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Army Industrial, Landscaping, and Agricultural Water Use

September 2014

KL McMordie Stoughton BK Boyd
SA Loper

Prepared for the **Deputy Assistant of the Army for Energy and Sustainability** under a Government Order with the U.S. Department of Energy (Contract DE-AC05-76RL01830, Related Services)

U.S. DEPARTMENT OF ENERGY

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14. ABSTRACT

The Pacific Northwest National Laboratory conducted a project for the Office of the Assistant Secretary of the Army to quantify the Army's ILA water use and to help improve the data quality and installation water reporting in AEWRS. Based on the research and data analysis, PNNL quantified the Army's FY 2013 ILA water use baseline, which totaled 5,657 million gallons (Mgal). Of this total, 4,543 Mgal were consumed in industrial applications, 1,106 Mgal in landscaping applications, and 8 Mgal in agricultural applications.

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Executive Summary

Executive Order (EO) 13514 introduced a new water reduction requirement for industrial, landscaping, and agricultural (ILA) water use. Specifically, federal agencies are required to reduce ILA water consumption 2% annually, or 20% by the end of fiscal year (FY) 2020, relative to an FY 2010 baseline. In addition, federal agencies are required to track ILA water consumption and report use annually. To meet the reporting requirements of EO 13514, the Army instituted a data collection process in the Army Energy and Water Reporting System (AEWRS). AEWRS is a database that the Army uses for all energy- and water-related data tracking and reporting. Installations are required to enter water data into AEWRS quarterly for potable and ILA water. The Army has defined ILA water as non-potable water collected on-site from freshwater sources (i.e., surface and groundwater sources) and all purchased non-potable water. AEWRS provides instructions and definitions for these water categories. However, few Army installations have been consistently and accurately entering ILA data into AEWRS. Therefore, the Army currently does not have a reliable ILA water use baseline or subsequent annual ILA data.

The Pacific Northwest National Laboratory (PNNL) conducted a project for the Office of the Deputy Assistant Secretary of the Army to quantify the Army's ILA water use and to help improve the data quality and installation water reporting in AEWRS. The project's scope included Army installations located in the United States and Puerto Rico, but did not include overseas installations.

PNNL performed the following tasks as part of this project:

- Disseminated a survey to Army installations that collected qualitative information on installation water sources and uses
- Interviewed personnel from an installation's Directorate of Public Works to collect additional data on installation ILA water use and verify ILA using installations
- Collected FY 2013 ILA water data from ILA users
- Conducted five site visits of Army installations that use ILA water: Fort Stewart, GA; Hunter Army Air Field, GA; Fort Jackson, SC; Fort Gordon, GA; and Holston Army Ammunition Plant (AAP), NC
- Assisted Army ILA users with AEWRS reporting, including conducting a webinar and site-specific instruction and recommendations for further enhancing AEWRS reporting
- Developed an Excel-based tool that installations can use to estimate unmetered landscape irrigation water use
- Developed a metric for installations to estimate annual cattle water consumption
- Quantified the Army's FY 2013 ILA water use

Based on the research and data analysis, PNNL quantified the Army's FY 2013 ILA water use baseline, which totaled 5,657 million gallons (Mgal). Of this total, 4,543 Mgal were consumed in industrial applications, 1,106 Mgal in landscaping applications, and 8 Mgal in agricultural applications. In FY 2013, the Army reported 34,018 Mgal of potable water use in AEWRS. The FY 2013 ILA water use represents approximately 14% of the total direct Army water use (Figure ES.1).

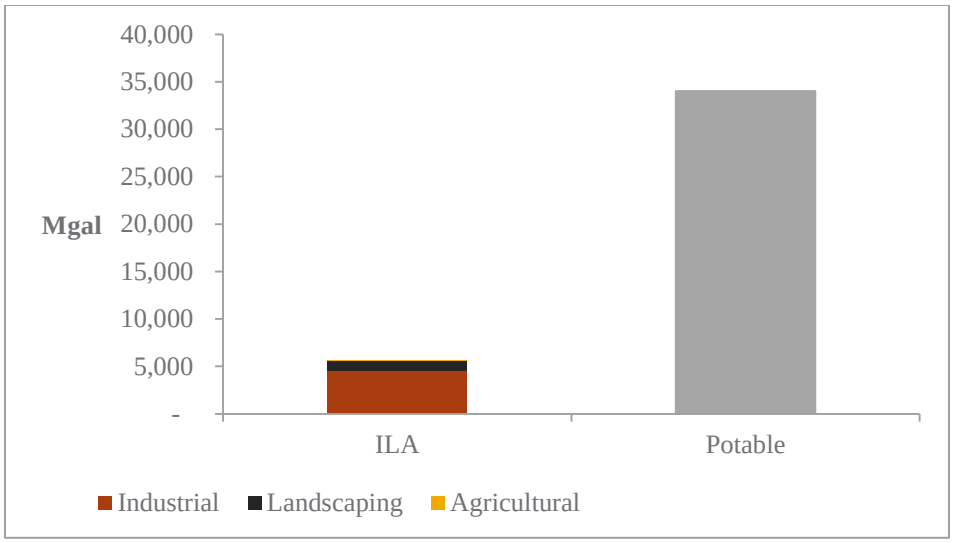

Figure ES.1. FY 2013 Army Potable and ILA Water Use

The Army Materiel Command (AMC) is the largest ILA user of all Army commands, consuming 4,286 Mgal in FY 2013. Radford AAP of AMC is the largest single ILA user, consuming 2,953 Mgal of industrial water in FY 2013, primarily in manufacturing processes. Holston AAP is the second largest AMC ILA user, consuming 1,325 Mgal of industrial water in FY 2013. These two sites combined represent 76% of the Army's ILA water use. Installation Management Command (IMCOM) is the second largest ILA-using command, consuming 1,355 Mgal in FY 2013, primarily in landscaping water use. AMC and IMCOM represent the vast majority of the total ILA water use, comprising over 99% of the total (Figure ES.2). Only one Army Reserve Command installation was identified as an ILA user, Fort Buchanan, PR, consuming 14 Mgal per year. Five Army National Guard (ARNG) sites were identified as ILA water users. However, ARNG provided little data on these sites and they are considered insignificant ILA users.

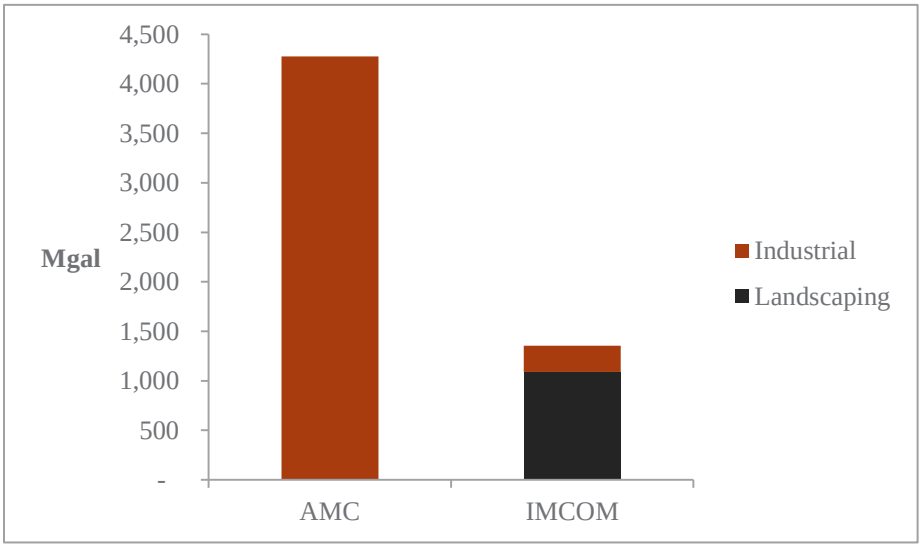

Figure ES.2. AMC and IMCOM FY 2013 ILA Water Use Breakout

As an outcome of this project, the following best practices are recommended so that the Army can more accurately track ILA water use and potentially reduce ILA water use:

- Redefine AEWRS water reporting categories in the user interface to better distinguish between the potable and ILA water categories
- Offer additional training to installations on AEWRS reporting
- Meter water uses at the application level, and when possible use advanced metering that has remote capability that uploads data automatically to a data management system
- For unmetered uses, disseminate standard methods to estimate unmetered water uses as presented in this document
- Focus effort on reducing water use at Radford AAP and Holston AAP by implementing water re-use and operational modifications in the industrial water-using processes
- Focus landscaping efficiency efforts on golf course irrigation at IMCOM installations; use advanced weather-based irrigation controls to increase system efficiency
- Annually, review AEWRS ILA water data to determine if the ILA water-using installations identified in this project are reporting ILA water data in AEWRS to ensure that ILA water use is complete and accurate

To meet the EO 13514 ILA water reduction goal, the Army is required to reduce ILA water consumption by 20% relative to the baseline. If the Army's ILA water baseline is set to the FY 2013 ILA water use of 5,657 Mgal, then the Army will need to achieve an annual ILA water use reduction of 162 Mgal through FY 2020, totaling 1,134 Mgal. The Army's target FY 2020 ILA water use is 4,523 Mgal. To track progress towards meeting this goal, it is recommended that the Army follow the best practices outlined above.

Acronyms and Abbreviations

AAP	Army Ammunition Plant
AEWRS	Army Energy and Water Reporting System
AKO	Army Knowledge Online
AMC	Army Materiel Command
AR	Army Reserve
ARNG	Army National Guard
CEQ	White House Council on Environmental Quality
CHPP	Combined heat and power plant
DPW	Directorate of Public Works
EO	Executive Order
ET	evapotranspiration
FY	fiscal year
ILA	industrial, landscaping, and agricultural
IMCOM	Installation Management Command
IWMI	International Water Management Institute
kgal	thousand gallons
Mgal	million gallons
OACSIM	Office of the Assistant Chief of Staff for Installation Management
ODASA	Office of the Deputy Assistant Secretary of the Army
OPORD	Operations Order
PNNL	Pacific Northwest National Laboratory
SCADA	supervisory control and data acquisition
WWTP	wastewater treatment plant

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1.0 Introduction

Pacific Northwest National Laboratory (PNNL) conducted a project for the Office of the Deputy Assistant Secretary of the Army (ODASA) to quantify the Army's industrial, landscaping, and agricultural (ILA) water use and to help improve data quality and installation water reporting. This report provides an overview of the work performed for this project with the quantified results.

1.1 Overview of EO 13514

Executive Order (EO) 13514, signed by President Obama in 2009, introduced a new water reduction requirement for ILA water use (NARA 2009). Specifically, federal agencies are required to reduce ILA water consumption 2% annually, or 20% by the end of fiscal year (FY) 2020, relative to a FY 2010 baseline.

The White House Council on Environmental Quality (CEQ) issued guidance on EO 13514, in 2013 (CEQ 2013). This guidance established guidelines for determining federal water uses, baseline development, reporting requirements, and strategies for implementing water efficiency. The guidance document defines ILA water as a distinct category from potable-water. Federal agencies are required to track ILA water use separately from potable water. For a specific water application to be considered ILA water, the guidance document specifies that these four criteria must be met:

- The water is used in ILA applications
- The water use is not currently tracked in the potable water baseline and subsequent annual water reports
- The water use occurs at a federal facility[1]
- The water use is not considered "*non-consumptive*"[2]

To meet the EO 13514 reporting requirements, the Army instituted a data collection process in the Army Energy and Water Reporting System (AEWRS). AEWRS is a database that the Army uses for all energy- and water-related data tracking and reporting. Installations are required to enter water data into AEWRS quarterly for potable, ILA water, and alternative non-potable water.

The Army has defined ILA water as non-potable water collected on-site from freshwater sources (i.e., surface and groundwater sources) and all purchased non-potable water, including purchased reclaimed wastewater. Alternative non-potable water is defined as untreated water generated on-site from supplies other than freshwater sources. Examples include reclaimed wastewater, water reused from other processes, and harvested rainwater. AEWRS provides instructions and definitions for these water categories. However, few Army installations have been consistently and accurately entering ILA data into AEWRS. Therefore, the Army currently lacks a reliable ILA water use baseline or subsequent annual ILA data.

[1] Federal facility is defined as any building, installation, structure, land, or other property owned or operated by, or constructed or manufactured and leased to, the federal government.

[2] Non-consumptive water use is defined as water that is diverted from its freshwater source and is returned to the point of diversion in the same quantity and quality as the original diversion (CEQ 2013).

1.2 Project Scope

The ODASA contracted with PNNL to quantify the Army's ILA water use and help improve data quality and installation water reporting. EO 13514 specifies FY 2010 as the baseline year for ILA water use. However, it was decided for this project that PNNL would quantify FY 2013 because it was the most recent annual data that would likely be more readily available from installations. The project's scope included Army installations located in the United States and Puerto Rico, but did not include overseas installations.

