2020 INNOVATIVE CONSERVATION PROGRAM

FINAL REPORT

LEAK DETECTION AND WATER CONSUMPTION MONITORING IN MULTI-FAMILY PROPERTIES

Burbank Water and Power

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In partnership with:

Conservation Labs, Inc.

Prepared for:

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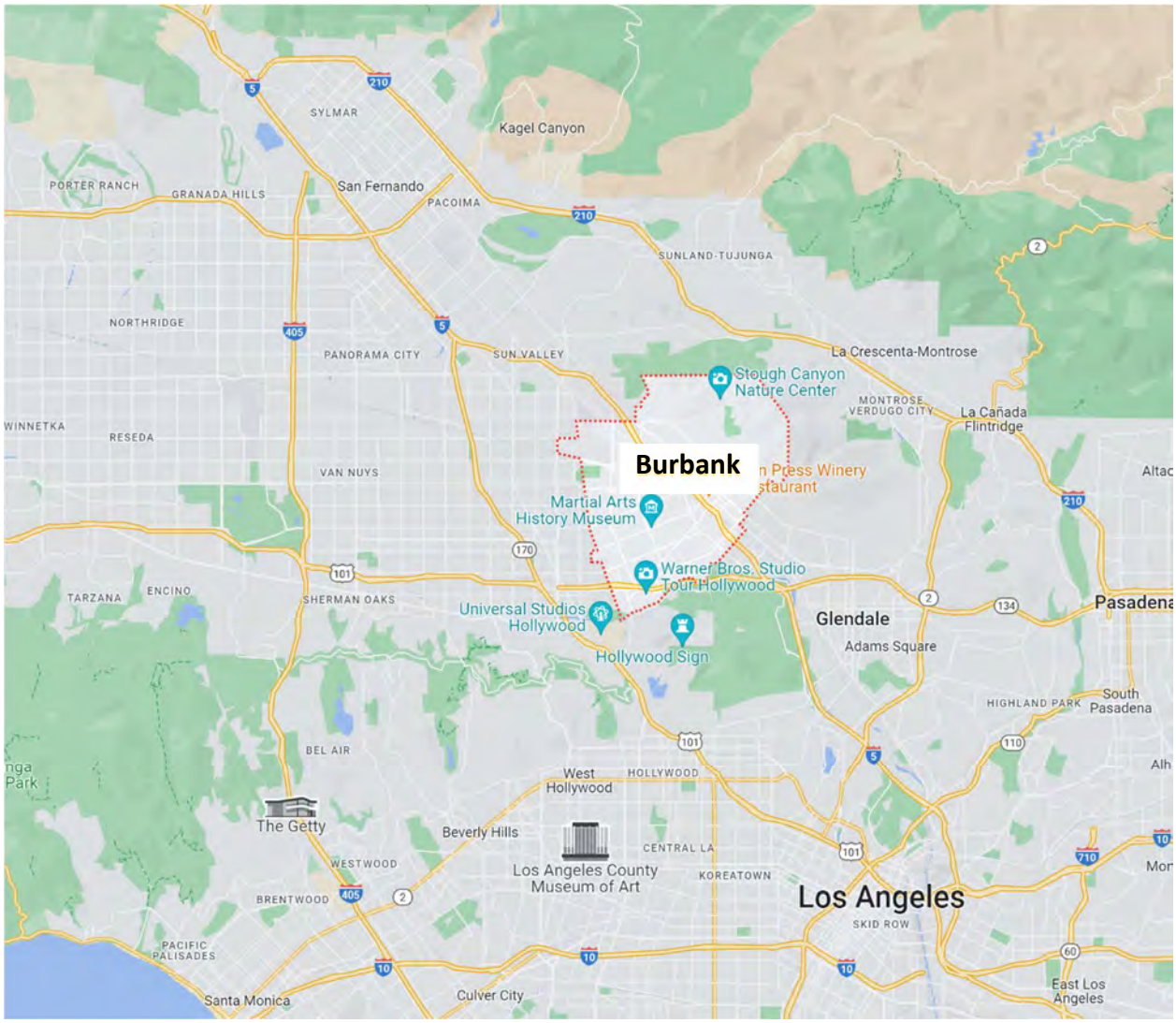
DISCLAIMER

This project was conducted with financial assistance from a grant from the Metropolitan Water District of Southern California (MWD), the U.S. Bureau of Reclamation, the Central Arizona Project, the Southern Nevada Water Authority, the Southern California Gas Company, and the Western Resource Advocates through MWD's Innovative Conservation Program (ICP). The ICP provides funding for research to help document water savings and reliability of innovative water savings devices, technologies, and strategies. The findings of this project, summarized in this report, are solely from the project proponent. MWD and the ICP funding partners do not endorse any particular product, service, or company, including those discussed in this report. The information provided within this report is not certified by MWD and any party referencing this report should verify information as needed for its own purpose

EXECUTIVE SUMMARY

The City of Burbank is located in southern California, approximately 12 miles north of downtown Los Angeles, as shown in Figure 1. The City of Burbank covers about 17 square miles (10,880 acres) of the eastern end of the San Fernando Valley. The City of Los Angeles lies to the north and west, and the City of Glendale to the south and east.

Figure 1.



The City of Burbank is known as the "Media Capital of the World." It is home to The Walt Disney Company, Warner Bros Studios, The Burbank Studios, Nickelodeon, Cartoon Network, ABC Studios, Netflix, and KCET. Numerous small media businesses also support these significant studios in Burbank by providing sound stages for music artists and a wide variety of other key services, from post-production to wardrobe and make-up, all of which are essential to the industry. Burbank is also home to unique

shopping and dining neighborhoods such as Downtown Burbank and Magnolia Park. You can also visit the powerhouse Empire Center, the Burbank Town Center, and one of the largest IKEAs in North America.

The City of Burbank also has a vibrant residential community, with a housing mix of about 21,750 single-family homes that range from post-war bungalows to two-story homes. There are also about 22,500 multi-family homes, which continues to increase with infill and high-density development.

Burbank Water and Power (BWP) provides sustainable, affordable, and reliable electric and water utility services and a wide variety of water efficiency rebates and water conservation programs to its residential and business customers.

