factor: Family Housing	0.90
Deployment Factor: Barracks	0.83
ET (Moisture Deficit)	30.00
Losses Factor	0.12

Table C-2. Baseline projected consumption for Fort Bliss.

Using Sector	MGD (annual average)	Number	Units	Consumption (gpud)
Family Housing	1.21	13,499	Occupants	100
Barracks	0.68	8,211	Spaces	100
Dependent Schools	0.00	80	Students	20
Medical	0.09	76	Buildings	1,236
Industrial and Maintenance	0.12	176	Buildings	700
Transient Housing/Lodging	0.12	772	Spaces	150
Administrative/Moderate Users	0.18	146	Buildings	1,204
Community and Commercial: Non-food related (indoor)	0.07	106	Buildings	629
Community and Commercial: Food-related	0.02	17	Buildings	906
Storage	0.00	218	Buildings	10
High Water Use Facilities	0.01	28	Buildings	500
Irrigated/Improved Land	1.49	335	Acres	
Pools, Wash Racks, etc	0.50			
Losses	0.45			
Total	4.95			

The model is then adjusted for increase or decrease in consumption in the various sectors based on expected changes (growth or reduction) in the various inputs. The installation population is adjusted for future changes, the various consuming sectors are adjusted based on planned construction, and the mobility factors are adjusted based on the expected rates of deployment. The baseline projection makes no assumptions about water conservation projects or implementation of BMPs. Figure C-2 shows the 30-year projection for Fort Bliss.

The model projects that the installation will increase its baseline water consumption from about 5.2 MGD to 9.8 MGD in the future due to the several force transformation initiatives. The projection indicates that water consumption could more than double. Figure C-2 also provides a modified projection based on implementation of the water-saving requirements of EO 13423, which requires a 2 percent reduction per year from FY08-FY15. Implementing water efficiency BMPs would result in a long-term consumption trend at an annual average of about 8.2 MGD. At this site, new construction and stationing activities are increasing consumption, while at the same time, water efficiency improvements are being made. Again, it is assumed irrigation requirements are met.

Note that newly constructed buildings should be more water efficient than existing buildings. However, the additional numbers of new buildings makes it more difficult to reduce overall water consumption, even though the greater efficiency of new construction may decrease water usage per square foot as required by the Executive Orders.

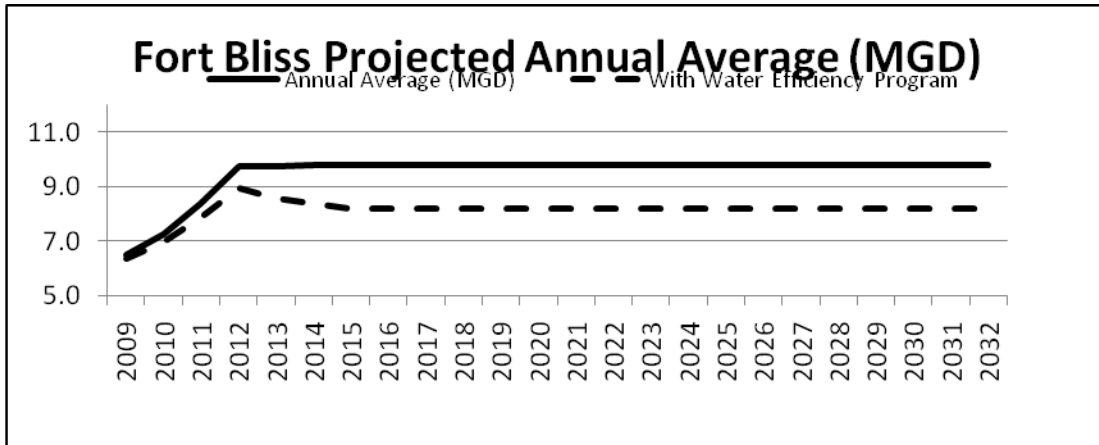


Figure C-2. Projected Fort Bliss water consumption.

Conclusion

The Water Projection model provides a rough estimate of future water consumption based on current trends, future construction and stationing, and irrigation requirements. The model is installation specific, and the baseline can be calibrated to the installation. The model also provides guidance in disaggregating the installation's water consumption to several key using sectors. The sectors can provide insight into where to best focus water efficiency improvement efforts on the installation. Appendix D provides instructions on using the Installation Water Demand Tool.

APPENDIX D

Instructions on Using the Tool

The Installation Water Demand Tool is a Microsoft Office Excel® spreadsheet application that projects water demand for most U.S. Army installations up to 2032, based on data input by the user. The model uses a programming macro to sort the installation's Real Property data, and then uses that plus other data entered by the user to calculate water demand. In the first section of this appendix, the headings correspond to a worksheet in the Tool. The second section of the appendix contains numbered instructions on how to use the Tool.

"Instructions" Worksheet

The "Instructions" worksheet provides instructions for using the Installation Water Demand Tool. Do not attempt to use the demand model before reading these instructions. An extended version of the instructions, with screenshots, is also found in the next section.

"Projection Input" Worksheet

The "Projection Input" Worksheet (Figure D-1) is one of two main worksheets into which data is entered. Here, the user enters data specific to the installation, such as number of housing units, number of military personnel stationed, and the estimated water consumption in gallons per unit per day (gpud) for certain use sectors. The bright yellow cells require data input, while the bright green cells contain default values that may be changed if the user wishes. Other cells should not be altered. At the bottom of the worksheet is a place to enter up to three possible water rates in the form of X price per thousand gallons of water, so that estimated future water costs can be calculated.