PNNL performed the following tasks as part of this project:

- Disseminated a survey to Army installations that collected qualitative information on installation-level water sources and uses
- Interviewed personnel from the installation's Directorate of Public Works (DPW) to collect additional data on installation ILA water use and verify ILA users
- Collected FY 2013 ILA water data from ILA users
- Conducted five site visits of Army installations that use ILA water
- Assisted Army ILA users on AEWRS reporting, including a webinar and site-specific instruction
- Developed an Excel-based tool that installations can use to estimate unmetered landscape irrigation
- Developed a metric for installations to estimate annual cattle water consumption
- Quantified the Army's FY 2013 ILA water use

This report summarizes the results of these projects and provides the estimated FY 2013 ILA water use for the Army.

2.0 Installation Data Collection

PNNL collected data on the Army's water use, which was used to determine Army installations' water supply and to quantify ILA water use. Data was gathered in a variety of ways:

- Initial data for the installations was downloaded from AEWRS for FY 2007 and FY 2010 through FY 2013.
- A survey was sent to all Army installations to ascertain water supply and use at the installations.
- Follow-up interviews were used to clarify and collect more detailed information.
- Site visits were conducted at five Army sites.

2.1 ILA Survey

A web-based survey was disseminated to Army commands, including the Army Materiel Command (AMC), the Army National Guard (ARNG), the Installation Management Command (IMCOM), and the Army Reserve (AR). The survey included qualitative questions related to water supply and use at Army

installations. The survey was intended to determine the Army's ILA water users who are installations that use non-potable freshwater produced on-site or purchased non-potable water, including purchased reclaimed water, in ILA water applications. The survey also determined whether installations meter or estimate water uses. Survey responses were gathered and summarized by PNNL. A complete copy of the survey can be found in Appendix A, section A.1.

The survey was sent to 154 installations. Off those, 136 submitted survey responses, for an 88% response rate. The preliminary results show that 92 installations only use potable water, 37 use non-potable freshwater in ILA uses, 2 purchase reclaimed non-potable water for ILA uses, and 13 produce alternative water (Table 2.1). PNNL subsequently collected additional data via phone calls and emails to verify this information and confirm the Army's installations that use ILA water. Follow-up information can be found in section 2.2 and the final results can be found in section 2.3.

Table 2.1. Preliminary Results from Survey

Command	Surveys Submitted	Total Number of Installations	Survey Response Rate	ILA Non-Potable Freshwater Users	ILA Purchased Reclaim Water Users	Alternative Water Users
AMC	22	22	100%	5	0	1
ARNG	45	57	79%	8	1	1
IMCOM	61	65	94%	22	1	11
AR	8	10	80%	2	0	0
Grand Total	136	154	88%	37	2	13

The data from the survey was compiled, analyzed, and compared to reported AEWRS data to determine if there were discrepancies between the installation's AEWRS data reporting and survey responses. PNNL conducted 55 interviews and emails with DPW personnel to clarify conflicting information and gather additional data on ILA water (Appendix A, section A.2). Information was clarified during the follow-up interviews, such as confirming ILA water sources and applications, metered and unmetered uses, data management methods, and AEWRS reporting (section 4.1).

2.2 ILA Water Users

The survey results and subsequent data collection determined that there are 37 Army installations that consume water in ILA applications. Of these, 12 are industrial users, 31 are landscaping users, and 3 are agricultural users. There are 9 installations that use ILA water in both industrial and landscaping applications. A total of 20 installations produce on-site non-potable water from groundwater, 16 produce on-site non-potable water from surface sources, and 2 purchase non-potable water (Table 2.2). There are 17 installations that meter ILA water supply, 6 estimate ILA water use, 10 have ILA applications that are not metered or estimated, and 8 did not provide information on how ILA water use is monitored (see section 5.0 for quantified results).

Table 2.2. ILA Water Users

Command	Installation Name	State	Industrial	Landscaping	Agricultural	Non-potable Water Source			Water Source Metered or Estimated?
						On-site Ground Water	On-site Surface Water	Purchased	
AMC	Blue Grass Army Depot	KY			Cattle		x		Estimated
AMC	Holston Army Ammunition Plant (AAP)	TN	Central plant, Manufacturing				x		Metered
AMC	Milan AAP	TN			Cattle	x			Estimated
AMC	Radford AAP	VA	Central plant, Manufacturing				x		Metered
ARNG	Michigan ARNG	MI	Central vehicle wash	Building landscape		x		x	Groundwater: none; Purchased: metered
ARNG	Montana ARNG	MT		Building landscape; Parade fields		x			None
ARNG	Nebraska ARNG	NE	Central vehicle wash	Building landscape		x			None
ARNG	Oregon ARNG	OR		Unknown					Unknown
ARNG	Virginia ARNG	VA	Central vehicle wash	Building landscape; Parade fields			x		None
IMCOM	Aberdeen PG	MD		Golf course		x			Metered
IMCOM	Carlisle Barracks	PA		Golf course		x			Metered
IMCOM	Fort Belvoir	VA		Golf course					Unknown
IMCOM	Fort Benning	GA		Building landscape; Golf course		x	x		None
IMCOM	Fort Bliss	NM		Golf course; Cemetery		x			Metered
IMCOM	Fort Bragg	CA		Golf course					Unknown
IMCOM	Fort Campbell	TN		Golf course			x		Metered
IMCOM	Fort Gordon	GA		Building landscape; Parade fields; Athletic fields, Golf course			x		Metered

Command	Installation Name	State	Industrial	Landscaping	Agricultural	Non-potable Water Source			Water Source Metered or Estimated?
						On-site Ground Water	On-site Surface Water	Purchased	
IMCOM	Fort Greely	AK	Dust suppression			x			Unknown
IMCOM	Fort Hood	TX		Golf course			x		Metered
IMCOM	Fort Irwin	CA	Central vehicle wash, Cooling tower	Building landscape; Parade fields; Athletic fields		x			Estimated
IMCOM	Fort Jackson	SC		Golf course			x		Estimated
IMCOM	Fort Knox	KY		Golf course		x			None
IMCOM	Fort Leavenworth	KS		Athletic fields; Golf course			x		Metered/ Estimated
IMCOM	Fort Lee	VA		Golf course		x			Metered
IMCOM	Fort Leonard Wood	MO		Golf course					Unknown
IMCOM	Fort Polk	LA		Golf course	Cattle	x	x		Unknown
IMCOM	Fort Rucker	AL		Golf course			x		Estimated
IMCOM	Fort Stewart	GA	Central plant, Central vehicle wash	Building landscape; Athletic fields; Golf course		x	x	x	Metered
IMCOM	Fort Wainwright	AK		Golf course		x			Unknown
IMCOM	Joint Base Lewis-McChord	WA	Hospital HVAC system	Golf course		x			Metered
IMCOM	Picatinny Arsenal	NJ	Central plant, Manufacturing	Golf course			x		Industrial: metered; Landscape: none
IMCOM	Redstone Arsenal	AL	Manufacturing, Cooling tower	Golf course		x	x		Industrial: metered; Landscaping: none
IMCOM	Rock Island Arsenal	IL		Golf course; Cemetery			x		None
IMCOM	USAG Detroit Arsenal	MI		Golf course					Unknown
IMCOM	West Point Military Reservation	NY		Golf course		x			Unknown

Command	Installation Name	State	Industrial	Landscaping	Agricultural	Non-potable Water Source			Water Source Metered or Estimated?
						On-site Ground Water	On-site Surface Water	Purchased	
IMCOM	Yuma Proving Ground	AZ	Dust suppression	Building landscape; Parade fields; Athletic fields		x			Metered
AR	Fort Buchanan	PR		Golf course		x			None

2.3 Alternative Non-potable Water Users

There are 11 Army installations that produce alternative non-potable water on-site and consume this water source in a variety of applications. About half of the installations do not meter this water source (Table 2.3). This use was not quantified because it was not part of the scope of work.

Table 2.3. Alternative Non-potable Water Users

Command	Installation Name	State	Use Type	Water Source	Water Source Metered?
AMC	Scranton AAP	PA	Cooling tower	Harvested rainwater	Yes
ARNG	Virginia ARNG	VA	Central vehicle wash facility; building landscape, parade fields, and athletic fields irrigation	On-site reclaimed wastewater	No
ARNG	Oregon ARNG	OR	Building landscape	On-site reclaimed wastewater	Yes
IMCOM	Fort Benning	GA	Building landscape	Harvested rainwater	No
IMCOM	Fort Carson	CO	Athletic fields, golf course, and park	On-site reclaimed wastewater	Yes
IMCOM	Fort Huachuca	AZ	Building landscape and golf course irrigation and aircraft wash	On-site reclaimed wastewater	No
IMCOM	Fort Irwin	CA	Building landscape, parade fields, athletic fields, and golf course	On-site reclaimed wastewater	Yes
IMCOM	Fort Sill	OK	Central plant	On-site reclaimed wastewater	Yes
IMCOM	USAG Hawaii	HI	WWTP reuse and irrigation used for agricultural lease	On-site reclaimed wastewater	No
IMCOM	USAG Miami	FL	Building landscape	Harvested rainwater	No

3.0 Site Visits

PNNL visited five Army installations to understand how they use and monitor ILA water. Four IMCOM sites were visited, focusing on landscaping water use, and one AMC site was visited, with a focus on industrial water use.

3.1 Landscaping Site Visits

PNNL conducted site visits in May 2014 at four installations with landscaping water use: Fort Stewart and Hunter Army Airfield in Savanah, GA, Fort Gordon in Augusta, GA, and Fort Jackson in Columbia, SC. PNNL selected these installations because of their close proximity, which allowed the team to tour multiple ILA water using installations in one week. PNNL toured landscaped areas that are supplied with on-site non-potable freshwater, from surface or groundwater sources, and purchased non-potable water.

3.1.1 Installation Overviews

3.1.1.1 Fort Stewart

Fort Stewart supplies non-potable water from groundwater wells to several landscaped areas, including athletic fields, hospital grounds, and a dog park. These wells are surficial, ~250 feet deep, and tend to have higher salts and irons, which is not typically used for potable water. Water from the Upper Floridian aquifer is used as potable water by Fort Stewart and is considered vulnerable because of the heavy regional demands from Florida, Georgia, and South Carolina. Therefore, Fort Stewart is using water from surficial wells for non-potable irrigation to offset withdrawals from the Upper Floridian aquifer.

Three locations are supplied with non-potable surficial well water. Fort Stewart monitors its surficial water use very closely because if total withdrawal exceeds 100,000 gallons per day, Fort Stewart is required to obtain a state permit. PNNL toured the following areas:

- Athletic fields: Three athletic fields are supplied by one surficial well and irrigation is controlled by a conventional timer-based controller.[1] No rain sensor was identified. The well is metered.
- Hospital grounds: The hospital grounds are irrigated by four surficial wells and controlled by a timer-based Hunter Pro-C irrigation controller. A rain sensor was found, but it was not activated at the time of the site visit. The system is monitored closely and turned off as needed. Each well is metered.
- Dog park: The dog park is irrigated by one surficial well and also controlled by a timer-based Hunter Pro-C irrigation controller. Irrigation is minimal due to a low lying area that tends to get muddy. A wireless rain gauge was identified, but it was not activated. The well is metered.

Fort Stewart's golf course is irrigated with non-potable water from an on-site pond. This pond receives supplemental reclaimed wastewater purchased from the City of Hinesville. The City of Hinesville built the infrastructure to deliver reclaimed water to Fort Stewart. The purchased reclaimed water also provides non-potable makeup water for the central plant's cooling towers and water for vehicle wash bays at the installation's motor pools which are considered industrial water uses. Even though the site visit was focused on landscaping water use, PNNL also toured these industrial water uses.

In addition to the three areas listed above, PNNL toured the following areas during the site visit:

- Golf course: The golf course is irrigated by an on-site stormwater pond that is supplemented by purchased reclaimed water. The irrigation is controlled by a Rainbird Nimbis irrigation controller. The golf course irrigation system has a rain gauge that it is not connected to the system, but is sometimes manually used by maintenance crew to monitor precipitation on the course. Water use is metered.
- Central plant: The central plant cooling tower is supplied with purchased reclaimed water for makeup. The system was installed in 2010, which is metered and is read by the City of Hinesville.
- Motor pool wash bays: Approximately eight motor pool wash bays use reclaimed water. Water use is metered.

[1] Timer-based controllers have a preset timed schedule that typically is set by individual zone and does account for actual environmental conditions.

Meters are manually read monthly and the results recorded in an Excel-based template that is used for AEWRS reporting.

3.1.1.2 Hunter Army Airfield

Hunter Army Airfield uses non-potable freshwater for landscape irrigation on the golf course via an on-site pond. The installation also has non-potable groundwater wells that are used to irrigate the cemetery and athletic field. Hunter Army Airfield's ILA water use is consolidated with the Fort Stewart data because Hunter Army Airfield is part of Fort Stewart.