Burbank depends on imported water purchased from the Metropolitan Water District (MWD) of Southern California. BWP is one of 26 member agencies of MWD, a regional wholesale water supplier that imports water from the Colorado River and Northern California. MWD helps its member agencies develop water recycling, storage, and other local resources to provide additional supplies and conservation programs to reduce regional demands. Furthermore, MWD has implemented the Innovative Conservation Program (ICP) since 2001, sponsoring pilot and demonstration projects of innovative water-saving devices, technologies, and strategies. BWP applied for ICP grant funds to perform a pilot study to evaluate the water-saving potential and reliability of water usage monitoring devices for providing leak detection and water usage presentment services to multi-family building owners and residents.

Water Usage Data

BWP utilizes an Advanced Metering Infrastructure (AMI) for all commercial and residential water meters. This system communicates the water usage data remotely and in real time to BWP's databases. Single-family residents can access their water usage data through an online water management tool. However, multi-family residents cannot view the same water usage data because each unit does not have its own water meter. There is one AMI meter for the entire building for multi-family buildings, which gives property owners and managers access to the whole building's water usage information but not the water usage information of individual multi-family units. Because of that, it is nearly impossible for multi-family property owners and unit residents to view their usage, identify leaks, and change their habits. Not having accessible water usage information makes it challenging for building managers to identify and fix leaks promptly, resulting in water waste and high water bills.

Identifying potential leaks in multi-family building units and monitoring water usage at the individual unit level can be challenging when each unit is not sub-metered. However, the new water monitoring devices may provide customers with water usage and leak detection information.

Conservation Labs, Inc.

BWP staff researched different water usage monitoring devices and determined to partner with start-up company Conservation Labs, Inc., since Conservation Labs' solution is specifically designed for commercial properties, including multi-family properties. This start-up company has produced an innovative water monitoring device for multi-family properties, H2know (Figure 2), that attaches to an individual residential unit's main water lines within a multi-family building to monitor water usage and identify potential leaks. The H2know device also connects to a Wi-Fi connection and reports usage data to an online platform where property managers, utility staff, and residents can view usage trends.

Figure 2. H2know Water Monitoring Device

The H2know monitor provides water usage information and leak detection services at the individual unit level, down to the fixture level (e.g., faucet, shower, toilet). Device installation requires no plumbing skills, and according to Conservation Labs, it can be installed in under ten minutes. H2know device identifies potential leaks and notifies customers at the individual unit level within minutes. H2know device connects to a Wi-Fi connection and reports usage data to an online platform where property managers, utility staff, and residents can view usage trends.

BWP installed the H2know devices at each unit in multi-family buildings and provided property managers and residents access to their water usage information. The monitoring device can also offer apartment managers and residents information on possible leaks and high water usage leading to water savings in multi-family building units. BWP performed a study that evaluated the reliability and water-saving potential of the H2know device.

Conservation Labs' primary role in this project was to supply and install the H2know devices and provide software support services to multi-family property owners and BWP. The software system was accessible by BWP, multi-family property owners, managers, and residents at no cost during the implementation of the pilot study project.

This pilot study that BWP conducted analyzes the reliability and water-saving potential of the H2know device and allows BWP to determine the feasibility of future rebates or programs for water usage monitoring devices that empower both multi-family building owners and residents.

H2know Devices Installation

BWP collaborated with two property management companies in Burbank to conduct the ICP Pilot Project. After selecting the property management companies and identifying the potential buildings for the pilot project, BWP staff met with Conservation Labs to identify and select the most accessible multi-family properties and units for the Pilot Project and to develop the H2know device installation plan.

After developing the installation plan, Conservation Labs Inc. sent out a team of three staff members to each property location identified to install the H2know device. Conservation Labs Inc. conducted the site assessments to install the H2know devices. During the installation process, Conservation Labs Inc. conducted Wi-Fi connection testing, confirmed available power sources, determined the need for additional equipment, such as extension cords and Wi-Fi extenders, tagged the pipe location for the H2know device installation, installed the H2know devices, and confirmed the sensor connection and ensured successful data transfer.

In May 2022, Conservation Labs Inc. installed eighty-nine H2know devices at several multi-family properties in Burbank.

H2know App

The H2know App is a web application viewable on desktop and mobile browsers that provides property managers and residents with water consumption presentment. The application identifies all reporting sensors and breaks down water usage by day, time, and fixture type. Users can use the application to view leak alerts and enable receiving leak notifications on a provided phone number or an email address.

