General Services Administration
Public Buildings Service

GPG-018 | JANUARY 2015

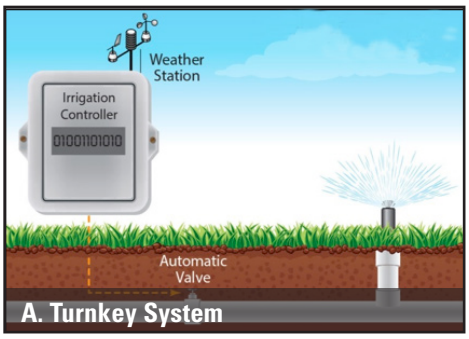
# WEATHER STATION FOR IRRIGATION CONTROL

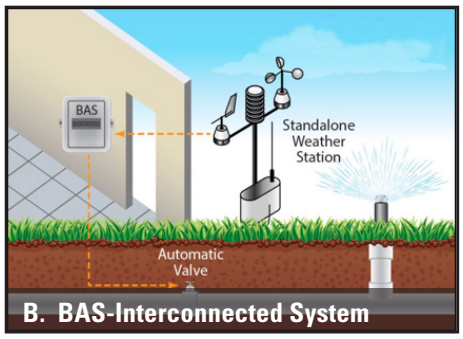
## BAS-Connected Weather Stations Target GSA Smart Buildings Initiative

Much of GSA landscaping relies on timer-based irrigation systems, which can overwater by as much as 50 percent.[1] Smart irrigation controllers, by contrast, water only as much as local conditions require, and can thereby significantly reduce irrigation water use. One type of smart irrigation, weather-based, uses local weather data to measure and respond to irrigation needs. Turnkey weather-based irrigation systems have been commercially available for years and have demonstrated water savings between 20 and 40 percent, depending on climate, soil, and vegetation profile.[2] In 2013, the GSA's GPG program commissioned the Pacific Northwest National Laboratory (PNNL) to assess the performance of a unique smart-irrigation system that connects a weather station to the building automation system (BAS) at the Hart-Dole-Inouye Federal Center in Battle Creek, Michigan. Connecting the weather station to the BAS aligns with GSA's "smart buildings initiative," the goal of which is to integrate building systems to enable data-sharing and enhanced operations. Ultimately, the challenges of connecting the weather station to Battle Creek's BAS outweighed the potential benefits, at least for the present. However, estimated water savings support the effectiveness of turnkey weather-based systems, which are replicable across landscaped sites in GSA's portfolio.

The GPG program enables GSA to make sound investment decisions in next generation building technologies based on their real world performance.

# INTRODUCTION




### Weather-Based Irrigation Control

A. Turnkey systems include a weather station, internal software to determine water needs, and flow sensors to monitor water use.

B. BAS-interconnected weather stations provide data to the BAS for calculating evapotranspiration and controlling irrigation.

*"Our region is taking innovative approaches to water conservation. It's no accident that in FY14 we won a FEMP award for reducing our water use by 55 percent."*

—Mark Hurley
Building Services Specialist
Great Lakes Region
U.S. General Services Administration

**PERFORMANCE SPECIFICATIONS**
Water Savings

**EXECUTIVE ORDER 13514**
Reduction in industrial, landscaping and agricultural water use compared to 2010 baseline — **20%**

**SMART-IRRIGATION**
Projected Water Savings — **20-40%**

## What Is This Technology?

### LOCAL WEATHER DATA ENABLES IRRIGATION CONTROLLER TO MEET IN-TIME LANDSCAPE WATER NEEDS

Most incumbent commercial irrigation systems are timer-based: they schedule the delivery of a predetermined amount of water—rain or shine. Smart-irrigation controllers, both sensor- and weather-based, irrigate landscapes according to actual need. Weather-based control systems, like those considered here, use live local weather data and information about the landscape to calculate evapotranspiration (ET)—the level of moisture loss from the soil due to evaporation and plant transpiration. Weather-based systems are typically turnkey, and can evaluate a landscape's water needs, schedule irrigation run time, and monitor water use. The evaluation at the Battle Creek demonstration site set out to implement a smart building version of this technology by connecting a scientific-grade weather station with the facility's BAS. This interconnection would allow building operators to collect and interpret water data, and to control irrigation via the BAS platform. A scientific-grade weather station was chosen for the Battle Creek demonstration site because it provided more robust data than are usually available from commercial weather stations.