PNNL toured the following locations at Hunter Army Airfield:

- Golf course: The golf course is irrigated by an on-site retention pond. The system is metered with a digital flow meter and the irrigation system is controlled with a conventional timer-based Rainbird Par-ES controller.
- Cemetery: The cemetery is irrigated by a surficial well, but appears to have little or no irrigation or maintenance. There is an irrigation clock and flow meter present.
- Athletic fields: The athletic fields are irrigated by a surficial well and are watered on a clock schedule and monitored with a flow meter.

Meters are manually read and the results recorded in an Excel-based template that is consolidated with the Fort Stewart data and reported in AEWRS.

3.1.1.3 Fort Gordon

Fort Gordon produces non-potable water for landscape irrigation from Butler Creek Reservoir, an on-site surface water source. The non-potable water plant was implemented in 2013 and is operated by Augusta Utilities. Currently, Fort Gordon supplies non-potable water to athletic fields and two parks. The installation plans to expand non-potable water use to additional landscaped areas. In addition, the Fort Gordon golf course irrigates with non-potable water from an on-site pond.

During the site visit, PNNL toured the golf course, water treatment plant, Butler Creek Reservoir, and various athletic fields and parks, all irrigated with non-potable water.

- Water treatment plant: The water treatment plant is operated by Augusta Utilities and provides non-potable water for landscape irrigation to athletic fields and two parks. This water use is metered and data is logged by a supervisory control and data acquisition (SCADA) system, which is managed by Augusta Utilities. Water data is sent to DPW monthly for AEWRS reporting.
- Golf course: The golf course has on-site ponds that are fed by a freshwater spring, Spirit Creek, and Mirror Lake. The pond level has decreased since the decommissioning of the on-site wastewater treatment plant for potable water use. Irrigation is controlled by a Toro network of 23 stations. Golf course personnel collects water use data monthly via their computerized irrigation control system and provides it to DPW for AEWRS reporting.
- Parks and athletic fields: Irrigation was evident around flower beds in the parks. However, there was no indication of irrigation in the park's grassy areas and athletic fields since they looked similar to non-irrigated areas.

3.1.1.4 Fort Jackson

Fort Jackson's golf course is irrigated with non-potable water from an on-site pond that is supplied with stormwater runoff and Upper Legion Lake. The golf course has a Toro irrigation controller that is a conventional timer-based system. Each irrigation sprinkler head is wired individually and can be controlled independently. Water use is not metered and instead estimated using run time of pumps multiplied by gallons per hour rating of each pump. This information is stored in an Excel spreadsheet and provided to DPW for AEWRS reporting.

3.1.2 Lessons Learned

The key lessons learned from the landscaping site visits include:

- DPW and grounds maintenance personnel at all four locations have exemplary management of water and landscaping grounds
- None of the sites use advanced weather-based controls
- Metering is critical for accurate water reporting

PNNL's interviews with DPW and ground maintenance personnel revealed that these installations are doing an excellent job properly managing irrigation. Grounds maintenance personnel at all four golf courses have multiple years of experience and specialized training. The personnel are very knowledgeable about system operation and maintenance which was evident during the tours. Irrigation schedules are closely monitored and manually adjusted to changes in the weather and season.

An interesting pattern observed by PNNL during the site visits was that not one location used advanced weather-based irrigation controls for the golf course or other landscaped areas. Weather-based irrigation controls use live weather data to calculate actual water requirements of the landscape and adjust the irrigation schedule accordingly. Several areas at Fort Stewart had rain gauges installed with a rain delay setting on the timer-based control, but the vast majority of these gauges were not enabled. In addition, Fort Gordon had an on-site weather station at the golf course, but it was not connected to the irrigation control system.

Although the grounds maintenance personnel closely monitored the weather and made appropriate adjustments to the irrigation schedule, PNNL found that typically there was only one person in charge of this process. There are likely times that the irrigation system is not shut down in case of a rain event or the irrigation time is not properly adjusted when the responsible person is out or busy. A weather-based system automatically suspends irrigation during rain events and uses pre-programmed algorithms to calculate the supplemental watering requirements based on real-time data. Weather-based control technology would likely significantly reduce water use. Several research studies show significant savings potential from proper use of advanced weather-based irrigation controllers, generally ranging between 20% and 40% reduction in irrigation (Dukes 2012). Significant savings potential is especially true in areas that receive intermittent rainfall during the irrigation season because irrigation events are suspended more often as a result of real-time precipitation data being used to determine irrigation requirements. The four sites that PNNL visited are prime candidates for advanced weather-based controls.

PNNL revealed an interesting finding as a result of the Fort Jackson site visit. Since Fort Jackson does not meter golf course irrigation, the head of grounds maintenance estimates water use based on pump flow rates and minutes of irrigation. This data was provided to PNNL in an Excel spreadsheet. The data indicates that Fort Jackson is significantly overestimating the minutes of runtime, leading to an overestimation of golf course irrigation. PNNL alerted Fort Jackson DPW personnel of this issue, but it is not clear if it has been resolved. Because this issue was not fully resolved during this project, Fort Jackson's golf course irrigation was estimated using a PNNL-derived irrigation model (sections 4.2 and 5.3).

3.2 Industrial Site Visit

3.2.1 Installation Overview

PNNL visited Holston AAP in July 2014. Holston AAP uses ILA water for industrial purposes in steam production and in manufacturing secondary detonation explosives. This non-potable water is pumped from the Holston River and filtered prior to being used in the steam plant or manufacturing processes. Holston AAP also uses a large volume of untreated river water for cooling in production processes. This cooling water is withdrawn from the Holston River, passes through the heat exchangers to remove heat from the processes, and is returned in the same quantity and quality directly back to the river. This cooling water is non-consumptive as defined by the CEQ guidance on EO 13514 (CEQ 2013) and therefore is not ILA water (section 1.1). All of the non-potable water uses at Holston AAP are metered and tracked monthly.

The PNNL site visit included interviews of site personnel as well as tours of the water intake, filter water plant, and central steam plant, and a step-by-step overview of the manufacturing process. Holston AAP meters the river water intake and tracks totals monthly. The total withdrawal in FY 2013 was 10,015 Mgal. Non-consumptive water use totaled 8,690 Mgal in FY 2013, representing 87% of the total water withdrawn. The remaining 1,325 Mgal is lightly treated at the site's filtration plant and is consumed in steam production and process water in the site's explosives manufacturing processes, which is the ILA water component for Holston AAP.

3.2.2 Lessons Learned

PNNL's interviews with Holston AAP personnel and observations during the site visit confirmed that the site accurately measures and tracks industrial water use. However, Holston AAP has been incorrectly reporting non-consumptive cooling water in the ILA water in AEWRS, resulting in a significant over-reporting. In FY 2013, Holston AAP reported ILA water use of 10,015 Mgal, of which 8,690 Mgal is attributed to water used for cooling and returned directly back to the Holston River. Holston AAP was advised to try to adjust the historical ILA water use value to 1,325 Mgal. This is the value that PNNL used in the FY 2013 baseline (section 4).

The majority of Holston AAP's process water is treated on-site at an industrial wastewater treatment plant (WWTP) before being discharged back into the Holston River. An opportunity for significant volumetric reductions in ILA water consumption would be to return discharge water from the industrial WWTP directly to the filtered water treatment facility for re-use in processes and/or steam production. In addition, a thorough evaluation of the steam production plant may reveal water efficiency opportunities

through purification processes, control parameters, or operational modifications that may allow the plant to run at higher cycles of concentration. The age and vintage of much of the infrastructure as well as the operating equipment indicates there are likely many opportunities for water efficiency projects[1].

4.0 ILA Water Use Baseline

The objective of this project was the quantification of the FY 2013 Army's ILA water use. An FY 2013 baseline was chosen because it was the most recent annual data that would likely be more readily available from installations. PNNL developed an ILA baseline by analyzing current installation data in AEWRS and data collected from installations as part of this project. This section of the document provides an overview of this process with the quantified results.

4.1 AEWRS Data

PNNL collected water use data from AEWRS using the Ad Hoc reporting tool. The Ad Hoc reporting tool provides data in all five water categories (potable, alternative non-potable, industrial non-potable, landscape non-potable, and agricultural non-potable) for FY 2010 to FY 2014. FY 2014 only includes the first three quarters (Figure 4.1).

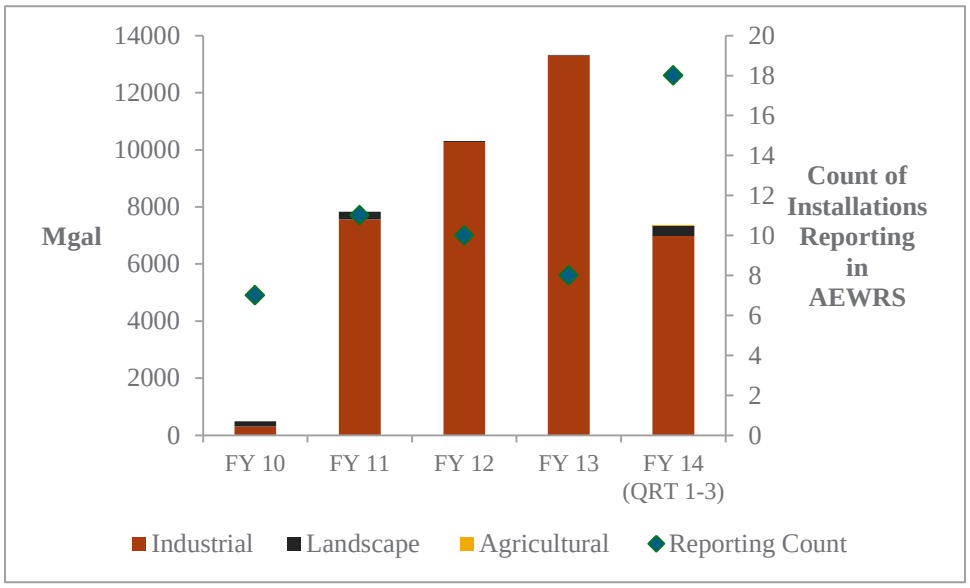

Figure 4.1. AEWRS ILA Water Reporting History

Careful review of the data along with follow-up interviews with installations revealed inconsistent or inaccurate AEWRS reporting. Some examples include:

- Six sites, Fort Greely, AK; Fort Irwin, CA; Redstone Arsenal, AL; Michigan ARNG, Nebraska ARNG, and Virginia ARNG, are currently not reporting industrial water use in AEWRS even though they confirmed this water use at their installation.

[1] Similar opportunities for water efficiency projects are potentially available at Radford AAP based on information and interviews provided to PNNL by the installation.

- Twenty-two sites with ILA landscaping water use are currently not reporting in AEWRS.
- Yuma Proving Ground entered potable water as industrial water use in FY 2013.
- Fort Carson entered potable water used in its central vehicle wash facility as industrial water use for the first quarter of FY 2014; the installation was alerted of the issue and has since corrected the problem.
- Blue Grass Army Depot, KY; Milan AAP, TN; and Fort Polk, LA, have agricultural water use and until FY 2014 none of these sites were entering this use into AEWRS. Blue Grass Army Depot and Milan AAP are now entering agricultural water use in AEWRS for FY 2014.

4.2 Installation ILA Water Use

In total, PNNL derived an Army consumption of 5,657 Mgal of ILA water in FY 2013. Of this total, 4,543 Mgal were consumed in industrial applications, 1,106 Mgal in landscaping applications, and 8 Mgal in agricultural applications (Table 4.1).

Installation level ILA water use was determined from several sources of data, including

- ***Installation metered data:*** Eight installations provided PNNL with FY 2013 metered data, typically in an Excel spreadsheet emailed to PNNL by the site POC.
- ***Installation estimated data:*** Fort Irwin provided an estimate of industrial and landscaping water use based on the approximate percentage the site's total water used for irrigation and for dust control and processing at the site's WWTP.
- ***IMCOM Golf Course Operations Order (OPORD):*** IMCOM disseminated an OPORD in 2012 to all IMCOM installations requesting data on golf course irrigation, including annual water use and supply source. PNNL used these data to approximate FY 2013 golf course irrigation for nine installations that are supplied with non-potable freshwater for golf course irrigation.
- ***PNNL model for landscape irrigation water use:*** Nine landscaping water using installations did not provide irrigation water use to PNNL or in the IMCOM OPORD. For these installations, a PNNL-developed modeling tool was used to estimate annual water use for these specific locations (section 5.3). Also, the tool was used to verify the relative accuracy of the installations that provided irrigation water use in the IMCOM OPORD.
- ***PNNL metric for agricultural water use:*** PNNL developed a metric to enable agricultural water users to estimate water consumed by cattle. Two sites provided PNNL with the number of cattle, which was used to derive the total FY 2013 annual water use (section 5.3).
- ***Annualized data from FY 2014 AEWRS reporting:*** PNNL used FY 2014 AEWRS data to approximate FY 2013 ILA water use for three installations—Oregon National Guard, Picatinny Arsenal, NJ; and Fort Buchanan, PR. These sites did not report AEWRS data in FY 2013 and did not provide PNNL with data in follow-up interviews, so it was assumed that FY 2014 closely approximated water use in FY 2013.