Figure 3. Water Usage Summary by Current Week on the H2know App Home Page

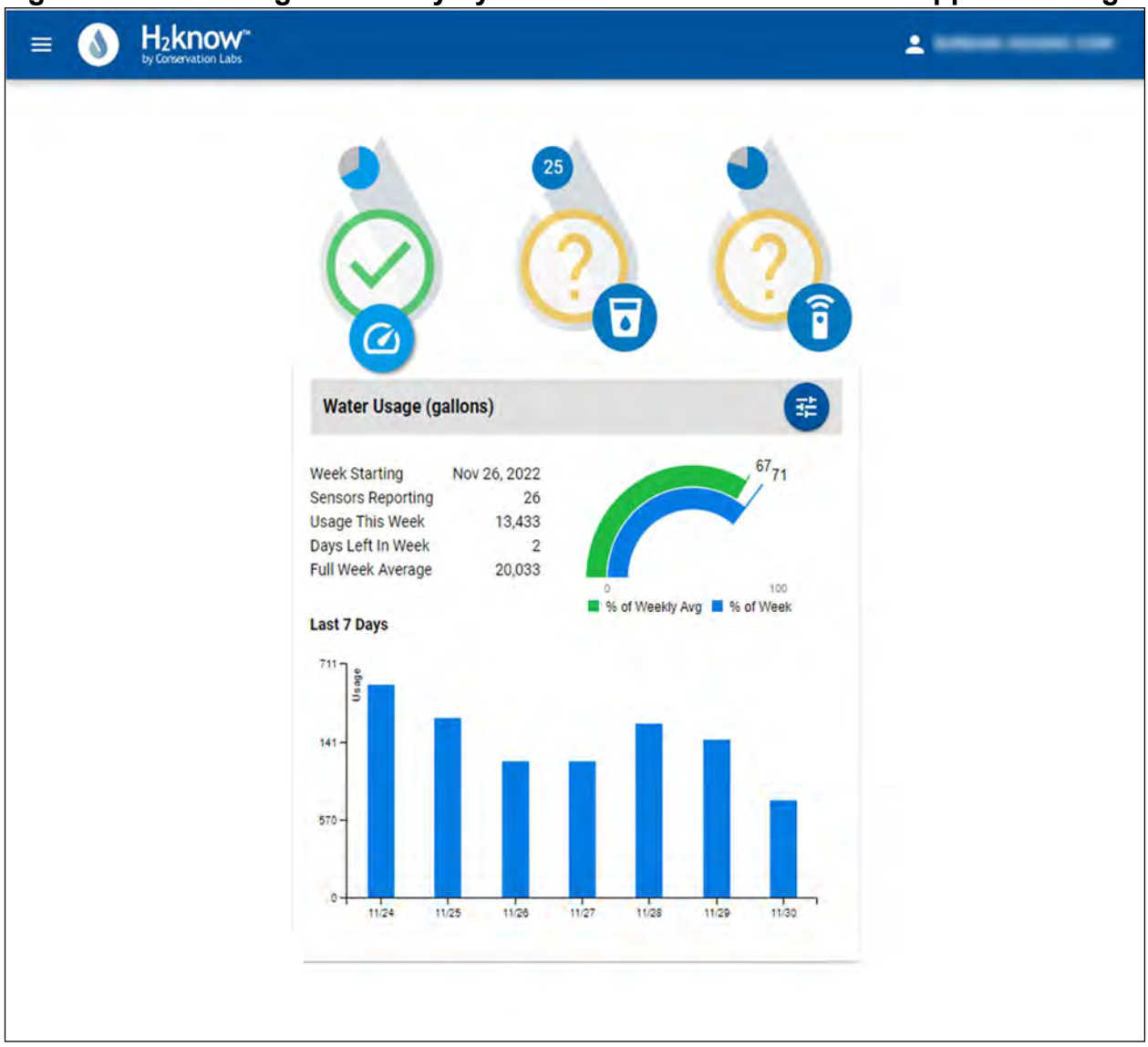


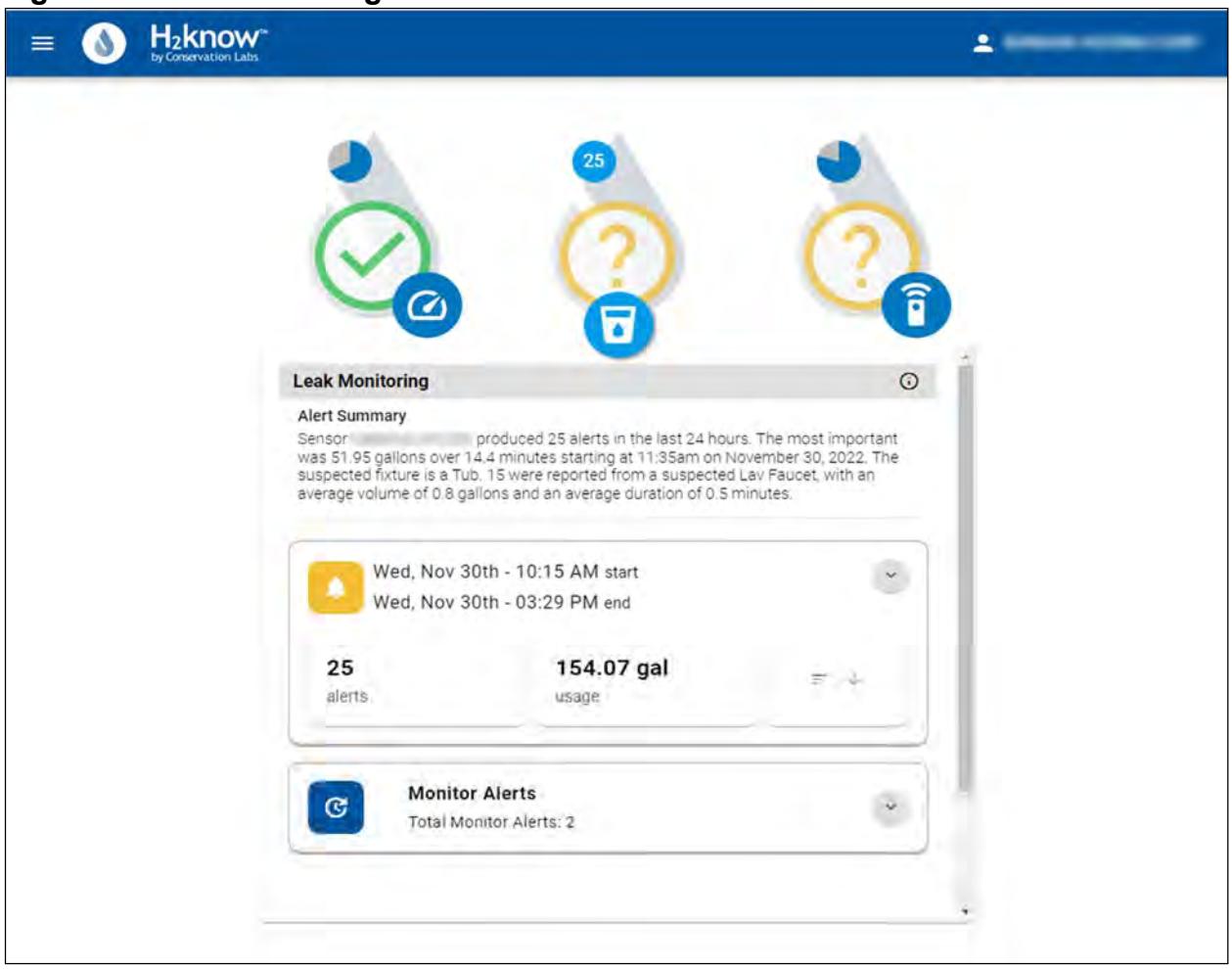
Figure 3 shows the home page of the H2know App. The curved green and blue bars indicate water usage progression during a week. The green curve represents the weekly usage and shows how much water the residential unit consumed as a percentage of the weekly average. The blue bar graph at the bottom of Figure 3 indicates daily water consumption.