"Water Proj Summary" Worksheet

The "Water Proj Summary" Worksheet (Figure D-2) displays the results of the projection model. It summarizes the data entered in the Projection Input worksheet, as well as shows values calculated from that data, such as the number of school-aged dependents.

	Baseline	2009	2010	2011	2012	2013	2014	2015	2016	2017
Barracks Units	18,284									
Housing Units	5,580	5,580	5,580	5,580	5,580	5,580	5,580	5,580	5,580	5,580
Military Stationed	47,435	49,161	51,522	51,103	51,168	51,315	51,315	51,315	51,315	51,315
Transient Population	2,451	2,434	2,432	2,351	2,321	2,321	2,321	2,321	2,321	2,321
Dependents	72,101	74,725	78,313	77,677	77,775	77,999	77,999	77,999	77,999	77,999
Civilian Workforce	16,290	16,804	17,830	19,817	19,929	19,891	19,889	19,889	19,889	19,889
Typical Military Family Size	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
Deployment Factor: Family Housing	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Deployment Factor: Barracks	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Industrial/Maintenance Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Storage Growth Factor	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
High Water Use Facilities Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Irrigated Land Factor	1.00	1.01	1.02	1.03	1.04	1.04	1.04	1.04	1.04	1.04
ET (Moisture Deficit)	16.66	16.66	16.66	16.66	16.66	16.66	16.66	16.66	16.66	16.66
Losses Factor	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10

	Baseline	2009	2010	2011	2012	2013	2014	2015	2016	2017
Consumption (gpcd)										
Family Housing	70	70	70	70	70	70	70	70	70	70
Barracks	70	70	70	70	70	70	70	70	70	70
Dependent Schools	15	15	15	15	15	15	15	15	15	15
Medical	1,236	1,236	1,236	1,236	1,236	1,236	1,236	1,236	1,236	1,236
Industrial/Maintenance	700	700	700	700	700	700	700	700	700	700
Lodging	150	150	150	150	150	150	150	150	150	150
Admin/Moderate Users	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204
Community and Commercial: Non-food related	629	629	629	629	629	629	629	629	629	629
Community and Commercial: Food-related	906	906	906	906	906	906	906	906	906	906

Figure D-1. "Projection Input" worksheet.

	Baseline	2009	2010	2011	2012	2013	2014	2015
Barracks Units	18,284	18,949	19,659	19,698	19,723	19,760	19,780	19,780
Housing Units	5,580	5,580	5,580	5,580	5,580	5,580	5,580	5,580
Military Stationed	47,435	49,161	51,522	51,103	51,168	51,315	51,315	51,315
Transient Population	2,451	2,434	2,432	2,351	2,321	2,321	2,321	2,321
Dependents	72,101	74,725	78,313	77,677	77,775	77,999	77,999	77,999
Civilian Workforce	16,290	16,804	17,830	19,817	19,929	19,891	19,889	19,889
Typical Military Family Size	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
Housing Population	23,250	23,250	23,250	23,250	23,250	23,250	23,250	23,250
Deployment Factor: Family Housing	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Deployment Factor: Barracks	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
School Aged Military Dependents	21,630	22,418	23,494	23,303	23,333	23,400	23,400	23,400
Dependent Schools Factor	1.00	1.04	1.09	1.08	1.08	1.08	1.08	1.08
Medical Factor	1.00	1.04	1.09	1.08	1.08	1.08	1.08	1.08
Industrial/Maintenance Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lodging Factor	1.00	1.04	1.09	1.08	1.08	1.08	1.08	1.08
Administration/Moderate Factor	1.00	1.04	1.09	1.11	1.12	1.12	1.12	1.12
Community Growth Factor	1.00	1.04	1.09	1.09	1.10	1.10	1.10	1.10
Dining Food/Community Factor	1.00	1.04	1.09	1.09	1.10	1.10	1.10	1.10
Storage Growth Factor	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01
High Water Use Facilities Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Irrigated Land Factor	1.00	1.01	1.02	1.03	1.04	1.04	1.04	1.04
ET (Moisture Deficit)	16.66	16.66	16.66	16.66	16.66	16.66	16.66	16.66
Losses Factor	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10

	Baseline	2009	2010	2011	2012	2013	2014	2015
Usage (MGD)								
Family Housing	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37
Barracks	0.86	0.89	0.93	0.92	0.93	0.93	0.93	0.93

Figure D-2. "Water Proj Summary" worksheet.

The bottom part of the worksheet shows water demand projections calculated out to 2032, in both table and chart form (Figure D-3). There are two projections shown:

1. The baseline annual average in MGD, which assumes that unit water consumption rates (in gpu) will remain constant into the future
2. The water-efficient annual average in MGD, which assumes a 2 percent annual decrease in consumption beginning in 2009 (in compliance with EO 13124).

"Cost Projection" Worksheet

The "Cost Projection" worksheet shows estimated water costs. In the "Projection Input" worksheet, the user is able to enter possible water rates. The water costs are calculated from the total projected water usage in MGD (in the Water Proj Summary worksheet) and the water rates entered in the Projection Input worksheet. Results are in terms of both water cost per day and water cost per year. A chart at the bottom of the worksheet is helpful for comparing costs between the baseline and water efficiency results.