Five sites that did not provide data on ILA water use and did not report ILA water use in AEWRS: Michigan ARNG, Montanan ARNG, Nebraska ARNG, Virginia ARNG, and Fort Greely, AK. These sites likely have an insignificant effect on the overall FY 2013 ILA water use.

Table 4.1. FY 2013 Installation ILA Water Use (Mgal per year)

Command	Installation Name	Industrial	Landscaping	Agricultural	Total ILA Use	Reporting in FY14 AEWRS?	Data Source
AMC	Radford AAP	2,952.5	-	-	2,952.5	Yes	Installation metered data
AMC	Holston AAP	1,325.0	-	-	1,325.0	Yes	Installation metered data
AMC	Blue Grass Army Depot	-	-	7.0	7.0	Yes	PNNL agricultural metric
AMC	Milan AAP	-	-	1.0	1.0	Yes	PNNL agricultural metric
ARNG	Oregon ARNG	-	2.4	-	2.4	Yes	Annualized data from FY14 AEWRS data
ARNG	Michigan ARNG	-	-	-	-		No data available
ARNG	Montana ARNG	-	-	-	-		No data available
ARNG	Nebraska ARNG	-	-	-	-		No data available
ARNG	Virginia ARNG	-	-	-	-		No data available
IMCOM	Fort Bliss	-	225.7	-	225.7	Yes	Installation metered data
IMCOM	Fort Irwin	70.0	140.0	-	210.0		Installation estimated data
IMCOM	Yuma Proving Ground	39.2	100.9	-	140.1	Yes	Installation metered data
IMCOM	Picatinny Arsenal	127.2	9.4	-	136.6	Yes	Industrial: Annualized data from FY14 AEWRS data; Landscaping: IMCOM Golf Course OPORD
IMCOM	Joint Base Lewis-McChord	-	79.1	-	79.1		IMCOM Golf Course OPORD
IMCOM	Fort Hood	-	71.1	-	71.1	Yes	Installation metered data
IMCOM	Fort Jackson	-	54.9	-	54.9	Yes	PNNL irrigation model
IMCOM	Fort Stewart (includes Hunter Army Airfield)	29.1	22.5	-	51.6	Yes	Installation metered data
IMCOM	Fort Gordon	-	38.6	-	38.6	Yes	Installation metered data
IMCOM	Fort Belvoir	-	36.8	-	36.8		PNNL irrigation model
IMCOM	Fort Campbell	-	34.0	-	34.0	Yes	IMCOM Golf Course OPORD
IMCOM	Redstone Arsenal	-	32.0	-	32.0		PNNL irrigation model
IMCOM	Fort Benning	-	28.0	-	28.0		IMCOM Golf Course OPORD
IMCOM	Fort Leavenworth	-	25.0	-	25.0		Installation metered data
IMCOM	Fort Rucker	-	23.7	-	23.7		PNNL irrigation model
IMCOM	Fort Bragg	-	23.5	-	23.5		IMCOM Golf Course OPORD
IMCOM	Fort Leonard Wood	-	20.0	-	20.0		IMCOM Golf Course OPORD
IMCOM	Aberdeen Proving Ground	-	17.1	-	17.1		IMCOM Golf Course OPORD
IMCOM	Fort Knox	-	15.5	-	15.5		PNNL irrigation model
IMCOM	USAG Detroit Arsenal	-	15.1	-	15.1		PNNL irrigation model
IMCOM	Fort Lee	-	15.0	-	15.0		IMCOM Golf Course OPORD
IMCOM	Rock Island Arsenal	-	14.8	-	14.8		PNNL irrigation model

Command	Installation Name	Industrial	Landscaping	Agricultural	Total ILA Use	Reporting in FY14 AEWRS?	Data Source
IMCOM	Carlisle Barracks	-	14.1	-	14.1	Yes	PNNL irrigation model
IMCOM	Fort Wainwright	-	14.0	-	14.0		PNNL irrigation model
IMCOM	Fort Polk	-	10.0	-	10.0		IMCOM Golf Course OPORD
IMCOM	West Point	-	8.5	-	8.5		IMCOM Golf Course OPORD
IMCOM	Fort Greely	-	-	-	-		No data available
AR	Fort Buchanan	-	13.7	-	13.7	Yes	Annualized data from FY14 AEWRS data
Grand Total		4,543.0	1,105.5	8.0	5,656.5		

In FY 2013, the Army reported 34,018 Mgal of potable water use in AEWRS. The PNNL-derived FY 2013 ILA water use totals 5,657 Mgal, representing approximately 14% of the total Army direct water use (Figure 4.2).

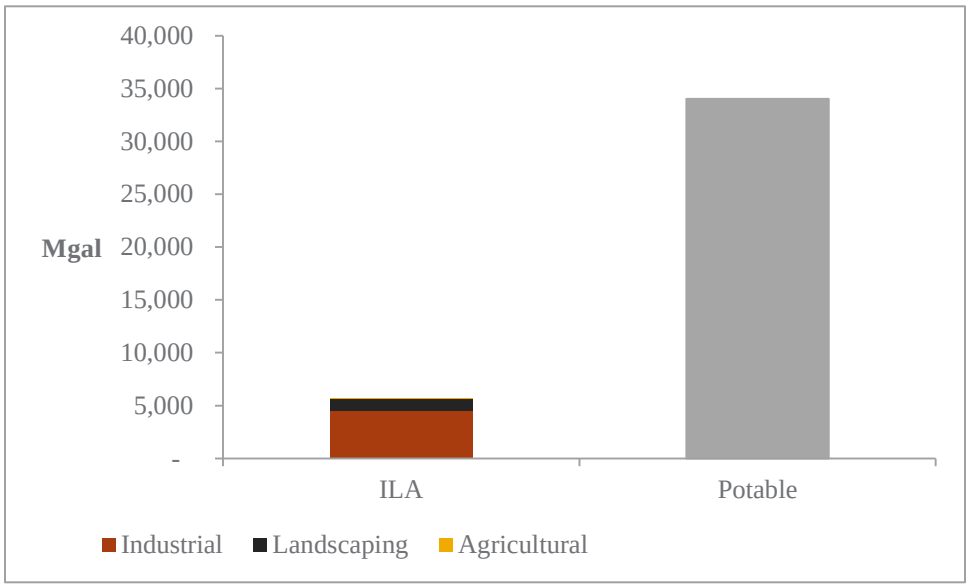

Figure 4.2. FY 2013 Army Potable and ILA Water Use

AMC is the largest ILA-using command, consuming 4,286 Mgal in FY 2013. Radford AAP in AMC is the largest ILA user, consuming 2,953 Mgal of industrial water in FY 2013, primarily in manufacturing processes. Holston AAP is the second largest AMC ILA user, consuming 1,325 Mgal of industrial water in FY 2013 (section 3.2). These two installations combined represent 76% of the Army's estimated ILA water use. IMCOM is the second largest ILA-using command, consuming 1,355 Mgal in FY 2013. AMC and IMCOM represent the vast majority of the total ILA water use, comprising over 99% of the Army's total (Figure 4.3). Only one Army Reserve Command installation was identified as an ILA user, Fort Buchanan, PR, consuming 14 Mgal. Five ARNG sites were identified as ILA water users. However, ARNG provided little data on these sites and they are considered insignificant ILA users.

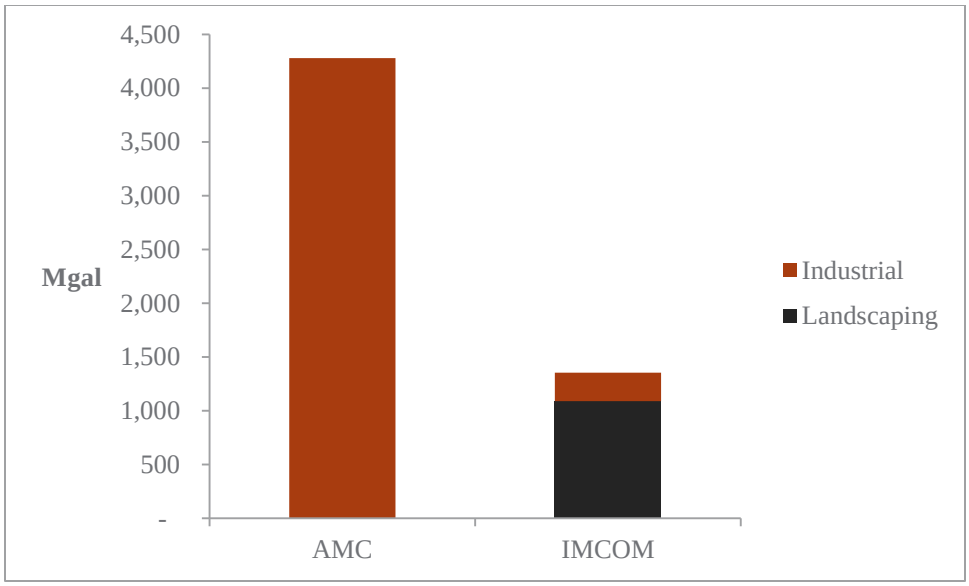

Figure 4.3. AMC and IMCOM FY 2013 ILA Water Use Breakout

As a result of this project, it was determined that AMC and IMCOM have not been accurately reporting ILA water data in AEWRS. AMC reported nearly 13,000 Mgal of ILA water use in FY 2013. However, PNNL determined that AMC's annual ILA use is actually 4,278 Mgal. AMC's over-reporting is due to Holston AAP including non-consumptive water use in their ILA reporting (section 3.2). On the other hand, IMCOM under-reported FY 2013 ILA water use in AEWRS, totaling 1,200 Mgal, while PNNL determined that FY 2013 ILA use was 1,355 Mgal (Figure 4.4). The under-reporting of IMCOM ILA use is mainly a result of installations not consistently entering non-potable water used in golf course irrigation.

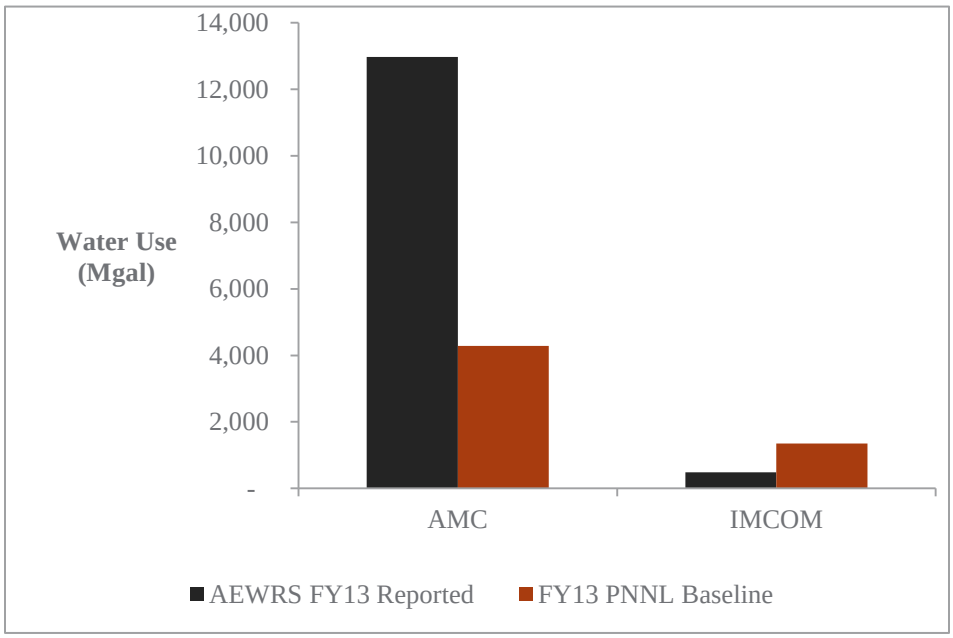

Figure 4.4. FY 2013 ILA Water Use by Command Pre- and Post-Project

Over time, Army installations have been increasing ILA water reporting in AEWRS, but this project has revealed a significant difference between reported and actual ILA water use (Figure 4.5). Again, this is mainly attributed to Holston AAP over-reporting industrial water use.