Leak events are published on the Leak Monitoring Dashboard, as shown in Figure 4. These alerts are categorized as Blue, Red, Orange, or Yellow. Blue alerts are updated hourly and show water use that H2know is currently monitoring to see if it develops into a leak. Once H2know gathers more information and determines whether or not it is a leak, it will either advance these Blue alerts to Red, Orange, or Yellow status or remove them from the leak dashboard:

- Red indicates a suspected catastrophic leak that needs to be addressed immediately.
- Orange indicates a suspected leak that is persistent and potentially causing water loss.
- Yellow is an unusual or new pattern of water behavior that may or may not be causing water loss.

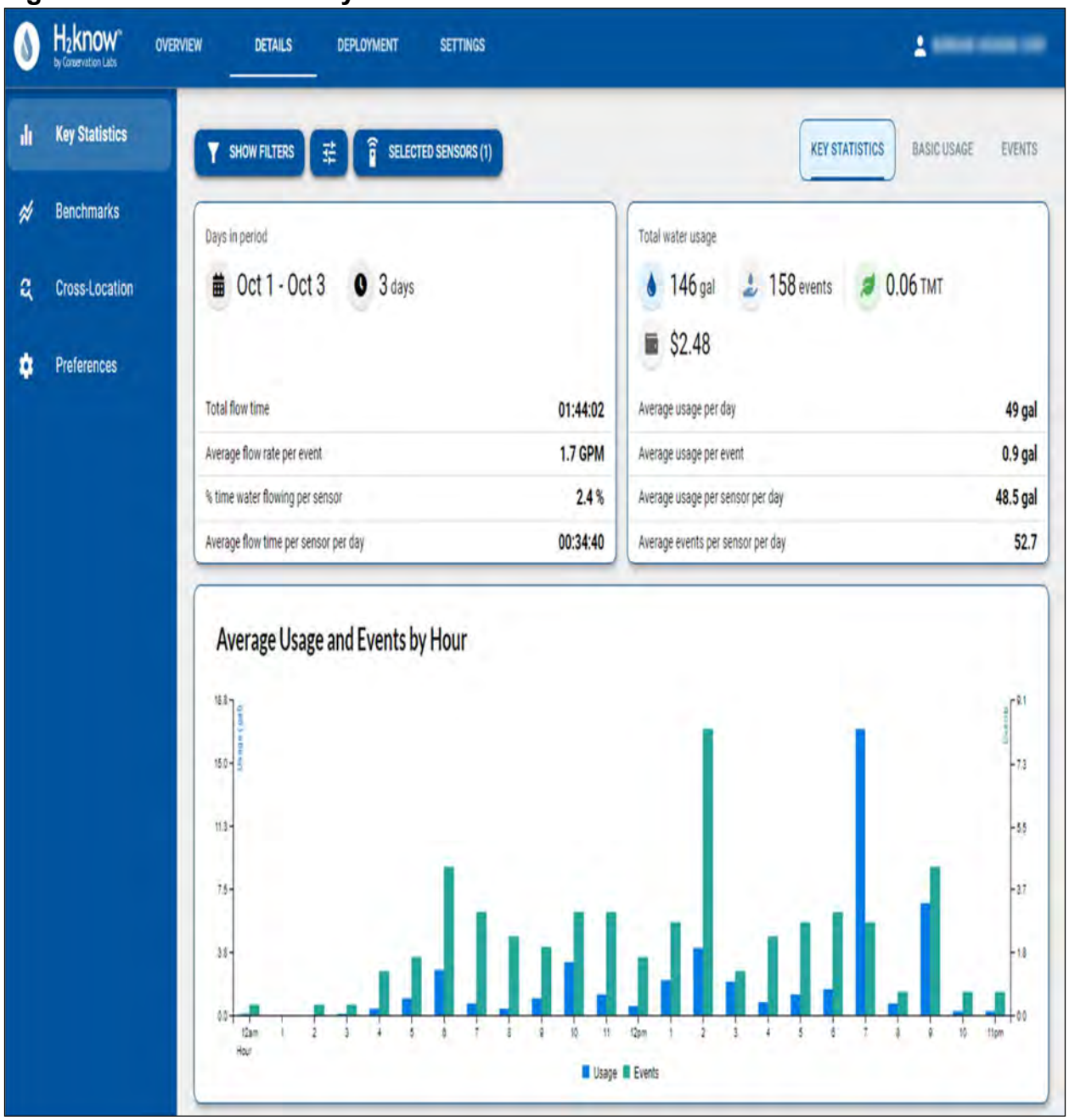
Each alert message contains the start time of the leak and the amount of water associated with the leak. The message will indicate if the leak is associated with a specific water fixture. This information helps investigate potential leaks and determine if further action is required.