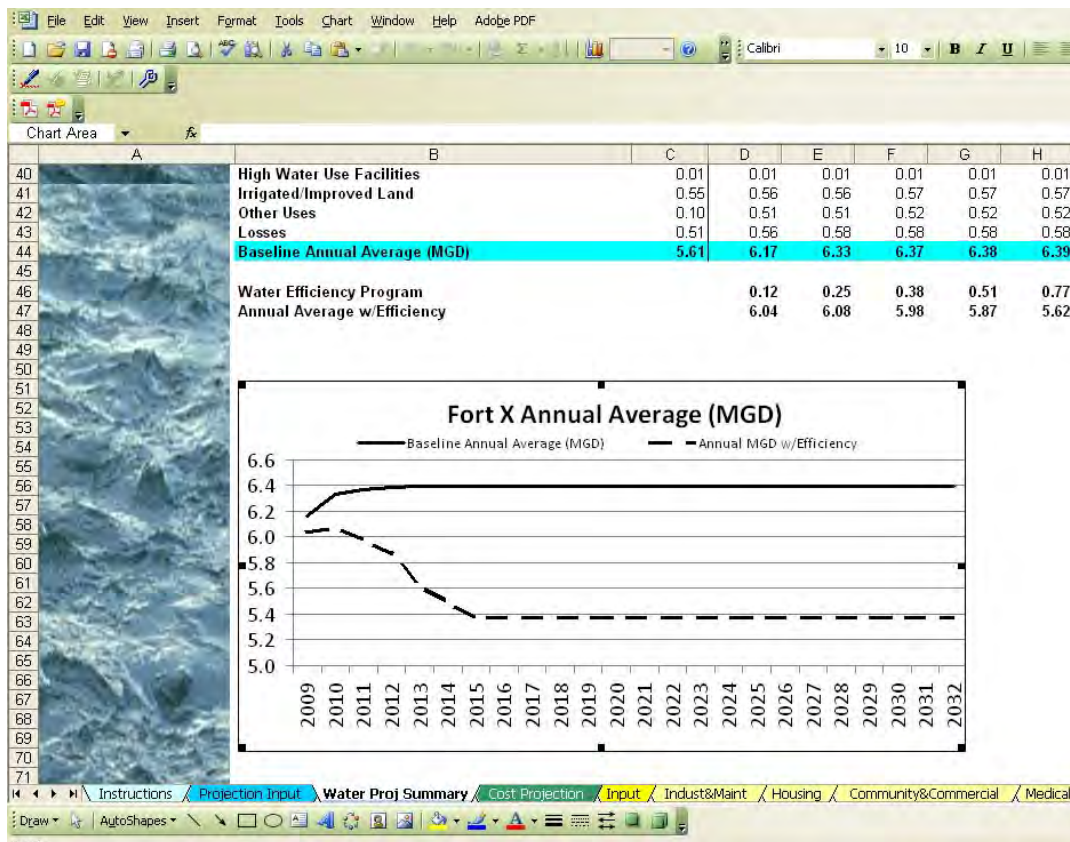


Figure D-3. "Water Proj Summary" chart.

"Input" Worksheet

In the "Input" worksheet, the user enters the real property data for the installation. The worksheet is set up so that only the category code, primary and secondary quantities, and total number of that particular category code need to be entered. The other columns will automatically fill. (The worksheet is set up to search the full list of category codes, which can be found in the CatCodes worksheet, for the category code value input by the user.) A description of the various units of measurement (UM) is also found at the top of this worksheet.

"Indust&Maint" Worksheet

Once the macro is run, this worksheet displays the industrial and maintenance buildings and structures at the installation.

"Housing" Worksheet

Once the macro is run, this worksheet displays the housing buildings at the installation. There are three subcategories: family housing, transient housing/lodging, and barracks. Each of these subcategories has a different water consumption rate, so it is necessary to separate them.

"Community&Commercial" Worksheet

Once the macro is run, this worksheet displays the community and commercial buildings and structures at the installation. There are three subcategories: non-food related indoor, non-food related outdoor, and food-related. Non-food related outdoor buildings and structures generally do not use water, and are not factored into the water demand projections. They are included for informational purposes.

"Medical" Worksheet

Once the macro is run, this worksheet displays the medical buildings at the installation. The yellow cells at the bottom need to be filled in with specific values. See the instructions for more details.

"Admin&Opns" Worksheet

Once the macro is run, this worksheet displays the administration and operations buildings and structures at the installation.

"Trng&Schools" Worksheet

Once the macro is run, this worksheet displays the training and school buildings and structures at the installation. There are two subcategories: dependent schools, and other training and schools.

"Special Category" Worksheet

Once the macro is run, this worksheet displays the "special category" buildings and structures at the installation, which are singled out for their water usage. There are three subcategories: high water use facilities, irrigated/improved land, and other land.

"CatCodes" Worksheet

This worksheet displays the full list of all U.S. Army facility category codes, their primary and secondary quantity units* of measurement (UM), and the short and long code descriptions. It is included for informational purposes.

Instructions on Using the Installation Water Demand Tool

Note: DO NOT change the name of the original document or resave it in .xlsx format. The name of the document, including the file extension, must remain the same until you have completed step three in order for the macro to work properly.

Tips:

- Do not enter any data until you have read the instructions.
- Make sure macros are enabled. If you did not enable the macros when you opened the document, close the document and open it again, this time enabling macros.
- Do not rearrange the order of the worksheets or add new ones. Also do not insert new rows or columns anywhere in this workbook. These actions may cause the macros to malfunction.