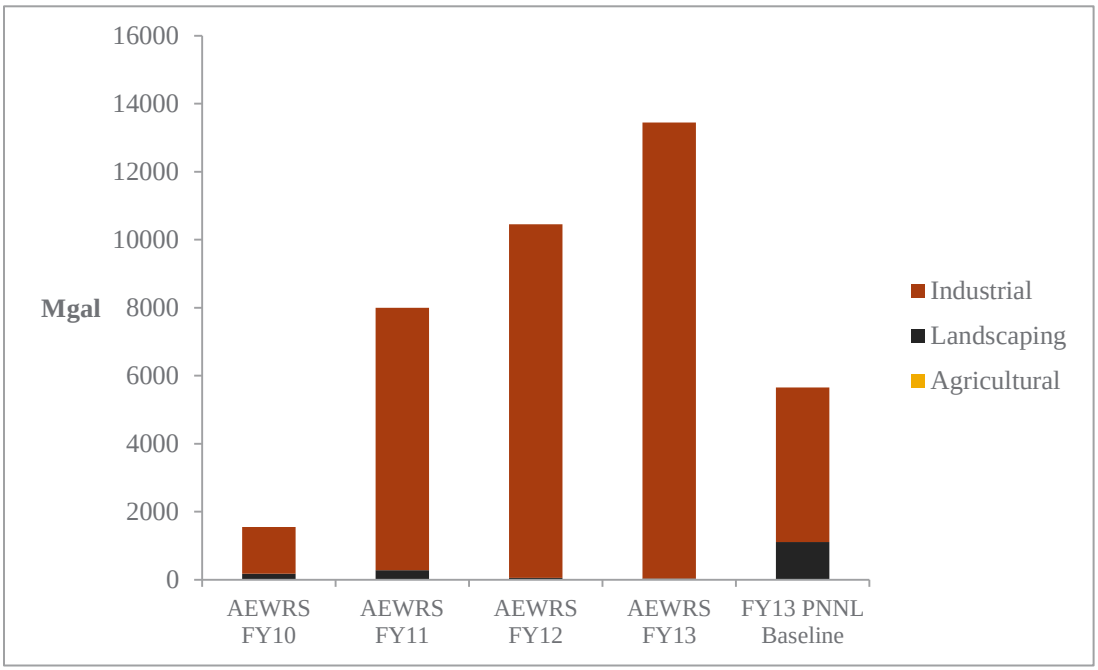

Figure 4.5. AEWRS ILA Water Reporting and FY 2013 PNNL Baseline

4.3 ILA Water Application Types

Army installations use ILA water in a variety of applications including manufacturing, steam production, golf course, and landscape irrigation (Figure 4.6).

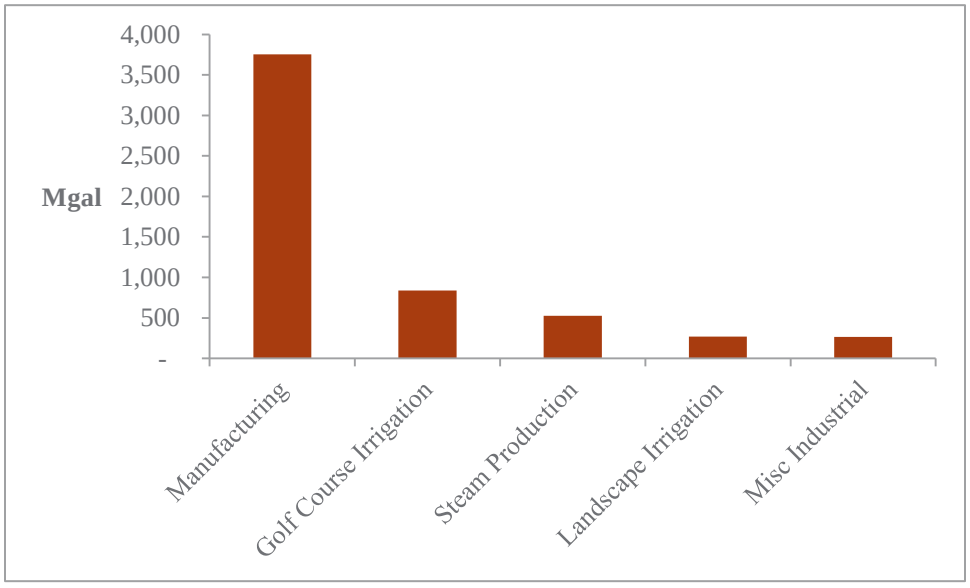

Figure 4.6. Breakout of ILA Water Use Applications

4.3.1 Industrial

PNNL identified six installations that consume ILA water in industrial applications. The two principal areas of industrial water use are process water for manufacturing (~3,753 Mgal/yr) and process water for steam production (~525 Mgal/yr). Dust suppression, WWTP uses, and construction water use account for ~265 Mgal/yr. Currently, all but one of the six industrial-using installations report quarterly industrial water use in AEWRS.

Radford AAP is the largest industrial user in the Army, consuming 2,953 Mgal in FY 2013. On average, Radford AAP withdraws between 14 and 29 Mgal of water daily from the New River. Approximately 10 to 12 Mgal per day of the river water is lightly treated at the site's filtration plant for use as boiler makeup water at the combined heat and power plant (CHPP) and as process water in production which represents the industrial ILA water component. The CHPP consumes about 1 Mgal per day for boiler makeup water for steam and power production from four 70 year old coal fired boilers.

Similar to Holston AAP, untreated river water is used to cool the Radford AAP's CHPP. Roughly 11 Mgal per day is withdrawn and used to cool two double extraction condensing turbines and two single extraction turbines, total generating capacity of 24 megawatts of electricity. This cooling water is non-consumptive because it is returned back to the New River in the same quality and quantity from where it is diverted. This non-consumptive water is not ILA water (section 1.1).

Holston AAP is the second largest industrial water user in the Army, consuming 1,325 Mgal in FY 2013. Holston AAP uses ILA water for industrial purposes in steam production and in manufacturing secondary detonation explosives (section 3.2).

Both Radford AAP and Holston AAP meters ILA and non-consumptive water use. Radford AAP has been accurately entering ILA water use in AEWRS, including only the consumptive portion of non-potable water. Holston AAP has been reporting all non-potable water in AEWRS, including the non-consumptive portion. Holston AAP was alerted to this issue and subsequently corrected the problem and entered only consumptive water use in FY 2014 quarter 3 reporting cycle.

4.3.2 Landscaping

PNNL identified 28 installations that consume ILA water in landscaping applications. Currently, 11 are reporting in AEWRS. Two main types of landscape irrigation were identified: golf courses and landscaped areas, such as athletic fields, parade fields, and building landscape. PNNL identified 24 Army golf courses that are ILA water users (Table 4.2). The total annual ILA water estimate for golf course irrigation is 837 Mgal which represents 76% of the total landscaping water use. It is estimated that 268 Mgal is consumed annually in other landscaped areas on Army installations. The vast majority of landscaping ILA users in the Army are IMCOM installations, consuming 99% of the total. Fort Bliss, TX/NM, is the largest user, representing 20% of the total landscaping use. Fort Bliss has two golf courses that irrigate with non-potable water. These golf courses have a very high water demand of 66 gallons per square foot per year (gal/sf/yr). The PNNL-derived irrigation model estimates an annual irrigation demand of 32 gal/sf/yr for Fort Bliss, which means that the installation likely has a potential for large efficiency gains in landscape irrigation.

Table 4.2. Army Golf Courses with ILA Water Use

Garrison	Annual Water Use (kgal)	Annual Irrigation Demand (gal/sf/yr)
Fort Bliss	225,714	66.4
Joint Base Lewis-McChord	79,073	17.3
Fort Hood	71,085	27.9
Fort Jackson	54,906	8.6
Fort Gordon	38,087	5.3
Fort Belvoir	36,844	10.8
Fort Campbell	33,996	20.0
Redstone Arsenal	32,000	8.2
Fort Benning	28,000	11.0
Fort Leavenworth	25,000	14.7
Fort Rucker	23,727	9.3
Fort Bragg	23,520	13.8
Fort Leonard Wood	20,000	11.8
Aberdeen Proving Ground	17,070	10.0
Fort Knox	15,507	9.1
Detroit Arsenal	15,070	8.9
Fort Lee	15,000	5.9
Rock Island Arsenal	14,828	8.7
Carlisle Barracks	14,084	8.3
Fort Stewart	13,751	7.4
Hunter Army Airfield	11,836	7.2
Fort Polk	10,000	5.9
Picatinny Arsenal	9,442	5.6
West Point	8,500	5.0

4.3.3 Agricultural

Three sites were identified as agricultural water users in the PNNL survey: Blue Grass Army Depot, Milan AAP, and Fort Polk. PNNL conducted follow-up interviews and identified the agricultural water use at all three sites as cattle watering. Milan AAP was estimating agricultural water use, but Blue Grass Army Depot and Fort Polk were not. Therefore, PNNL provided a metric for estimating cattle water use and instructed the sites to enter that water use into AEWRS under the Agricultural category (section 5.3.2). Two sites, Blue Grass Army Depot and Milan AAP, are now entering agricultural water use in AEWRS in FY 2014. Other Army installations have agricultural leases, but follow-up interviews found that none of those leases included non-potable water use.

5.0 Implementation Plan

An objective of this project is to assist the Army in developing an implementation plan to improve ILA water reporting in AEWRS. The recommended elements of the implementation plan include:

- AEWRS reporting guidelines
- AEWRS training
- Estimating methods for unmetered uses

5.1 AEWRS Reporting Guidelines

Through this project, PNNL determined that many installations are recording inaccurate data in AEWRS and are unclear on the precise reporting requirements (section 4.1). The main area of confusion is the distinction between potable and non-potable water and how the ILA water uses apply. As result, PNNL recommends changes to the AEWRS web site user interface (Figure 5.1). These recommended changes will help to clearly define the three general types of water categories in AWERS: potable water, ILA water, and on-site alternative non-potable water. These recommendations may help to alleviate some of the confusion that installations are currently experiencing with the AEWRS water categories by clearly differentiating between potable, on-site non-potable freshwater, purchased non-potable, and on-site produced alternative water. In addition, PNNL is recommending a new data entry field to identify the type of alternative non-potable water so that the Army can track key sources of alternative water being accessed by installations.

Consumption (Million Gallons (MGAL)): Enter quarterly water consumption data for the following categories if consumed at the installation.

1. **Potable:** Enter the quarterly consumption of water that is treated to sufficient quality for human consumption. Potable water consumption includes ***ALL*** applications that use potable water including indoor building equipment, industrial applications, landscape irrigation, and agricultural uses.

Potable	Data Field

2. **On-site Non-potable Freshwater and Purchased Non-potable Water:** Enter the quarterly consumption of water used in the following applications that are supplied with on-site non-potable (untreated) freshwater (i.e., surface or groundwater) or purchased non-potable water.

Non-potable Industrial	Data Field
Non-potable Landscaping	Data Field
Non-potable Agricultural	Data Field

3. **On-site Alternative Non-potable:** Enter the quarterly consumption of water used in applications, such as irrigation and vehicle wash that are supplied with on-site non-potable water ***not*** obtained from freshwater sources (i.e., surface or groundwater) nor purchased from a third party.

Alternative Non-potable	Data Field
Alternative Non-potable Water Source	Data Field

Cost

Potable	Data Field
Non-potable Industrial	Data Field
Non-potable Landscaping	Data Field
Non-potable Agricultural	Data Field
Alternative Non-potable	Data Field

Figure 5.1. Recommended Changes to the AEWRS User Interface

In addition, PNNL recommends the following definitions be added to the "hover help" instructions in AEWRS:

- Potable water hover help definition: This value is the total potable water consumption for the installation. This value excludes water uses entered in AEWRS water category #2, non-potable industrial, landscaping, and agricultural water uses, and water category #3, on-site alternative non-potable water use.
- ILA categories hover help instructions: Do not report non-consumptive water uses which are defined as water that is diverted from its freshwater source and is returned to the point of diversion in the same quantity and quality as the original diversion. Treated wastewater that is discharged to surface water is not considered non-consumptive. Also, water used for irrigation is a consumptive use.
- Alternative non-potable water hover help definition: Water that is recycled multiple times in a process, such as a central vehicle wash facility, is not considered on-site alternative non-potable. Water used to recharge surface or groundwater is not considered on-site alternative non-potable water.

It is also recommended that the Office of the Assistant Chief of Staff for Installation Management (OACSIM) open AEWRS FY 2014 data upon request to allow sites to correct FY 2014 quarterly data. PNNL assisted many installations on FY 2014 data corrections. Allowing sites to correct previously entered data will create a more accurate FY 2014 ILA water use.

5.2 AEWRS Training

PNNL provided AEWRS training and instructions to the major Army commands.

- ***IMCOM:*** As part of the implementation plan to improve tracking ILA water use, a webinar training session was presented on July 31, 2014, by PNNL to instruct IMCOM installations on how to more accurately track and report water use in AEWRS. The webinar also included a demonstration of the irrigation estimation tool (section 5.3.1). A total of 46 people signed up for the webinar, but only 20 attended. Questions asked during the webinar with the answers can be found in Appendix A, section A.4.

  A recording of the webinar along with the slides presented, the irrigation tool, and questions and answers addressed can be found on the Army Knowledge Online (AKO) website at https://www.us.army.mil/suite/files/43306693. Because of the low turnout, it is suggested that OACSIM coordinate additional training or direct installations to the files on AKO to ensure that installations are educated on AEWRS water reporting.
- ***AMC***: PNNL held a conference call with all AMC installations to provide them with information on ILA water use, including the defining ILA water applications and AEWRS data reporting instructions.
- ***AR***: PNNL held a call with the AR AEWRS point of contact to instruct on ILA water use definition and reporting. PNNL also instructed Fort Buchanan on reporting ILA water in AEWRS. (This project determined that Fort Buchanan is the only ILA water-consuming site in the AR.)
- ***ARNG***: PNNL contacted all ARNG sites that were identified as ILA water users in this project to instruct on AEWRS data reporting.