Figure 4. Leak Monitoring Dashboard



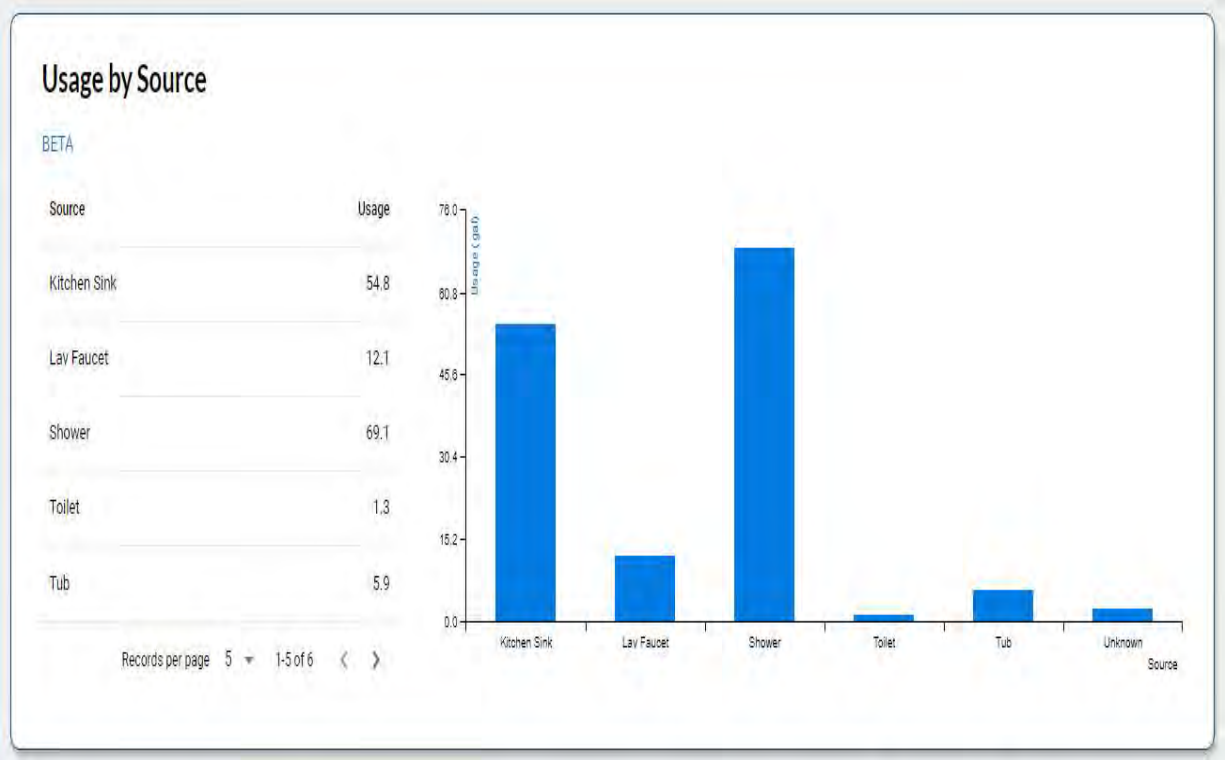
Property managers can view the water usage of all residential units or specific units selected through the filter shown in Figure 5. Figure 5 shows three-day water usage for one sensor or residential unit. The key statistics include the total time of water used, average flow rate, and average gallons of water used daily. The bar graph at the bottom of Figure 5 shows the average volume of water used by hour over the selected three-day period. Each “event” is the start and stop of a water flow. An example of one event is turning on a faucet and then turning it off.

Figure 5. Detail View of Key Statistics with Selected Sensor



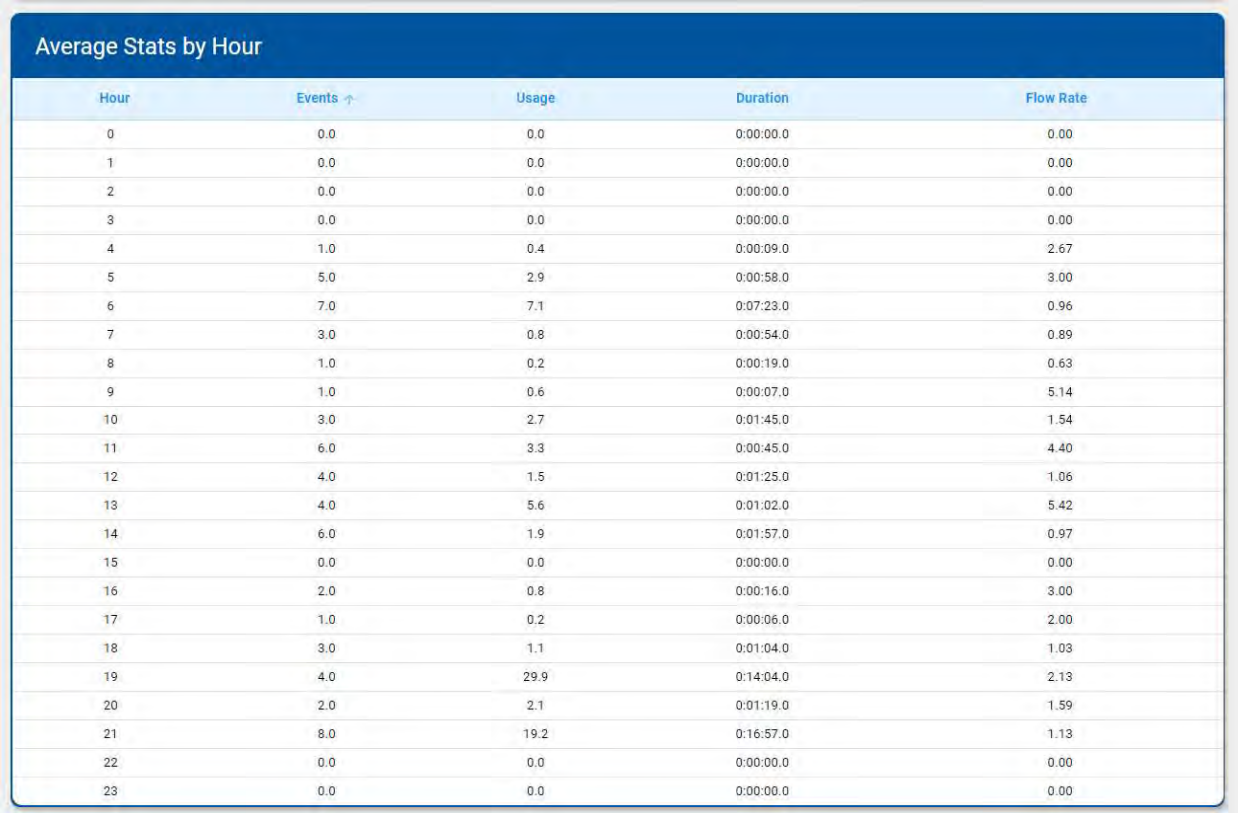
Property managers and residents can view the water usage of a residential unit by a specific water fixture, as shown in Figure 6.

Figure 6. Usage by Source



Furthermore, property managers and residents can view the hourly water usage of a residential unit, as shown in Figure 7 and the water fixture type, as shown in Figure 8.