* A note about units: On some of the building/structure worksheets (Indust&Maint, Housing, etc.), the secondary quantities are summed at the bottom, while others are not. This is because the secondary quantity units are not always able to be added. Always check to make sure these can be added before doing so. For example, "spaces" and "persons" (as found in the Housing worksheet) may be added, but "vehicles" and "seats" (as found in the Community&Commercial tab) cannot. See the UM description at the top of the Input worksheet to determine whether two different UMs may be added.

- Data may be entered only into cells that are bright yellow or bright green, found only in the Projection Input, Input, and Medical worksheets.

Go to the "Projection Input" worksheet (Figure D-4). Enter the category codes for all uses on the installation, as well as the primary and secondary quantities, and the total number of buildings or structures in each category code. **Only** the bright yellow columns should be filled. If you are copying and pasting from another spreadsheet, make sure that you right click and select "Paste Special" and then select "Values" so that you are pasting the values only. Ensure that any pasted data is formatted as a number. To format data in Excel 2007, select "Home" and then select "Format" in the "Cells" section.

1. Go to the Indust&Maint tab and select cell B4.
2. Next, run all macros. If you are using Excel 2003, go to "Tools", "Macro", and click on "Macros". If you are using Excel 2007, go to "View" and click on the "Macros" icon. When the macro window opens (Figure D-5), select "RunAll" and click "Run". The macro will sort the information you entered in Step 1, and each of the light yellow tabs will now display their respective buildings and structures (Figure D-6).

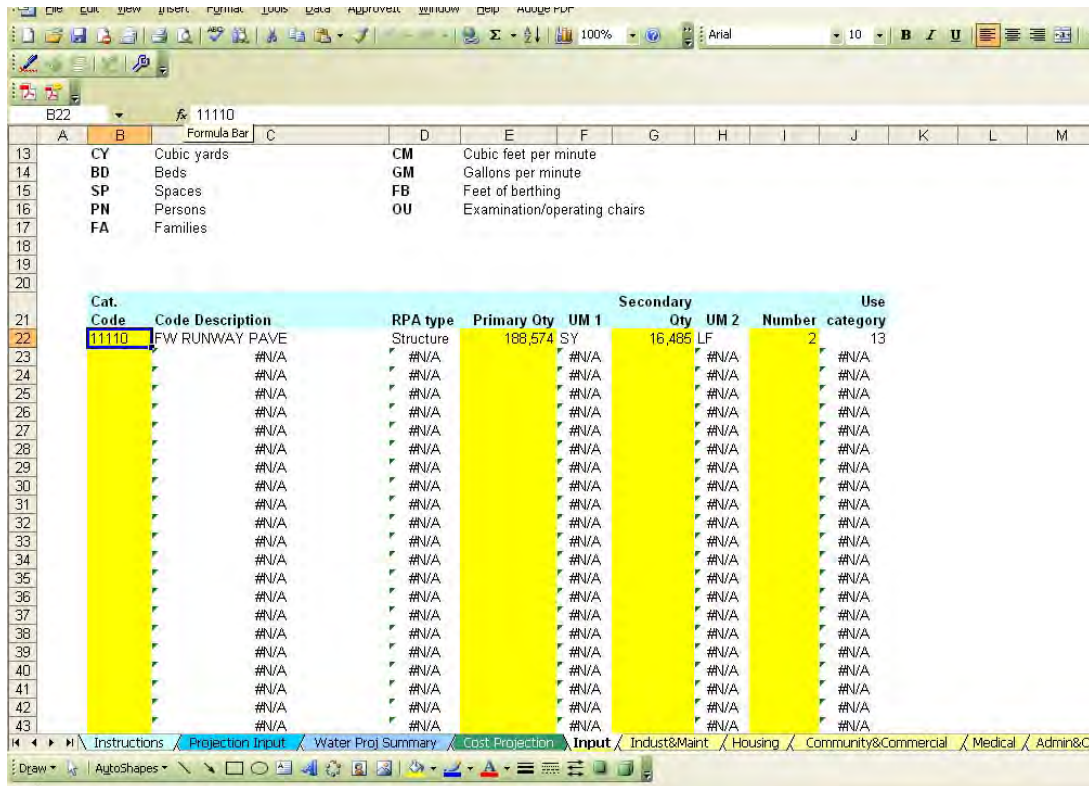


Figure D-4. "Projection Input" Worksheet.