5.3 Estimating Methods

PNNL developed methods to calculate landscape irrigation and agricultural water use to assist installations in estimating water use for unmetered applications.

5.3.1 Landscape Irrigation Estimating Model

PNNL developed an Excel-based model to assist Army installations in estimating unmetered non-potable water use for landscape irrigation. Measuring actual water use with flow meters is the best method for tracking water use. However, there are at least 20 Army sites that do not meter these applications. In these instances, the PNNL model allows the user to enter basic information on a landscape area and the tool estimates the quarterly and annual irrigation requirements. Historical weather and evapotranspiration data is used along with the information on the landscape type to estimate the typical supplemental irrigation requirements of the landscape in the given location (Appendix A, section A.5).

The tool is laid out in a step-by-step format. The user can enter multiple landscape areas and the model consolidates the information for AEWRS reporting. The model tracks water use by supply type broken out by non-potable freshwater, on-site alternative water, and purchased reclaimed water. User-required information includes:

- Location
- Water rates
- Water supply type
- Specific information on landscape type including turfgrass type
- Soil type
- Irrigated landscape area
- Irrigation season
- System efficiency

Outputs of the model include the following.

- ***Annual Irrigation Factor***: This value is provided for each landscape area and provides the amount of annual irrigation demand by the landscape per square foot of area. This value can be used to compare the irrigation demand for different landscape areas at a given installation. This can help to determine the relative degree of efficiency between different landscape areas.
- ***Estimated Quarterly Irrigation***: These values provide the quarterly irrigation requirements for each AEWRS reporting category for individual irrigation landscape areas and the total quarterly value summed by AEWRS water use category.
- ***Estimated Total Annual Irrigation***: This value provides the user with the total annual irrigation requirements for each AEWRS reporting category for individual irrigation landscape areas and the total quarterly value summed by AEWRS water use category.

PNNL demonstrated the landscape irrigation estimating tool to IMCOM installations on July 31, 2014, as part of the project.

5.3.2 Agricultural Water Use Metric

PNNL developed a metric for estimating cattle water consumption. PNNL reviewed current literature on cattle water use and compiled data. The research revealed distinct water consumption needs for different types of cattle, in part because of factors that affect water intake such as age (calf vs. adult), size, food intake, lactation, and air temperature. Three types of cattle that were selected for water consumption estimates are beef, dairy, and calves. Water consumption for calves was estimated based on an average daily consumption. Dairy and beef water consumption was estimated average daily consumption at various air temperatures and cattle weights. Based on this research, PNNL developed metrics for Army installations that provide non-potable water consumption estimates by cattle (Table 5.1).

Table 5.1. Cattle Water Use

Cattle Type	Gallon per Cow per Day	Data Source
Beef	8.8	(Rasby and Walsh 2011; Parish 2008; Hamlyn-Hill 2014)
Dairy	23.9	(Dyer 2012; Ward 2007; Looper 2007; Falk 2014; Hamlyn-Hill 2014)
Calf	6.5	(Filley 2005; Hamlyn-Hill 2014; Ward and McKague 2007)

5.4 Best Practices

As an outcome of this project, the following best practices are recommended so that the Army can more accurately track ILA water use and potentially reduce ILA water use:

- Redefine AEWRS water reporting categories in the user interface to better distinguish between the different water categories
- Offer additional training to installations on AEWRS reporting through OACSIM
- Meter water uses at the application level and when possible use advanced metering that has remote capability that uploads data automatically to a SCADA or building automation system
- For unmetered uses, disseminate standard methods to estimate unmetered water uses as prescribed in this document
- Focus effort on reducing water use at Radford AAP and Holston AAP by implementing water re-use strategies and reviewing options for water efficiency in the central steam plants. The age and vintage of much of the infrastructure as well as the operating equipment at both locations indicate there are likely many opportunities for water efficiency projects (section 3.2)
- Focus landscaping efficiency efforts on golf course irrigation at IMCOM installations; use advanced weather-based irrigation controls to increase system efficiency (section 3.1)

- Annually, review AEWRS ILA water data to determine if the ILA water-using installations identified in this project are reporting ILA water data in AEWRS to ensure that ILA water use is complete and accurate

To meet the EO 13514 ILA water reduction goal, the Army is required to reduce ILA water consumption by 20% relative to the baseline. If the Army's ILA water baseline is set to the FY 2013 ILA water use of 5,657 Mgal, then the Army will need to achieve an annual ILA water use reduction of 162 Mgal through FY 2020, totaling 1,134 Mgal. The Army's target FY 2020 ILA water use is 4,523 Mgal. To track progress towards meeting this goal, it is recommended that the Army follow the best practices outlined above.

6.0 References

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Appendix A

Supporting Documentation

A.1 Survey

Pacific Northwest National Laboratory (PNNL) disseminated a survey to Army installations determine industrial, landscaping, and agricultural (ILA) water users by asking a series of quantitative questions on water sources and uses. The survey also determined the main methods that installations are using to monitor water uses.

ILA Water Use Survey

The Executive Order 13514 requires all federal agencies to track, report, and reduce their use of industrial, landscaping, and agricultural (ILA) water. The following survey will assist the Army in better understanding its current ILA water use, how it is being measured, and tracked. Thanks for your participation and information.

Survey Instructions

The survey is a series of qualitative questions related to water supply and use at your installation. Please note that the survey will automatically skip entire sections depending on the complexity of water uses at your installation. Therefore, the survey could take as little as 5 minutes to complete or as long as 30 minutes. Note, the term "installation" is used throughout the survey, which denotes either an individual installation, Reserve Regional Support Commands, or statewide National Guard units.

The survey may time-out; please try to complete the survey within one hour. If your survey does time-out; you have the option of starting over.

If you would like a PDF version of the survey to review so you can gather the answers before starting the survey, please send a request to: kate.mcmordie@pnnl.gov.

Contacts

If you have any questions about the survey contact

- [redacted]

Contact Information

So we can track responses and follow-up as necessary, please provide your contact information.

Command: _____

Installation: _____

Name: _____

Phone Number _____

Email: _____

In case we are unable to reach you, please provide an alternate contact.

Name: _____

Phone Number _____

Email: _____

Part 1: Water Supply

What type of water is used at your installation? (Select all that apply.)

❑ Potable water (water that is treated to the level that is safe for human consumption)

❑ Non-potable water (water that has not been treated to the level that is safe for human consumption)

(End of Page 1)

Part 1: Potable Water Supply

What type of potable water is used at your installation? (Select all that apply.)

❑ Purchased from a third party

❑ On-site supplied water that is treated to potable water standards

(End of Page 2)

Part 1: Non-potable Water Supply

What type of non-potable water is used at your installation? (Select all that apply.)

❑ Purchased water from freshwater* surface and/or groundwater source(s) >>>> Skip to Page 4: **Select the type of applications at your installation that use non-potable freshwater (surface or groundwater; <u>does not include on-site alternative water or purchased reclaimed water</u>).** (Select all that apply.)

❑ On-site supplied water from freshwater* surface and/or groundwater source(s) >>>> Skip to Page 4: **Select the type of applications at your installation that use non-potable freshwater (surface or groundwater; <u>does not include on-site alternative water or purchased reclaimed water</u>).** (Select all that apply.)

❑ On-site alternative water (water ***not*** from freshwater* source(s); e.g., harvested rainwater, reclaimed water, reused water from process discharge) >>>> Skip to Page 8: **Select the type of applications at your installation that use on-site alternative non-potable water (e.g., rainwater harvesting, reclaimed wastewater, process reuse, and air handling condensate capture; <u>does not include non-potable freshwater or purchased reclaimed water).</u>** (Select all that apply.)

❑ Purchased reclaimed non-potable water >>>> Skip to Page 12: **Select the type of applications at your installation that use purchased reclaimed water (<u>does not include non-potable freshwater or on-site alternative water</u>).** (Select all that apply.)

**Freshwater is naturally occurring non-potable water from surface or groundwater sources such as but not limited to lakes, streams, and aquifers that have low concentrations of total dissolved solids.*

(End of Page 3)

Part 2: Non-potable Freshwater Applications

Select the type of applications at your installation that use non-potable freshwater (surface or groundwater; <u>does not include on-site alternative water or purchased reclaimed water</u>). (Select all that apply.)

❑ Industrial processes (e.g., central plants, cooling towers, wash applications, manufacturing process) >>>> Skip to Page 5: **What industrial processes use non-potable freshwater?** (Select all that apply and briefly describe each application you use.)

❑ Landscape irrigation (e.g., turf, landscape beds, athletic fields, golf course) >>>> Skip to Page 6: **What landscape types are irrigated with non-potable freshwater?** (Select all that apply.)

❑ Agricultural applications* (e.g., crop irrigation or animal/livestock related applications, wildlife tanks) >>>> Skip to Page 7: **What agricultural applications use non-potable freshwater?** (Select all that apply and briefly describe each application.)

❑ Other (e.g., fire suppression), please specify _____ >>>> Skip to Page 16: Thank you for your time to complete this survey. Please click SUBMIT SURVEY below.

**Water supplied by the installation to an agricultural lease is considered agricultural water use.*

(End of Page 4)

Part 2: Industrial Processes

What industrial processes use non-potable freshwater? (Select all that apply and briefly describe each application you use.)

- ❑ Central energy plants _____
- ❑ Central vehicle wash _____
- ❑ Manufacturing process _____
- ❑ Cooling tower _____
- ❑ Other (specify and describe) _____

Is non-potable freshwater used in industrial processes metered or estimated? Fill out the following table to identify how industrial water is measured for each source type.

	Metered	Estimated	Not metered or estimated	Not a source at my installation
Purchased	❍	❍	❍	❍
On-site groundwater well	❍	❍	❍	❍
On-site surface water	❍	❍	❍	❍

If estimated, what technique do you use?

Purchased _____

On-site groundwater well _____

On-site surface water _____

Do you have any comments about use of non-potable freshwater for industrial processes?

_____

_____

_____

(End of Page 5)

Part 2: Landscape Irrigation

What landscape types are irrigated with non-potable freshwater? (Select all that apply.)

- ❑ Landscape around buildings
- ❑ Parade fields
- ❑ Athletic fields
- ❑ Golf course(s)
- ❑ Other (please specify) _____

Is non-potable freshwater used in landscaping metered or estimated? Fill out the following table to identify how landscaping water is measured for each source type.

	Metered	Estimated	Not metered or estimated	Not a source at my installation
Purchased	❍	❍	❍	❍
On-site groundwater well	❍	❍	❍	❍
On-site surface water	❍	❍	❍	❍

If estimated, what technique do you use?

Purchased _____

On-site groundwater well _____

On-site surface water _____

Do you have any comments about use of non-potable freshwater for landscape irrigation?

_____

_____

_____

(End of Page 6)

Part 2: Agricultural Applications

What agricultural applications use non-potable freshwater? (Select all that apply and briefly describe each application.)

- ❑ Crop irrigation _____
- ❑ Animal/livestock operations _____
- ❑ Other (specify and describe) _____

Is non-potable freshwater used in agricultural applications metered or estimated? Fill out the following table to identify how agricultural water is measured for each source type.

	Metered	Estimated	Not metered or estimated	Not a source at my installation
Purchased	❍	❍	❍	❍
On-site groundwater well	❍	❍	❍	❍
On-site surface water	❍	❍	❍	❍

If estimated, what technique do you use?

Purchased _____

On-site groundwater well _____

On-site surface water _____

Do you have any comments about use of non-potable freshwater for agricultural applications?

_____

_____

_____

(End of Page 7)

Part 3: On-Site Alternative Non-Potable Applications

Select the type of applications at your installation that use on-site alternative non-potable water (e.g., rainwater harvesting, reclaimed wastewater, process reuse, and air handling condensate capture; <u>does not include non-potable freshwater or purchased reclaimed water).</u> (Select all that apply.)

❑ Industrial processes (e.g., central plants, cooling towers, wash applications, manufacturing process) >>>> Skip to Page 9: **What industrial processes use on-site alternative non-potable water?** (Select all that apply and briefly describe each application you use.)

❑ Landscape irrigation (e.g., turf, landscape beds, athletic fields, golf course) >>>> Skip to Page 10: **What landscape types are irrigated with on-site alternative non-potable water?** (Select all that apply.)

❑ Agricultural applications (crop irrigation, animal/livestock related applications, wildlife tanks) >>>> Skip to Page 11: **What agricultural applications use on-site alternative non-potable water?** (Select all that apply and briefly describe each application.)

❑ Other (e.g., fire suppression), please specify _____ >>>> Skip to Page 16: Thank you for your time to complete this survey. Please click SUBMIT SURVEY below.

(End of Page 8)

Part 3: Industrial Processes

What industrial processes use on-site alternative non-potable water? (Select all that apply and briefly describe each application you use.)