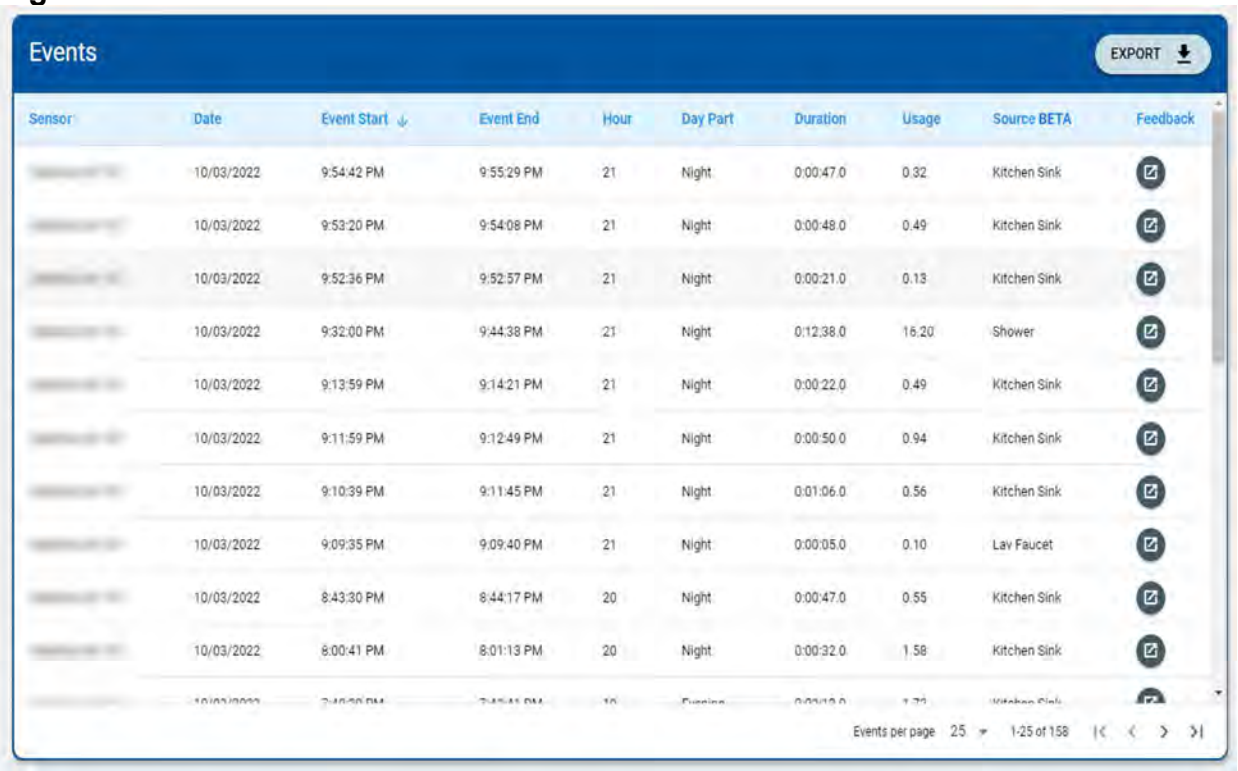
Figure 7. Average Stats by Hour



Average Stats by Hour

Hour	Events	Usage	Duration	Flow Rate
0	0.0	0.0	0:00:00.0	0.00
1	0.0	0.0	0:00:00.0	0.00
2	0.0	0.0	0:00:00.0	0.00
3	0.0	0.0	0:00:00.0	0.00
4	1.0	0.4	0:00:09.0	2.67
5	5.0	2.9	0:00:58.0	3.00
6	7.0	7.1	0:07:23.0	0.96
7	3.0	0.8	0:00:54.0	0.89
8	1.0	0.2	0:00:19.0	0.63
9	1.0	0.6	0:00:07.0	5.14
10	3.0	2.7	0:01:45.0	1.54
11	6.0	3.3	0:00:45.0	4.40
12	4.0	1.5	0:01:25.0	1.06
13	4.0	5.6	0:01:02.0	5.42
14	6.0	1.9	0:01:57.0	0.97
15	0.0	0.0	0:00:00.0	0.00
16	2.0	0.8	0:00:16.0	3.00
17	1.0	0.2	0:00:06.0	2.00
18	3.0	1.1	0:01:04.0	1.03
19	4.0	29.9	0:14:04.0	2.13
20	2.0	2.1	0:01:19.0	1.59
21	8.0	19.2	0:16:57.0	1.13
22	0.0	0.0	0:00:00.0	0.00
23	0.0	0.0	0:00:00.0	0.00

Figure 8. Events



Events

EXPORT

Sensor	Date	Event Start	Event End	Hour	Day Part	Duration	Usage	Source BETA	Feedback
[redacted]	10/03/2022	9:54:42 PM	9:55:29 PM	21	Night	0:00:47.0	0.32	Kitchen Sink	
[redacted]	10/03/2022	9:53:20 PM	9:54:08 PM	21	Night	0:00:48.0	0.49	Kitchen Sink	
[redacted]	10/03/2022	9:52:36 PM	9:52:57 PM	21	Night	0:00:21.0	0.13	Kitchen Sink	
[redacted]	10/03/2022	9:32:00 PM	9:44:38 PM	21	Night	0:12:38.0	16.20	Shower	
[redacted]	10/03/2022	9:13:59 PM	9:14:21 PM	21	Night	0:00:22.0	0.49	Kitchen Sink	
[redacted]	10/03/2022	9:11:59 PM	9:12:49 PM	21	Night	0:00:50.0	0.94	Kitchen Sink	
[redacted]	10/03/2022	9:10:39 PM	9:11:45 PM	21	Night	0:01:06.0	0.56	Kitchen Sink	
[redacted]	10/03/2022	9:09:35 PM	9:09:40 PM	21	Night	0:00:05.0	0.10	Lav Faucet	
[redacted]	10/03/2022	8:43:30 PM	8:44:17 PM	20	Night	0:00:47.0	0.55	Kitchen Sink	
[redacted]	10/03/2022	8:00:41 PM	8:01:13 PM	20	Night	0:00:32.0	1.58	Kitchen Sink	
[redacted]	[redacted]	[redacted]	[redacted]	19	Evening	[redacted]	1.72	Kitchen Sink	

Events per page 25 1-25 of 158

COMMUNICATION AND MARKETING

BWP sent out mail and email communications to engage participating residents in the Pilot Project and to increase the awareness about water consumption and conservation.