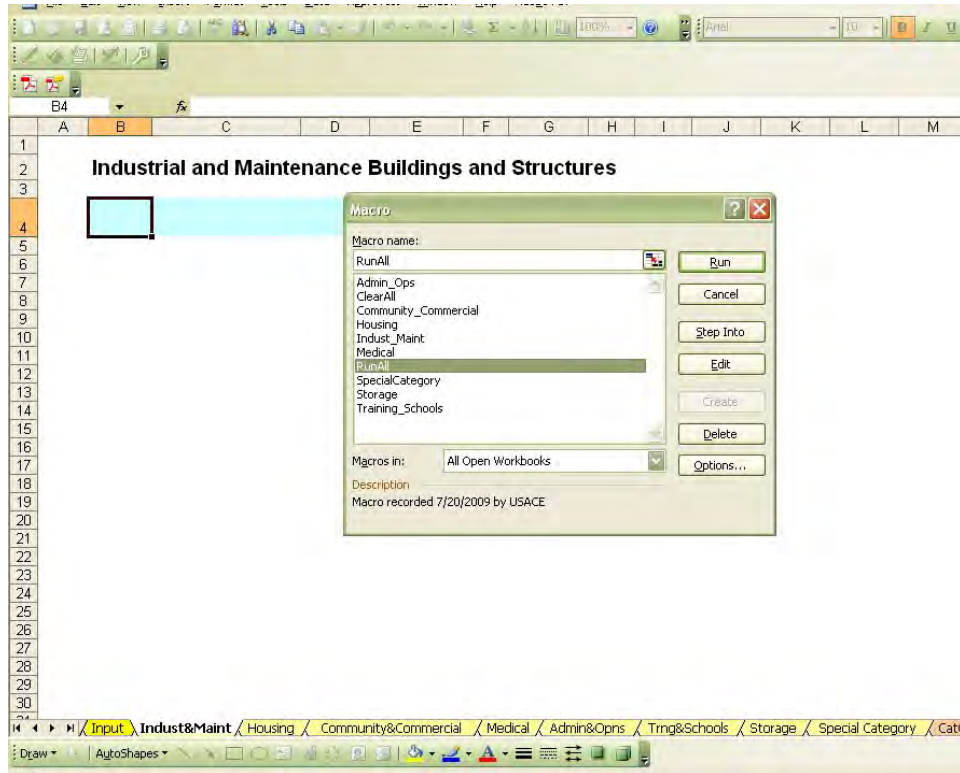


Figure D-5. "RunAll" macro window.

Cat. Code	Code Description	RPA type	Primary Qty	UM 1	Secondary		Use category
					Qty	UM 2	
21110	AC MAINT HGR	Building	544,305	SF	0	None	13
21117	AVION MNT SHP I	Building	7,181	SF	0	None	5
21130	AC PAINT SHOP	Building	17,237	SF	0	None	1
21141	AC ENG TST STRU	Structure	12,000	SF	1	EA	1
21330	SHIP REP SHOP	Building	7,066	SF	0	None	1
21408	COMPT CLNG FAC	Building	3,942	SF	0	None	4
21409	USAR VEH MAINT	Building	7,928	SF	0	None	1
21410	VEH MAINT SHOP	Building	1,315,141	SF	1,284	VE	129
21411	REPAIR BAYS	Building	4,000	SF	4	VE	1
21413	ADMIN/SHOP CONT	Building	11,964	SF	0	None	7
21414	GEN ITEM REPAIR	Building	1,780	SF	0	None	1
21415	COMP ITEM REP	Building	5,600	SF	0	None	2
21416	MSL MAINT FAC	Building	8,000	SF	0	None	2
21419	CSMS/MATES	Building	61,016	SF	0	None	2
21470	OIL STR BLDG	Building	10,352	SF	0	None	33
21670	AMMO REPAIR, IN	Building	86,966	SF	0	None	2
21712	C-E QA/CAL DEP	Building	3,173	SF	0	None	1
21840	RR EQ/EN MAINT	Building	4,000	SF	0	None	1
21850	BATTERY SHOP	Building	7,964	SF	0	None	5
21865	OIL STR BLD DOL	Building	540	SF	0	None	1
21870	MNT STORAGE DOL	Building	13,760	SF	0	None	4
21872	QA/CAL GEN PURP	Building	13,434	SF	0	None	2
21881	ABN EQ/PARA REP	Building	522,800	SF	0	None	16
21882	GEN ITM REP DOL	Building	99,466	SF	0	None	3
21885	MNT GEN PURPOSE	Building	278,555	SF	0	None	14
21887	COM ITM REP DOL	Building	5,000	SF	0	None	3

Figure D-6. "RunAll" macro output, "Indust&Maint" worksheet.

3. If the macro returns an error message, take the following steps. Otherwise, skip to Step 4. Go to the Special Category tab and select cell B4. Open the macro window and select "ClearAll" (Figure D-7) and click "Run." The macro will clear all data from the light yellow tabs (Figure D-8). Repeat Step 3.

If the macro still returns an error message, you may sort the data tab-by-tab by doing the following:

- a. Go to the "Special Category" tab and select cell B4 and run the "ClearAll" macro again.
- b. Go to the "Indust&Maint" tab and select cell B4.
- c. Open the macro window and select "Indust_Maint" and click Run.
- d. Repeat this step for all light yellow tabs, selecting cell B4 and running the macro with the corresponding name for each one.