- ❑ Central energy plants _____
- ❑ Central vehicle wash _____
- ❑ Manufacturing process _____
- ❑ Cooling tower _____
- ❑ Other (specify and describe) _____

Is on-site alternative non-potable water used in industrial processes metered or estimated? Fill out the following table to identify how industrial water is measured for each source type.

	Metered	Estimated	Not metered or estimated	Not a source at my installation
Rainwater	❍	❍	❍	❍
Process discharge water	❍	❍	❍	❍
Air handling unit condensate	❍	❍	❍	❍
On-site wastewater reclaim	❍	❍	❍	❍
Other	❍	❍	❍	❍

If estimated, what technique do you use?

Rainwater _____

Process discharge water _____

Air handling unit condensate _____

On-site wastewater reclaim _____

Other _____

If you choose *other* above, please describe the application at your installation.

_____

_____

_____

Do you have any comments about use of on-site alternative non-potable water for industrial purposes?

_____

_____

_____

(End of Page 9)

Part 3: Landscape Irrigation

What landscape types are irrigated with on-site alternative non-potable water?
(Select all that apply.)

- ❑ Landscape around buildings
- ❑ Parade fields
- ❑ Athletic fields
- ❑ Golf course(s)
- ❑ Other (please specify) _____

Is on-site alternative non-potable water used in landscaping metered or estimated? Fill out the following table to identify how landscaping water is measured for each source type.

	Metered	Estimated	Not metered or estimated	Not a source at my installation
Rainwater	❍	❍	❍	❍
Discharge water	❍	❍	❍	❍
Air handling unit condensate	❍	❍	❍	❍
On-site wastewater reclaim	❍	❍	❍	❍
Other	❍	❍	❍	❍

If estimated, what technique do you use?

Rainwater _____

Discharge water _____

Air handling unit condensate _____

On-site wastewater reclaim _____

Other _____

If you choose *other* above, please describe the application at your installation.

_____

_____

_____

Do you have any comments about use of on-site alternative non-potable water for landscape irrigation?

_____

_____

_____

(End of Page 10)

Part 3: Agricultural Applications

What agricultural applications use on-site alternative non-potable water? (Select all that apply and briefly describe each application.)

- ❑ Crop irrigation _____
- ❑ Animal/livestock operations _____
- ❑ Other (specify and describe) _____

Is on-site alternative non-potable water used in agricultural applications metered or estimated? Fill out the following table to identify how agricultural water is measured for each source type.

	Metered	Estimated	Not metered or estimated	Not a source at my installation
Rainwater	❍	❍	❍	❍
Discharge water	❍	❍	❍	❍
Air handling unit condensate	❍	❍	❍	❍
On-site wastewater reclaim	❍	❍	❍	❍
Other	❍	❍	❍	❍

If estimated, what technique do you use?

Rainwater _____

Discharge water _____

Air handling unit condensate _____

On-site wastewater reclaim _____

Other _____

If you choose *other* above, please describe the application at your installation.

_____

_____

_____

Do you have any comments about use of on-site alternative non-potable water for agricultural applications?

_____

_____

_____

(End of Page 11)

Part 4: Purchased Reclaimed Water Applications

Select the type of applications at your installation that use purchased reclaimed water (<u>does not include non-potable freshwater or on-site alternative water</u>). (Select all that apply.)

❑ Industrial processes (e.g., central plants, cooling towers, wash applications, manufacturing process)

❑ Landscape irrigation (e.g., turf, landscape beds, athletic fields, golf course)

❑ Agricultural applications (crop irrigation, animal/livestock related applications, wildlife tanks)

❑ Other (e.g., fire suppression), please specify _____ >>>> Skip to Page 16: Thank you for your time to complete this survey. Please click SUBMIT SURVEY below.

(End of Page 12)

Part 4: Industrial Processes

What industrial processes use purchased reclaimed water? (Select all that apply and briefly describe each application you use.)

- ❑ Central energy plants _____
- ❑ Central vehicle wash _____
- ❑ Manufacturing process _____
- ❑ Cooling tower _____
- ❑ Other (specify and describe) _____

Is purchased reclaimed water used in industrial processes metered or estimated? Fill out the following table to identify how reclaimed water is measured.

	Metered	Estimated	Not metered or estimated
Reclaimed water	❍	❍	❍

If estimated, what technique do you use?

Reclaimed water _____

Do you have any comments about the use of purchased reclaimed water for industrial processes?

_____

_____

_____

(End of Page 13)

Part 4: Landscape Irrigation

What landscape types are irrigated with purchased reclaimed water? (Select all that apply.)

- ❑ Landscape around buildings
- ❑ Parade fields
- ❑ Athletic fields
- ❑ Golf course(s)
- ❑ Other (please specify) _____

Is purchased reclaimed water used in landscaping metered or estimated? Fill out the following table to identify how landscaping water is measured.

	Metered	Estimated	Not metered or estimated
Reclaimed water	❍	❍	❍

If estimated, what technique do you use?

Reclaimed water _____

Do you have any comments about the use of purchased reclaimed water for landscape irrigation?

_____

_____

_____

(End of Page 14)

Part 4: Agricultural Applications

What agricultural applications use purchased reclaimed water? (Select all that apply and briefly describe each application.)

- ❑ Crop irrigation _____
- ❑ Animal/livestock operations _____
- ❑ Other (specify and describe) _____

Is purchased reclaimed water used in agricultural applications metered or estimated. Fill out the following table to identify how agricultural water is measured.

	Metered	Estimated	Not metered or estimated
Reclaimed water	❍	❍	❍

If estimated, what technique do you use?

Reclaimed water _____

Do you have any comments about the use of purchased reclaimed water for agricultural applications?

_____

_____

_____

(End of Page 15)

A.2 Interview Questionnaire

PNNL conducted follow-up interviews with Army installations to verify information that was collected in the survey.

ILA Installation Questionnaire **PNNL POC:** _____

Site Name:_____ **Site POC:** _____**Date:**_____

- Is the site ***supplied*** non-potable water that is **not** treated to potable standards:
- If yes, what is the source of the water? Circle type and provide information such as source name/location…

On-site surface	On-site ground	Purchased freshwater	Purchased reclaim	Alternative (list type)
Describe:				

What applications use this water? How is it measured? In the table, check the type of applications for each water category and describe how it is monitored and how data is managed.

	Onsite non-potable freshwater	**Purchased non-potable freshwater**	**Purchased reclaim wastewater**	**Alternative**
Industrial				
Landscaping				
Agricultural				
Other				
Metered or Estimated* List estimating technique, type of meter, manual read or data logger, who will read the meter?	Describe:			

**If the site uses both industrial and landscaping water and the water is metered at the supply – does the site split water use between industrial and landscaping uses? If yes, describe.*

- Does the site enter ILA data into AEWRS? Yes / No
  - If no, explain to the site that this is required and get confirmation that they will enter quarterly data
  - Who enters AEWRS data quarterly?
  - Can the site provide historic quarterly ILA water use data? For which years? (try to get FY13 and FY14)
  - Does the site need assistance in estimating water use?
  - Follow up with site POC on estimating tool/resources

A.3 Site Visit Data

The following information is data collected during the site visits (section 3.0).

Fort Stewart and Hunter Army Airfield

	FS Purple Pipe		Surficial Aquifer (L)						Surface Water (L)
Date	CEP (I)	FS Golf Course (L)	McFarland Wash Racks (I)	FS Youth Athletic Field	FS Winn Hospital	FS Dog Park	HAAF Athletic Field	HAAF Belmont Cemetery	HAAF Golf Course
Jun-10	308,700	2,149,900							
Jul-10	581,300	7,267,200							
Aug-10	1,288,000	8,609,300							
Sep-10	1,664,000	2,258,900							
FY 10 Totals	3,842,000	20,285,300	-	-	-	-	-	-	-
Oct-10	1,164,900	4,038,300							
Nov-10	381,300	3,563,000							
Dec-10	-	2,537,200							
Jan-11	197,500	1,335,100							
Feb-11	415,300	-							
Mar-11	926,800	-							
Apr-11	2,053,000	2,031,000							
May-11	2,231,800	3,697,500							
Jun-11	1,790,300	3,626,600							
Jul-11	6,463,700	5,684,500							
Aug-11	5,316,900	6,060,600							
Sep-11	5,884,400	5,850,700							
FY 11 Totals	26,825,900	38,424,500	-	-	-	-	-	-	-
Oct-11	2,846,500	2,823,800							
Nov-11	1,595,200	821,700							
Dec-11	1,993,500	904,500							
Jan-12	3,982,800	352,400							
Feb-12	3,648,200	248,000							
Mar-12	2,938,600	408,000							
Apr-12	4,108,200	1,504,200							
May-12	5,377,000	4,278,000							
Jun-12	4,312,000	2,117,000							
Jul-12	4,374,100	3,062,600							

	FS Purple Pipe			Surficial Aquifer (L)					Surface Water (L)
Date	CEP (I)	FS Golf Course (L)	McFarland Wash Racks (I)	FS Youth Athletic Field	FS Winn Hospital	FS Dog Park	HAAF Athletic Field	HAAF Belmont Cemetery	HAAF Golf Course
Aug-12	6,130,100	5,534,600							
Sep-12	4,107,500	-							
FY 12 Totals	45,413,700	22,054,800	-	-	-	-	-	-	-
Oct-12	2,621,000	1,610,000							
Nov-12	1,992,000	3,027,000							
Dec-12	1,409,000	1,764,000							641,705
Jan-13	1,059,000	254,000					128,900		215,666
Feb-13	1,586,900	1,157,500					51,700		322,471
Mar-13	936,400	-					-		4,158
Apr-13	1,512,400	1,092,100			3,390		128,600		287,246
May-13	2,151,500	1,685,100		165,300	128,180		407,600		2,251,772
Jun-13	3,276,700	3,882,300		111,500	102,770		324,100		532,688
Jul-13	3,937,500	595,300		146,200	44,640		207,500		56,348
Aug-13	4,466,600	-	37,100	128,600	-	200	-		63,716
Sep-13	2,845,300	359,000	1,304,900	21,900	59,880		-		524,608
FY 13 Totals	27,794,300	15,426,300	1,342,000	573,500	338,860	200	1,248,400	-	4,900,378
Oct-13	-	3,051,300	1,156,200	26,400	92,310		148,400		415,774
Nov-13	344,000	1,986,300	1,079,500	22,700	84,160		208,100		224,599
Dec-13	2,478,500	1,523,400	940,100	-	-		-		22,929
FY14 Qtr 1 Total	2,822,500	6,561,000	3,175,800	49,100	176,470	-	356,500	-	663,302
Jan-14	1,569,600	600,000	895,400	44,900	67,670		40,000		123,716
Feb-14	1,395,800		824,900	24,600	190				77,626
Mar-14	1,249,300		773,100	21,800					206,229
FY14 Qtr 2 Total	4,214,700	600,000	2,493,400	91,300	67,860	-	40,000	-	407,571
Apr-14				21,900	90		281600		294,359
May-14									
Jun-14									
Jul-14									
Aug-14									
Sep-14									
FY14 Totals	7,037,200	7,161,000	5,669,200	162,300	244,420	-	678,100	-	1,365,232

Fort Gordon

Year	Month	Volume (gal/month)
2012	October	10,762,927
2012	November	2,219,871
2012	December	2,690,623
2012	TOTAL	15,673,421
2013	January	-
2013	February	-
2013	March	-
2013	April	1,654,069
2013	May	5,899,551
2013	June	3,950,100
2013	July	1,681,575
2013	August	4,772,570
2013	September	4,941,423
2013	October	4,866,007
2013	November	727,733
2013	December	133,673
2013	TOTAL	28,626,701
2014	January	-
2014	February	22,693
2014	March	62,463
2014	April	3,570,592

Fort Jackson

Year	Month	Volume (gal/month)
2011	January	390,000.0
2011	February	2,656,500.0
2011	March	11,745,900.0
2011	April	16,047,300.0
2011	May	20,978,400.0
2011	June	12,025,800.0
2011	July	16,619,400.0
2011	August	21,918,000.0
2011	September	21,143,100.0
2011	October	13,515,600.0
2011	November	7,521,900.0
2011	December	-
2011	TOTAL	144,561,900.0
2012	January	3,269,100
2012	February	4,521,600
2012	March	14,525,400
2012	April	21,949,500
2012	May	21,315,900
2012	June	24,837,000
2012	July	28,588,800
2012	August	13,550,400
2012	September	21,445,200
2012	October	11,168,400
2012	November	7,792,800
2012	December	4,802,100
2012	TOTAL	177,766,200
2013	January	4,869,300
2013	February	4,677,900
2013	March	10,440,900
2013	April	15,602,700
2013	May	23,557,500
2013	June	29,185,800
2013	July	12,751,200
2013	August	28,553,100
2013	September	24,351,000
2013	October	18,982,500
2013	November	9,290,100
2013	December	6,438,000
2013	TOTAL	188,700,000
2014	January	36474.1
2014	February	36821.2
2014	March	37153.1

A.4 Webinar Question Log

AEWRS Water Reporting and Estimating ILA Water Use Webinar Questions and Answers Log:

Questions on AEWRS Reporting

Q: How does one report Alternative Water used for Landscaping?