Welcome Mail and Email

BWP sent letters and emails to welcome the participants into the Pilot Project. The Welcome Mail is shown in Figure 9 and the Welcome Email is shown in Figure 10. The letter and email notified residents about the Pilot Project and invited residents to register on the H2know flow monitoring application to view their water usage. The email received a 74 percent email open rate. However, as of November 18, 2022, no customer signed up to use the flow monitoring application.

Saving Challenge Start Email

On September 29, 2022, BWP emailed participating residents about a water savings challenge for the month of October, resulting in a 69 percent email open rate. The email is shown in Figure 11 and communicated about the water savings challenge for October 2022. It also provided the baseline water use data for the month of September 2022 for each residential unit. The email contained customers' unique information, such as the top three uses of water in the customer's home that are opportunity areas for conservation.

Weekly Water-Saving Update

BWP sent Weekly Water-Saving Update emails to the participating residents encouraging them to view and keep track of their water usage. The email is shown in Figure 12 and provided details on the Pilot Project and encouraged the resident to participate in a water-savings challenge that BWP conducted in October and November.

Water Saving Challenge Winner

BWP entered the participating residents into a water savings challenge for the month of October to make the Pilot Project a meaningful experience. BWP used this communication to encourage the Pilot Project participants to sign up for the H2know flow monitoring application so that they can see more information on their water usage. BWP also used this communication to ask customers provide their feedback about participating in the Pilot Project.

The top three participants who saved the most water won a $100, $50, or $25 Amazon gift card as a prize. Anyone who reduced their water use by 15 percent or more was also entered into a raffle for a chance to win a $25 Amazon gift card. Winning participants received a notification and Amazon gift card prizes via email.

Figure 9.

CITY OF BURBANK
WATER AND POWER

November 8, 2022

Get Access to the Free Water Monitoring App

Fill out this online form to get access to the app!

https://bit.ly/bwp-app

Dear Valued Customer,

You're invited to use a *free* Water Monitoring App to see how you use water on a daily basis and find opportunities to save water in your home.

Burbank Water and Power (BWP) is partnering with {insert property name} on a pilot project to help residents save water. You may have noticed small H2Know devices being installed around your building. The H2Know device is a non-invasive flow monitoring device that monitors and collects data on water use in your unit and around your building.

As part of this pilot project, you and your neighbors will get access to a free water monitoring app. All you have to do is complete the online form using the link below to get access.

The free Water Monitoring App will allow you to see your water usage data, see if you have a leak, and get insights to help you conserve water. We hope you take advantage of this free resource to help you save water.

If you have any questions, please get in touch with the BWP Conservation team by email at **BWPConservation@burbankca.gov**, or by phone at **(818) 238-3730** from Monday through Friday, 8 am to 5 pm.

Sincerely,

Ruzan Soloyan
Program Manager, Burbank Water and Power

164 WEST MAGNOLIA BOULEVARD
BURBANK, CA 91502

BWPCONSERVATION@BURBANKCA.GOV
(818) 238-3730

Figure 10.