## What We Did

### ASSESSED BAS-CONNECTED DEMONSTRATION PROJECT AND PROVIDED LIFE-CYCLE COST (LCC) ANALYSIS

In 2013, GSA staff installed a scientific-grade weather station at the Battle Creek demonstration site, hardwired it to the facility's BAS, and programmed the BAS to set irrigation equipment runtime for 3.2 landscaped acres. PNNL assessed water usage and the performance of the BAS weather station configuration over a one-month period, which was shorter than originally intended because of challenges in programming the system. Using projected water savings supported by the assessment period, PNNL researchers performed life-cycle cost analyses for medium and large facilities to demonstrate when and where turnkey systems will be most cost-effective.

# FINDINGS

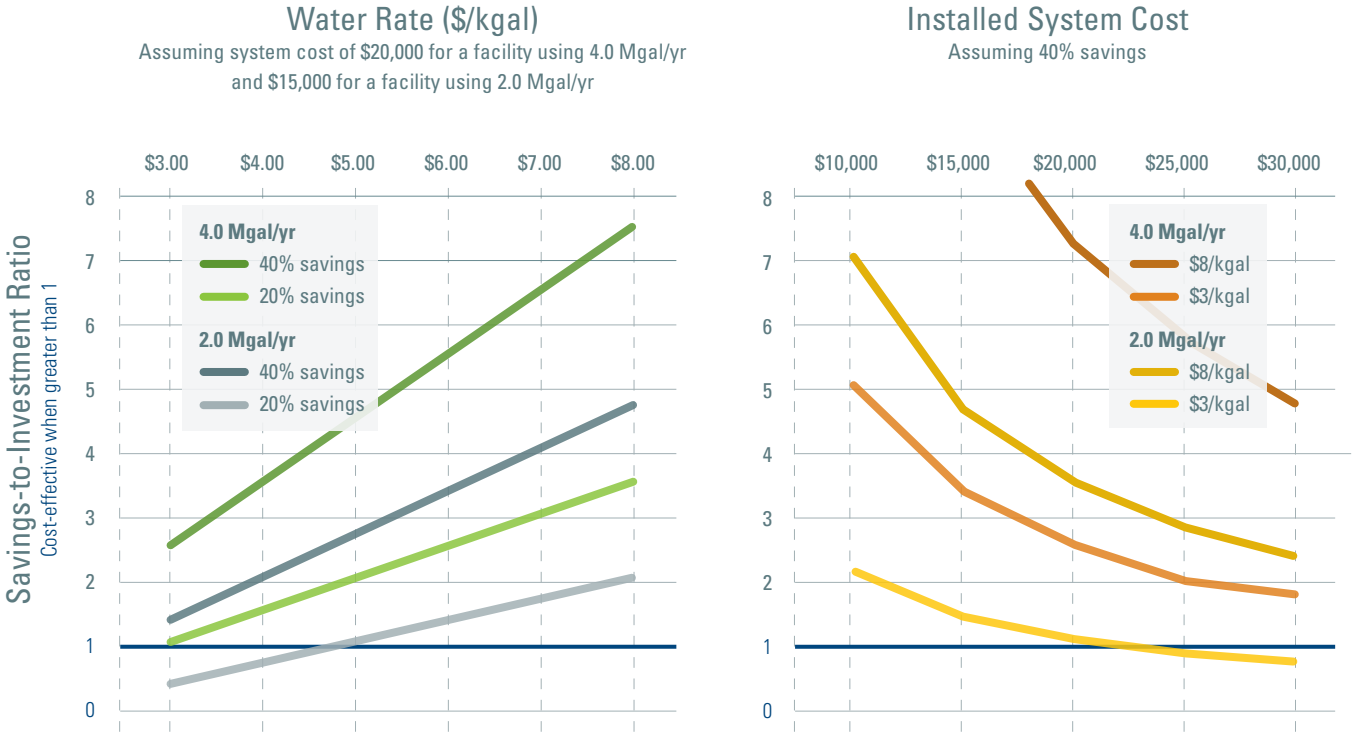
**BAS-CONNECTED WEATHER STATION CHALLENGING TO PROGRAM** The potential benefits of connecting a weather station to a BAS are outweighed by the complexities of custom programming at this time. Until clearer guidelines for BAS integration can be established, turnkey weather-based systems are recommended.