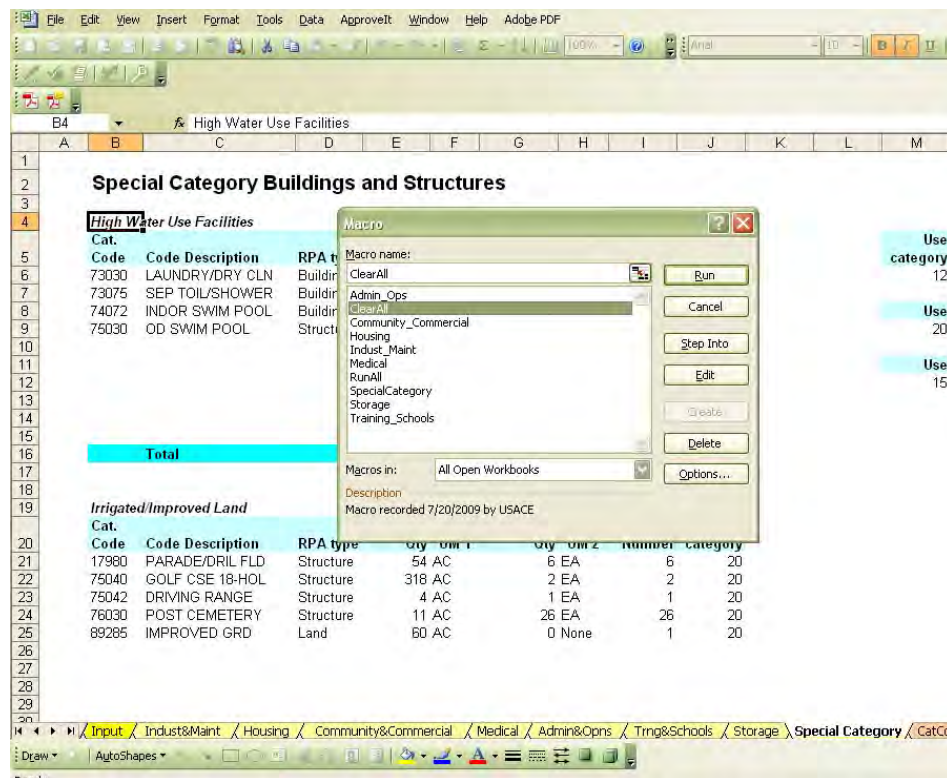


Figure D-7. "ClearAll" macro window.

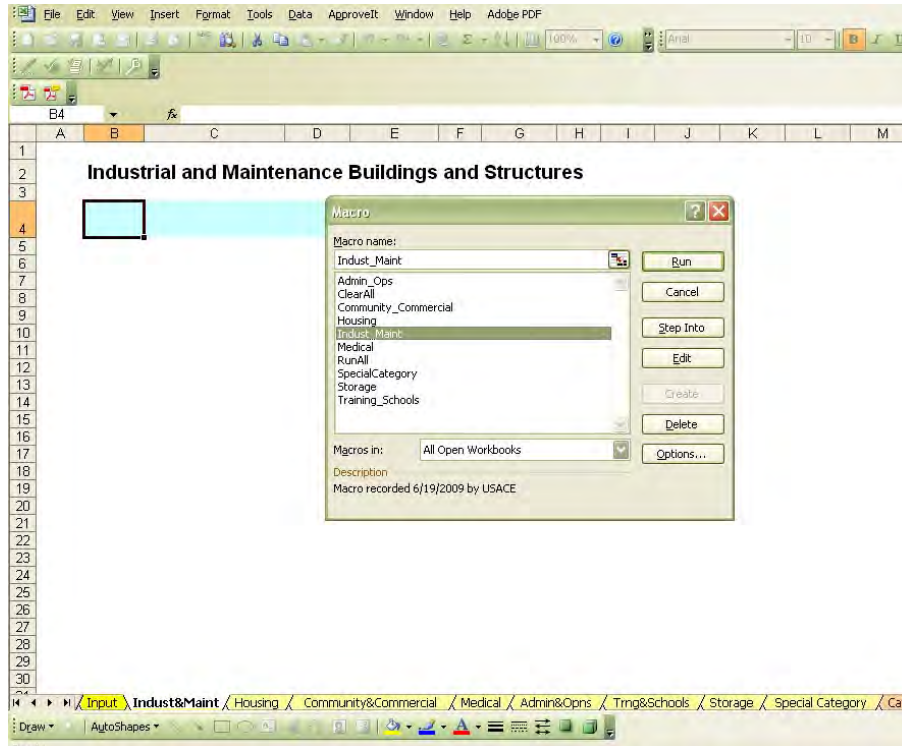


Figure D-8. "Indust&Maint" worksheet after running the "ClearAll" macro

4. Note: at this point, you may resave or change the name of the document.

Go to the "Medical" tab. Since the medical center is so much larger than the rest of the medical buildings, you will need to do a few calculations (Figures D-9 and D-10). Cell E18 is equal to the total square footage of the health clinics (category code 55010, column E) divided by the number of health clinics (column I).

Cell E19 is equal to the total square footage of the medical center (category code 51010, column E) divided by the value in cell E18.

Cell E20 is equal to the sum of all the buildings (cell I15) minus the number of medical centers (in this case, cell I5). Cell E21 is equal to cell E19 plus cell E20.