1. Alternative non-potable water collected on-site, not obtained from a freshwater source or purchased from a third party should be reported in the "Alternative Non-potable" entry field in AEWRS.
2. Purchased reclaimed water from a third party should be reported in the "Landscaping" field in AEWRS.

Q: Does a well count?

1. If the well water is from a fresh groundwater source but not treated to potable water standards (i.e., safe for human consumption), it is non-potable freshwater and should be reported in the data field in AEWRS under "Industrial", "Landscaping", or "Agricultural" depending on the application.
2. If the well water is treated to the level that is potable (i.e., safe for human consumption), it should be reported in the "Potable" entry field in AEWRS no matter the application. For example, if potable water is supplied for landscape irrigation, this use remains in the potable water category and is not split out and entered into the "Landscaping" entry field.

Q: If an installation has a closed loop wash rack that has potable water for make-up but it recirculates the water for multiple washing, is only the potable make-up water reported or is the recirculated water also reported?

Q: Can you run thru a Tactical Equipment Vehicle Wash that uses potable water for makeup water but recycles and treats onsite the water for reuse multiple times? Do we capture water quantity of water recycled, treated onsite, & re-pumped as alternate non-potable water?

Q: Can we count recycled treated water in a vehicle wash count as alternate non-potable?

The following provides specific instructions on how to report water use in AEWRS for closed loop Central Vehicle Wash Facilities (CVWF):

- Recycled water: The amount of water recycled in a closed loop CVWF should not be entered into AEWRS in any of the water fields.
- "Potable" Water: If the installation uses potable water for CVWF make-up and has a master meter on the potable water supply (which is typical), the potable water used for vehicle wash make-up should already be captured in the total potable water measured by the master meter. Therefore the installation should not add the CVWF potable water make-up to the total because it is already accounted for by the total water use measured by the master meter.
- "Industrial" Water: If non-potable freshwater or purchased reclaimed water is used for CVWF make-up, the make-up should be metered and that amount should be included in the "Industrial" field in AEWRS. If the make-up is not metered, then the amount of water can be estimated by calculating losses from the system due to evaporation, overspray, and system discharge.
- "Alternative Non-potable":
    - If an installation uses water collected on-site, not obtained from a freshwater source or purchased from a third party (e.g. on-site reclaimed water) as CVWF make-up, this amount should be included in "Alternative Non-potable" water category in AEWRS.

Q: Currently our filter backwash effluent (which is potable water) goes to sanitary. If we made the necessary hurdles for safe usage could it be used to irrigation and have it count as Alternative Non-potable?
Yes, if an installation captures, treats, and reuses filter backwash effluent, this is considered "Alternative Non-potable" water and should be reported in that field in AEWRS.

Q: Should reported potable water consumption figures be reduced by removing usage of "excluded" tenants (reimbursable customers)? I ask because water consumption is now measured by Intensity (Use/SF) and these tenants' square footage is not top-loaded to AEWR, nor does the installation dictate their water consumption practices or invest in water saving features for these tenants?
Q: Do we include water used for RCI/PAL (privatized housing/temporary lodging)?
If the building/s is privatized and not federally owned, such as privatized family housing, then the square footage should be excluded from the total gross facility floor space and energy and water use should not be reported by the installations in AEWRS. However, if the building/s is a reimbursable tenant and is owned by the Army, then the square footage should be captured in the total gross facility floor space and energy and water should be reported in AEWRS for those tenants.

Q: Does Alternative Non-potable include water used for recharge?
Water data reported in AEWRS is only related to consumption not recharge. Installations should not report recharge data into AEWRS in any of the water related fields.

Q: Can installations be exempted from AEWRS reporting if they are way ahead of the curve with water conservation?
No. All Army installations are required to enter all of their water use in AEWRS quarterly. Installations that have exceeded the reduction requirements need to be accounted for in AEWRS to show their progress in helping the Army meet the water reduction goals!

Questions on the Irrigation Estimating Tool

Q: What if a post has 10 areas and some are turf only, some are mixed bed only, and some are mixed bed only?
Q: Some areas are mixed bed and turf only. Does the tool account for this?
The irrigation estimating tool has the capability to run landscape irrigation areas for turf only and mixed bed separately. Each area's irrigation is estimated and shown separately on the #4 Outputs tab.

Q: Can tool be adapted to xeriscaping in desert climates where you only water bushes, trees, plantings with no turf at all?
Yes. For a mixed bed that has native and adaptive plantings (e.g. xeriscape), the tool allows the user to enter the specific requirements for that landscape type. For a xeriscape landscape type, the specific inputs are as follows:

- "Mixed Bed Water Requirements": native and adaptive plantings, the input is "low"
- "Plant Density": if the bed is sparsely planted, which is typical for xeriscape style landscape, the input is "low" (however if the area is more densely planted, then select the most appropriate choice between "average" or "high")

Q: Where does drip irrigation go as far as efficiency?
In the #3 Irrigation Inputs tab, irrigation system efficiency for drip irrigation would typically be around 85% for systems that have regular maintenance and proper scheduling. (Drip system efficiency is noted in the instructions provided for this input.)

A.5 Calculations Used in Irrigation Estimating Model

Information provided in this section documents the approach taken to calculate the annual irrigation factor in the irrigation estimating model, which is used to compute the water requirements of landscape area. The data used to calculate the annual irrigation factor is the following:

- Reference evapotranspiration (ET)
- Turfgrass ET (also called crop ET)
- Landscape ET
- Turfgrass and landscape coefficients
- Precipitation

The following information details these factors and equations used to develop the annual irrigation factor.

A.5.1 Evapotranspiration

ET is the amount of water loss from the soil due to evaporation and plant transpiration, which represents the amount of water required by the plant to maintain a health state. ET is typically measured in inches over a specific period. ET was used to calculate the annual irrigation factor. This approach utilizes information on actual water requirements for specific landscape types based on the evaporation and transpiration of the plants in the landscape.

Turfgrass ET: The general equation used to calculate water requirements for turfgrass is as follows:

$$ET_c = K_c \, x \, ET_o$$

Where:

ET_c = Turfgrass ET (also known as crop ET)
K_c = Turfgrass coefficient (also known as crop coefficient)
ET_o = Reference ET

The turfgrass ET is amount of water needed to maintain healthy turf for a given location. This value is adjusted based on a "reference crop." The reference crop is alfalfa, which is a high water-consuming grass. In other words, water required for all turf types whether it is Kentucky bluegrass or Bermuda grass is compared to the water needs of alfalfa. So, the reference ET is the total amount of water needed to grow alfalfa grass during a specific time frame and location under typical regional conditions for that area (including variables such as humidity, temperature, and wind speed).

The turfgrass coefficient indicates the relative amount of water needed for the landscape compared to the reference crop (which has a K_c of 1). This term is also referred to as crop coefficient and represents the fraction of water lost from different species of turfgrass relative to the reference ET. Cool season grasses, such as fescue, have a K_c of 0.8, while warm season grasses have a K_c of 0.6. This means that cool season grasses typically require about 80% of the water of alfalfa to retain a healthy state while warm season grasses such as Bermuda and zoysiagrass need about 60% of the water (California Department of Water Resources 2000).

Mixed Bed ET: The irrigation estimating model also has the capability of calculating irrigation requirements of landscaped areas with mixed plantings such as shrubs, trees, and flower beds. The general equation used to calculate water requirements of landscaped areas is as follows (California Department of Water Resources 2000):

$$ET_L = K_L \times ET_o$$

Where:

ET_L = Landscape ET
K_L = Landscape Coefficient
ET_o = Reference ET

Similar to the description above for turfgrass, landscape ET calculates the amount of water needed to maintain a healthy landscape. The landscape coefficient reflects the fraction of water needed to maintain the health of a given landscape relative to the amount of water needed for the reference crop of alfalfa. The landscape coefficient is based on three factors:

1. Type of species
2. Density of plants in the landscape
3. Microclimate of the landscape (e.g., protected vs. exposed)

Each of these factors are multiplied together to determine the overall landscape coefficient, represented in the following equation:

$$K_L = k_s \times k_d \times k_{mc}$$

Where:

k_s = Species Factor
k_d = Density Factor
k_{mc} = Microclimate Factor

The factors are explained below:

Species Factor (k_s)*:* The species factor is defined by the water needs of the plants in the landscape for the given location and climate. The following species factors can be applied to three general landscape types:

- Low k_s: Plants with minimal water needs have a low k_s ranging between 0.1 and 0.3
- Average k_s: Plants with moderate water needs have an average k_s of between 0.4 and 0.6
- High k_s: Plants with elevated water requirements have a high k_s of between 0.7 and 0.9.

Note, if there is a mixture of plants with differing water needs, the species factor is chosen for the plant type with the highest water requirement.

Density Factor (k_d): The density factor determines how densely populated the plants are in the landscape. The following density factors can be applied to three general landscape types:

- Low k_d: Immature and sparsely planted landscape have a low k_d ranging between 0.5 and 0.9

- Average k_d: Predominantly one vegetation type have an average k_d of 1
- High k_d: Landscape with mixture of plant types with full coverage have a high k_d ranging between 1.1 and 1.3.

Microclimate Factor (k_{mc}): The microclimate factor takes into consideration the environment in which the landscape is planted. Factors determining k_{mc} include effects of temperature, wind, and amount of sunlight received by the area. The following microclimate factors can be applied to three general landscape types:

- Low k_{mc}: Areas shaded from sunlight and protected from wind and heat gain have a low k_{mc} ranging between 0.5 and 0.9
- Average k_{mc}: Landscape areas that are in an open, flat field (the same as the reference conditions) have an average k_{mc} of 1
- High k_{mc}: Landscape areas with intense exposure to the elements such as high heat gain or windy conditions have a high k_{mc} ranging between 1.1 and 1.4.

A.5.2 Reference ET_o Rates and Precipitation Data

ET_o and precipitation data used in the model was provided by the U.S. Environmental Protection Agency's WaterSense program. WaterSense has developed a tool called the WaterSense Landscape Water Budget Tool (http://www.epa.gov/watersense/nhspecs/water_budget_tool.html) (U.S. Environmental Protection Agency 2010).

The WaterSense tool utilizes ET_o rates and precipitation developed by the International Water Management Institute (IWMI) Climate Atlas. The IWMI Climate Atlas utilizes 30 years of historical climate data. The data includes monthly data for ET_o and precipitation by location.

Effective Precipitation: The effective precipitation is taken into account in the model, which assumes a certain percentage of precipitation is taken up by the plants depending on the soil type:

- Sandy: 40%
- Loam: 50%
- Clay 60%

A.5.3 Annual Irrigation Factor

The annual irrigation factor calculated in the model represents the amount of water in gallons per square foot required to maintain a healthy landscaped or turf area over 1 year. The annual irrigation factor takes into account the growing season for the location and plant type as well as the amount of effective precipitation that is typically received in that area on a monthly basis. The following formula represents the annual irrigation factor:

$$Annual\ Irrigation\ Factor\ \frac{gallons}{sqft-year} = \left[\sum monthly\ ETc - \sum monthly\ precipitation\ \times EP\right] \times\ Cu$$

Where:

Annual Irrigation Factor (gallons per square foot per year) = supplemental water required to maintain healthy landscape per square foot of landscaped area

$\sum ET_c$ = sum of monthly crop or landscape coefficients during the growing season for the specific location, in inches per month.

$\sum$Rainfall = sum of monthly historical rainfall received during the growing season for the specific location, in inches per month.

EP = effective precipitation factor representing the amount of precipitation that is actually absorbed by the soil for plant growth

C_u = conversion factor of 0.6233 to convert annual irrigation from inches to gallons

The annual irrigation factor represents the sum of monthly supplemental water requirements to maintain a healthy landscape or turf area.

A.5.4 Water Estimate

The water use estimate is determined by multiplying the annual irrigation factor by the landscaped area (in square feet) and divide by the system efficiency. This is represented in the following formula:

$$Annual\ Landscape\ Water\ Use\ (gallons\ per\ year) = \frac{Annual\ Irrigation\ Factor\ \left(\frac{gal}{sqft-yr}\right) \times Irrigation\ Area\ (sqft)}{Irrigation\ System\ Efficiency}$$

A.5.5 References

California Department of Water Resources. August 2000. *A Guide to Estimating Irrigation Water Needs of Landscape Planting in California – The Landscape Coefficient Method and WUCOLS III*, University of California Cooperative Extension, Sacramento, CA – provided basic methodology for calculating annual irrigation factors: www.water.ca.gov/wateruseefficiency/docs/wucols00.pdf.

U.S. Environmental Protection Agency. March 2010. *Water Budget Tool Website*, N.W. Washington, D.C. – provided monthly reference evapotranspiration and precipitation data: http://www.epa.gov/watersense/nhspecs/wb_data_finder.html.

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