**SIGNIFICANT WATER SAVINGS POSSIBLE** Researchers estimated a 66% savings in water use at Battle Creek by comparing irrigation needs with the baseline water usage of the incumbent timer-based system. Because of the shortened study period, they were not able to measure actual water savings.

**LCC ANALYSIS SHOWS WHEN SMART-IRRIGATION SYSTEMS WILL BE COST-EFFECTIVE** Assuming a more typical savings of 40%, a GSA facility that uses 4 million gallons (Mgal) annually is LCC-effective at a water rate of $1.40 per thousand gallons (kgal) and an installed cost of $20,000.

**SMART-IRRIGATION SYSTEMS BEST WHERE GROWING SEASONS HAVE INTERMITTENT RAIN** Areas with intermittent rain throughout the growing season will have higher water savings and should be targeted first for deployment.*

## Life-Cycle Cost Analysis for Smart-Irrigation Systems



# CONCLUSIONS

These Findings are based on the report, "Assessment of Weather Station Used for Irrigation Control: Hart-Dole-Inouye Federal Center, Battle Creek, MI ," which is available from the GPG program website, www.gsa.gov/gpg

For more information, contact
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## What We Concluded

### INTEGRATING BUILDING DATA CAN ENABLE EFFICIENCIES BUT WILL NEED MORE SUPPORT

In its attempt to integrate irrigation control into the BAS, the Hart-Dole-Inouye Federal Center demonstration project supported GSA's smart building initiative. To fully realize the potential for system-wide data sharing and performance efficiencies, a standardized algorithm for programming BAS-interconnected weather-based irrigation systems could be developed, leveraging the lessons from the demonstration project. In the interim, turnkey systems for weather-based irrigation control, which have demonstrated water savings of up to 40 percent with minimal programming required by facilities staff, are commercially available. Modeling has helped to determine where smart irrigation systems will be life-cycle cost-effective, providing deployment guidance for GSA facilities.

## Best Practices

- Until standards are developed for BAS interconnection, procure turnkey systems that are fully integrated with an on-site weather station or with real-time weather data integrated into the irrigation controller. Contract with local irrigation professionals for aid in system selection and installation.
- Controllers should achieve WaterSense[5] performance requirements of 80% irrigation adequacy and maximum 10% irrigation excess, in accordance with the Irrigation Association's SWAT testing protocol.
- Choose systems that automatically calculate system runtime based on evapotranspiration, interrupt the system when it rains, and allow user input for on-site conditions, such as landscape and soil type.
- Make sure that the weather-based system has a "deficit watering" setting, which reduces irrigation below the required soil moisture content. This can be critical in drought conditions, where watering restrictions may be in place.
- If the weather-based system uses wireless connections, test it thoroughly to ensure that wireless signals can be transmitted consistently.
- During commissioning, the controller and weather gauges should be tested to make sure that weather data is accurately uploaded and the schedule is adjusting to weather conditions. Weather gauges and water flow sensors should be regularly calibrated to support accurate readings.
- For large facilities with multiple irrigations zones, consider implementing a centralized control system over all irrigation zones and equipment.

*Reference to any specific commercial product, process or service does not constitute or imply its endorsement, recommendation or favoring by the United States Government or any agency thereof.*

### Footnotes

[1]U.S. Environmental Protection Agency. 2013b. WaterSense. WaterSense Labeled Irrigation Controllers. http://www.epa.gov/watersense/products/controltech.html

[2]U.S. Environmental Protection Agency. 2012. WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities. http://www.epa.gov/watersense/commercial/docs/watersense_at_work/#/160/

[3]Dukes, MD. Water Conservation Potential of Landscape Irrigation Smart Controllers. American Society of Agricultural and Biological Engineers. ISSN 2151-0032. 2012.

[4]American Water Works Association. 2014. 2013 Water and Wastewater Rate Survey. Denver, CO.

[5]WaterSense, an EPA Partnership Program, http://www.epa.gov/watersense/

*Subject to evaluation and approval by GSA-IT and Security.

*Technology for test-bed measurement and verification provided by Campbell Scientific.*