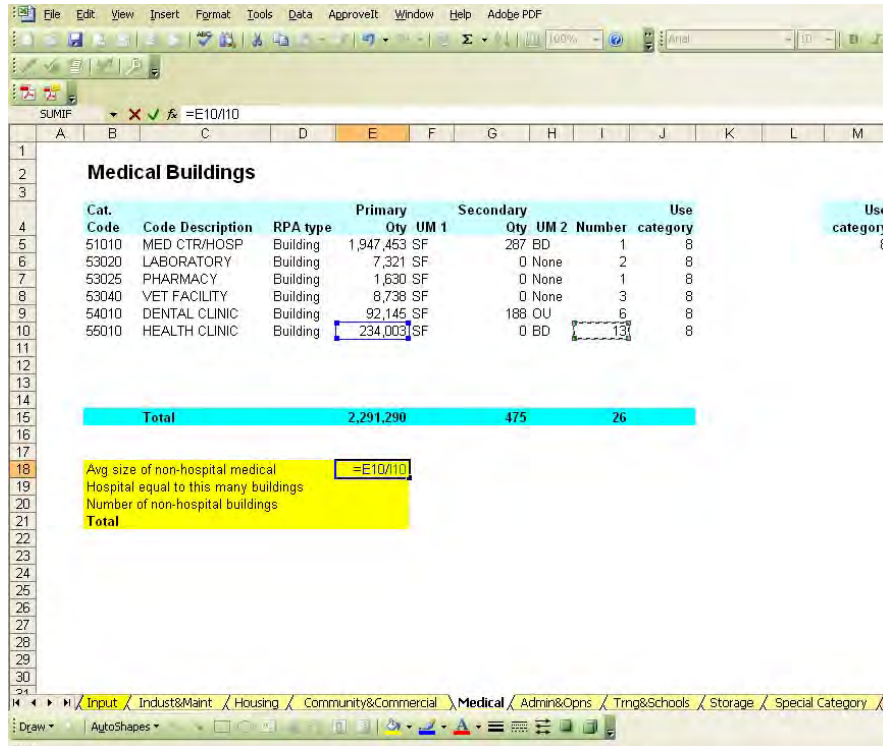


Figure D-9. "Medical" worksheet calculations.

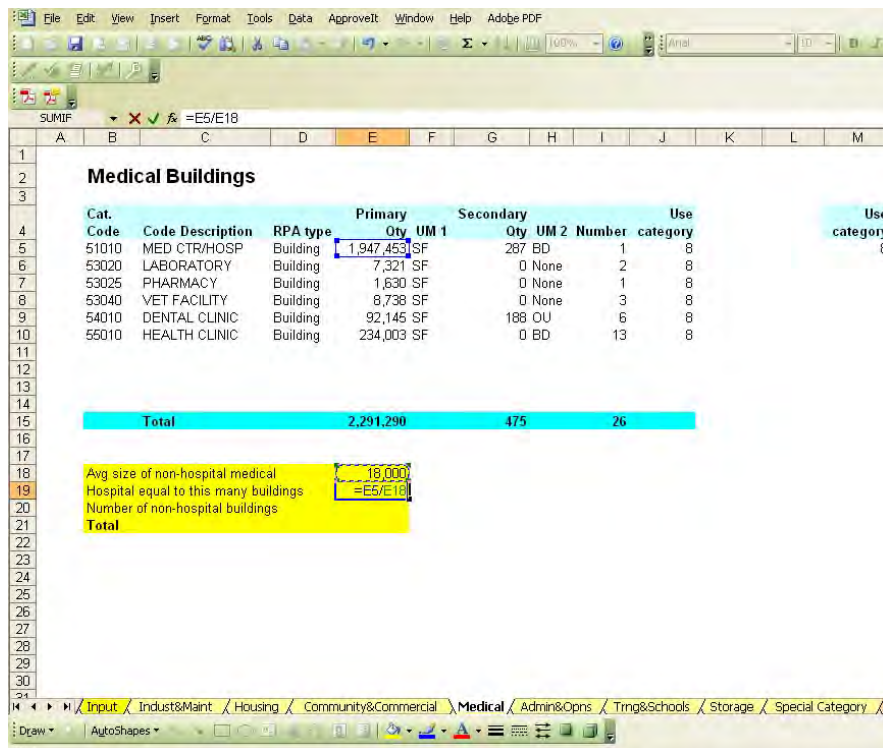


Figure D-10. "Medical" worksheet calculations (cont'd).

5. In the "Projection Input" tab (Figure D-11), enter the appropriate data into all of the bright yellow cells in Rows 5-10, 12-19, 23-25, and 33. Only bright yellow cells should be filled. White cells do not require any data input. For example, the typical military family size in row 11 is calculated from other values. If you do not have data beyond a specific year, you may drag the value for the last year for which you do have data over to the rest of the years. Use your best judgment. For example, if you know there will be an increase in the number of soldiers at your installation in 2011, you should enter data to reflect that increase.

The data in rows 5-10 and 12-19 will likely be given by the installation. The water consumption data in rows 23-25 and 33 are derived from the regional water consumption data.

Once this step is completed, a summary of water use is available under the "Water Projection Summary" tab.

	Baseline	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Barracks Units	18,284										
Housing Units	5,580	5,580	5,580	5,580	5,580	5,580	5,580	5,580	5,580	5,580	5,580
Military Stationed	47,435	49,161	51,522	51,103	51,168	51,315	51,315	51,315	51,315	51,315	51,315
Transient Population	2,451	2,434	2,432	2,351	2,321	2,321	2,321	2,321	2,321	2,321	2,321
Dependents	72,101	74,725	78,313	77,677	77,775	77,999	77,999	77,999	77,999	77,999	77,999
Civilian Workforce	16,290	16,804	17,890	19,817	19,929	19,891	19,889	19,889	19,889	19,889	19,889
Typical Military Family Size	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
Deployment Factor: Family Housing	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Deployment Factor: Barracks	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Industrial Maintenance Factor	1.00										
Storage Growth Factor											
High Water Use Facilities Factor											
Irrigated Land Factor											
ET (Moisture Deficit)											
Losses Factor											
Consumption (gpcd)	Baseline	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Family Housing											
Barracks											
Dependent Schools											
Medical	1,236	1,236	1,236	1,236	1,236	1,236	1,236	1,236	1,236	1,236	1,236
Industrial Maintenance	700	700	700	700	700	700	700	700	700	700	700
Lodging	150	150	150	150	150	150	150	150	150	150	150
Admin/Moderate Users	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204
Community and Commercial: Non-food related	629	629	629	629	629	629	629	629	629	629	629
Community and Commercial: Food-related	906	906	906	906	906	906	906	906	906	906	906

Figure D-11. "Projection Input" data entry.

6. In the bright yellow cells at the bottom of the page (rows 40-42, Figure D-12), under "Costs," enter data for cost projections. Data will likely be in the form of a certain price per thousand gallons of water. You may enter a

description of the pricing in the first column (e.g., Price A, 2011 Price, etc.).

Once the cost information is entered, a cost summary is available under the "Cost Projection" tab.

- Note that, in the "Projection Input" tab, you may alter the default values in the bright green cells if you wish, but these values are widely accepted as the standard (as published in the Jennings and Jones 2008 American Water Works Association (AWWA) book).

	A	B	C	D	E	F	G	H	I	J	K	L	M
25		Dependent Schools	15	15	15	15	15	15	15	15	15	15	15
26		Medical	1,236	1,236	1,236	1,236	1,236	1,236	1,236	1,236	1,236	1,236	1,236
27		Industrial/Maintenance	700	700	700	700	700	700	700	700	700	700	700
28		Lodging	150	150	150	150	150	150	150	150	150	150	150
29		Admin/Moderate Users	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204	1,204
30		Community and Commercial: Non-food related	629	629	629	629	629	629	629	629	629	629	629
31		Community and Commercial: Food-related	906	906	906	906	906	906	906	906	906	906	906
32		Storage	10	10	10	10	10	10	10	10	10	10	10
33		High Water Use Facilities	200	200	200	200	200	200	200	200	200	200	200
34													
35		gpad=gallons per unit per day											
36													
37													
38													
39		Costs											
40		Description	Scenario	Rate	#	UM							
41		Current price	1	\$1.00	per	1,000 gal							
42		Price A	2	\$1.25	per	1,000 gal							
43		Price B	3	\$1.11	per	1,000 gal							
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Figure D-12. "Projection Input" water cost data entry.

Appendix E
Acronyms and Abbreviations

Term	Spellout
ACSIM	Assistant Chief of Staff for Installation Management
AEWRS	Army Energy and Water Reporting System
APA	American Planning Association
AWWA	American Water Works Association
BLS	Bureau of Labor Statistics
BRAC	Base Realignment and Closure
BMP	best management practice
CASI	Center for the Advancement of Sustainability Innovations
CERL	Construction Engineering Research Laboratory
DA	Department of the Army
DC	District of Columbia
DOD	U.S. Department of Defense
EA	exit air
EIA	Energy Information Administration
EIS	Environmental Impact Statement
EISA	U.S. Energy Independence and Security Act of 2007
EO	Executive Order
EPA	Environmental Protection Agency
ERDC	Engineer Research and Development Center
ESA	U.S. Endangered Species Act
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FORSCOM	U.S. Army Forces Command
FRA	Federal Railroad Administration
FY	fiscal year
GIS	geographic information system
HHS	U.S. Department of Health and Human Services
HQ	headquarters
HQUSACE	Headquarters, U.S. Army Corps of Engineers
HUC	hydrologic unit code
IMCOM	Installation Management Command
IRRIS	Intelligent Road/Rail Information Server
JAWRA	Journal of American Water Resources Association
JLUS	Joint Land Use Study
MGD	million gal/day
MSA	Metropolitan Statistical Areas
MTR	Military Training Routes
NACJD	National Archive of Criminal Justice Data
NEPA	National Environmental Policy Act
NERC	North American Electricity Reliability Council
NLCD	National Land Cover Data
NOAA	National Oceanic and Atmospheric Administration
NREL	National Renewable Energy Laboratory
NW	Northwest (NW)
NWS	National Weather Service
OSD	Office of the Secretary of Defense

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Term	Spellout
PDF	Portable Document Format
PHIND	Public Health Indicators and National Data
POC	point of contact
PWTB	Public Works Technical Bulletin
RDT&E	Research, Development, Test and Evaluation
REIS	U.S. Department of Commerce, Bureau of Economic Analysis
SERDP	Strategic Environmental Research and Development Program
SIRRA	Sustainable Installations Regional Resource Assessment
SUA	Special Use Airspace
SWWRP	System-Wide Water Resources Program
TAF	Terminal Aerodrome Forecasts
TES	threatened and endangered species
TR	Technical Report
TTI	Travel Time Index
UM	units of measurement
UPH	Unaccompanied Personnel Housing
URL	Universal Resource Locator
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USGS	U.S. Geological Survey
WGS	World Geodetic System (WGS)
WWW	World Wide Web

**Appendix F:
Related Publications**

Jenicek, Elisabeth M., Natalie R.D. Myers, Donald F. Fournier, Kevin Miller, MeLena Hessel, Rebecca Carroll, and Ryan Holmes. 2009. *Army Installations Water Sustainability Assessment: An Evaluation of Vulnerability to Water Supply*, U.S. Army Corps of Engineers, Construction Engineering Research Laboratory. ERDC/CERL TR-09-38. September 2009.

Jenicek, Elisabeth M., Donald F. Fournier, Natalie R. Downs, and Brad Boesdorfer. 2005. *Watershed application of the sustainable installations regional resource assessment tool*, U.S. Army Corps of Engineers, Construction Engineering Research Laboratory. ERDC/CERL TR-05-24. September 2005. Available at:
http://www.cecer.army.mil/techreports/Jenicek_SIRRA_Watershed_TR/Jenicek_SIRRA_Watershed_TR.pdf

Jennings, R., and C. Jones. 2008. Forecasting urban water demand. Denver, Colorado: American Water Works Association (AWWA).

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