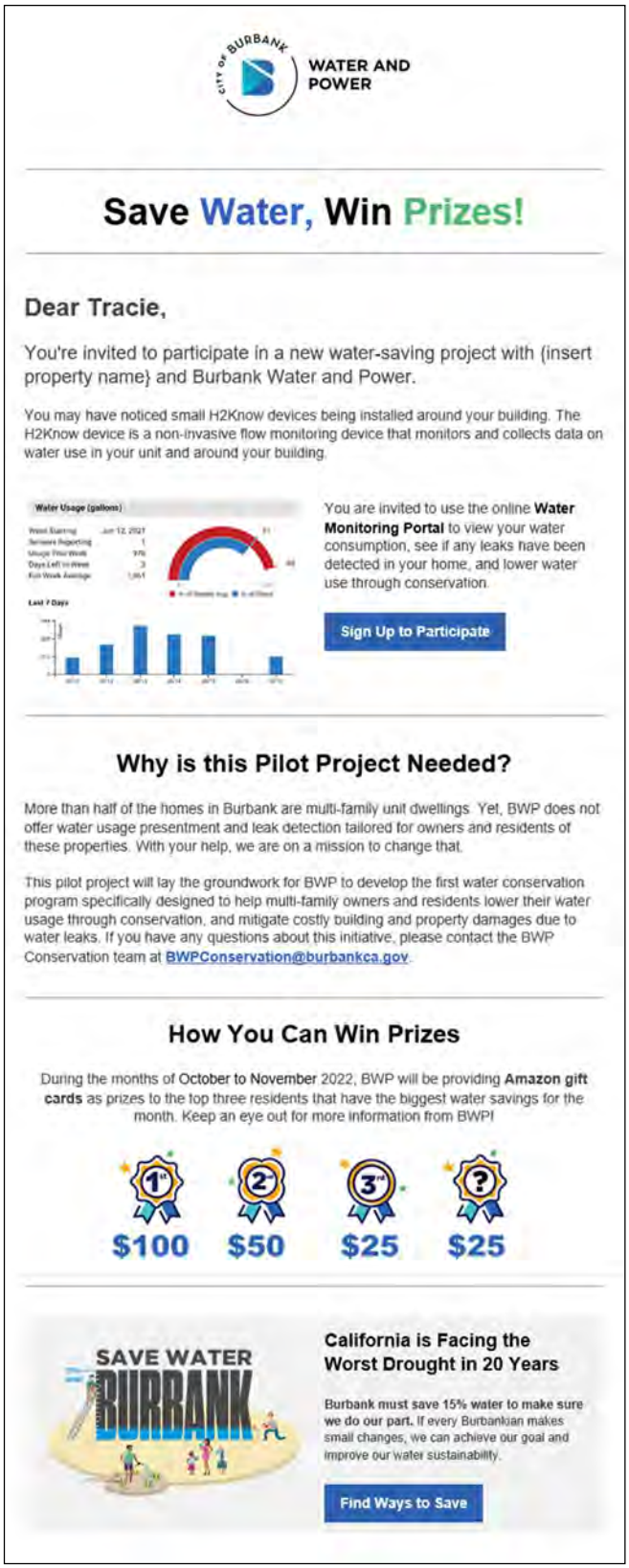
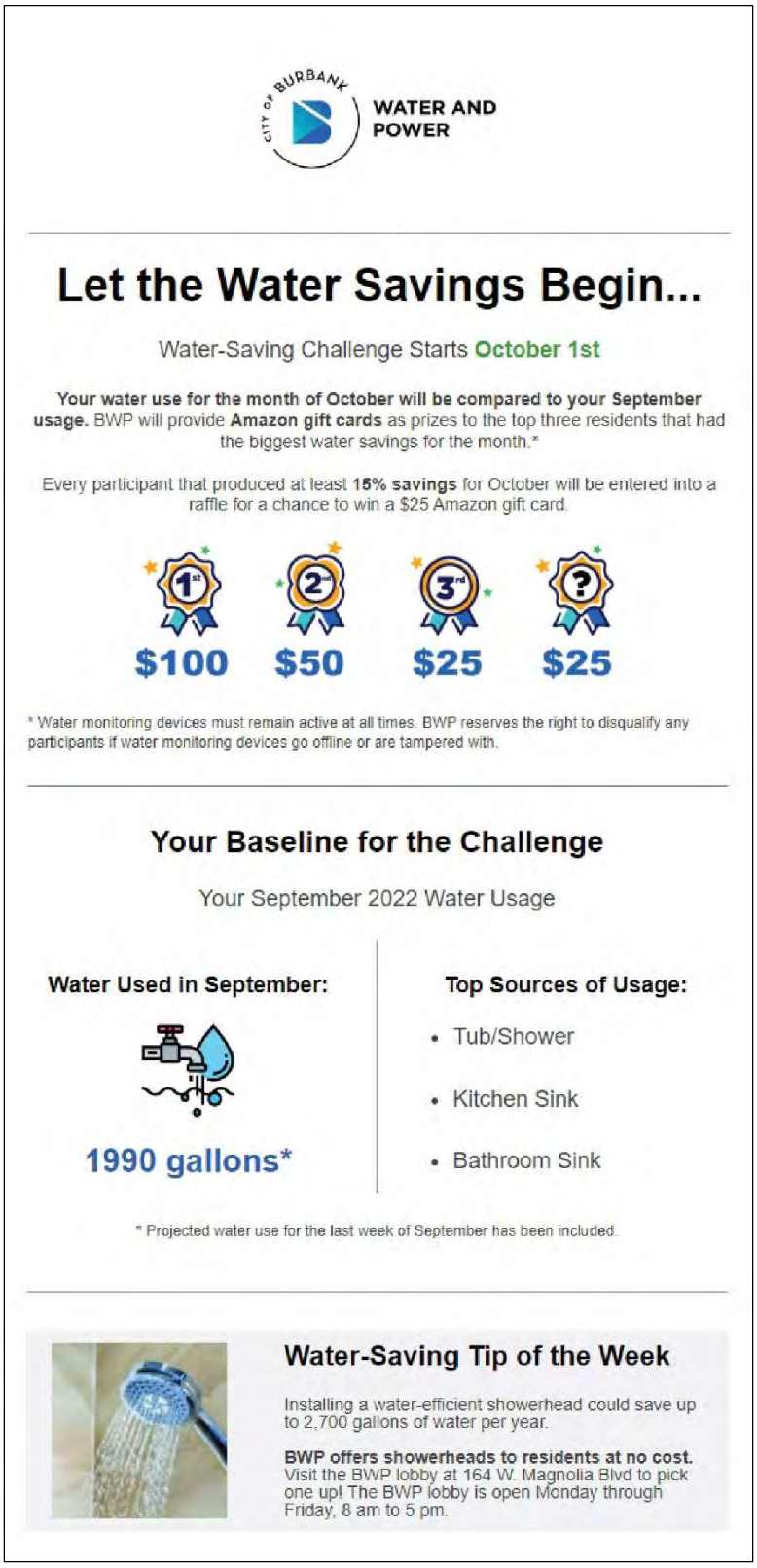

CITY OF BURBANK
WATER AND POWER
Save Water, Win Prizes!
Dear Tracie,
You're invited to participate in a new water-saving project with {insert property name} and Burbank Water and Power.
You may have noticed small H2Know devices being installed around your building. The H2Know device is a non-invasive flow monitoring device that monitors and collects data on water use in your unit and around your building.
Water Usage (gallons)
Last 7 Days
You are invited to use the online Water Monitoring Portal to view your water consumption, see if any leaks have been detected in your home, and lower water use through conservation.
Sign Up to Participate
Why is this Pilot Project Needed?
More than half of the homes in Burbank are multi-family unit dwellings. Yet, BWP does not offer water usage presentment and leak detection tailored for owners and residents of these properties. With your help, we are on a mission to change that.
This pilot project will lay the groundwork for BWP to develop the first water conservation program specifically designed to help multi-family owners and residents lower their water usage through conservation, and mitigate costly building and property damages due to water leaks. If you have any questions about this initiative, please contact the BWP Conservation team at BWPConservation@burbankca.gov.
How You Can Win Prizes
During the months of October to November 2022, BWP will be providing Amazon gift cards as prizes to the top three residents that have the biggest water savings for the month. Keep an eye out for more information from BWP!
1st
2nd
3rd
?
$100
$50
$25
$25
SAVE WATER
BURBANK
California is Facing the Worst Drought in 20 Years
Burbank must save 15% water to make sure we do our part. If every Burbankian makes small changes, we can achieve our goal and improve our water sustainability.
Find Ways to Save

Figure 11.



CITY OF BURBANK
WATER AND POWER

Let the Water Savings Begin...

Water-Saving Challenge Starts **October 1st**

Your water use for the month of October will be compared to your September usage. BWP will provide **Amazon gift cards** as prizes to the top three residents that had the biggest water savings for the month.*

Every participant that produced at least **15% savings** for October will be entered into a raffle for a chance to win a $25 Amazon gift card.

1st $100 | 2nd $50 | 3rd $25 | ? $25

* Water monitoring devices must remain active at all times. BWP reserves the right to disqualify any participants if water monitoring devices go offline or are tampered with.

Your Baseline for the Challenge

Your September 2022 Water Usage

Water Used in September:

1990 gallons*

Top Sources of Usage:

- Tub/Shower
- Kitchen Sink
- Bathroom Sink

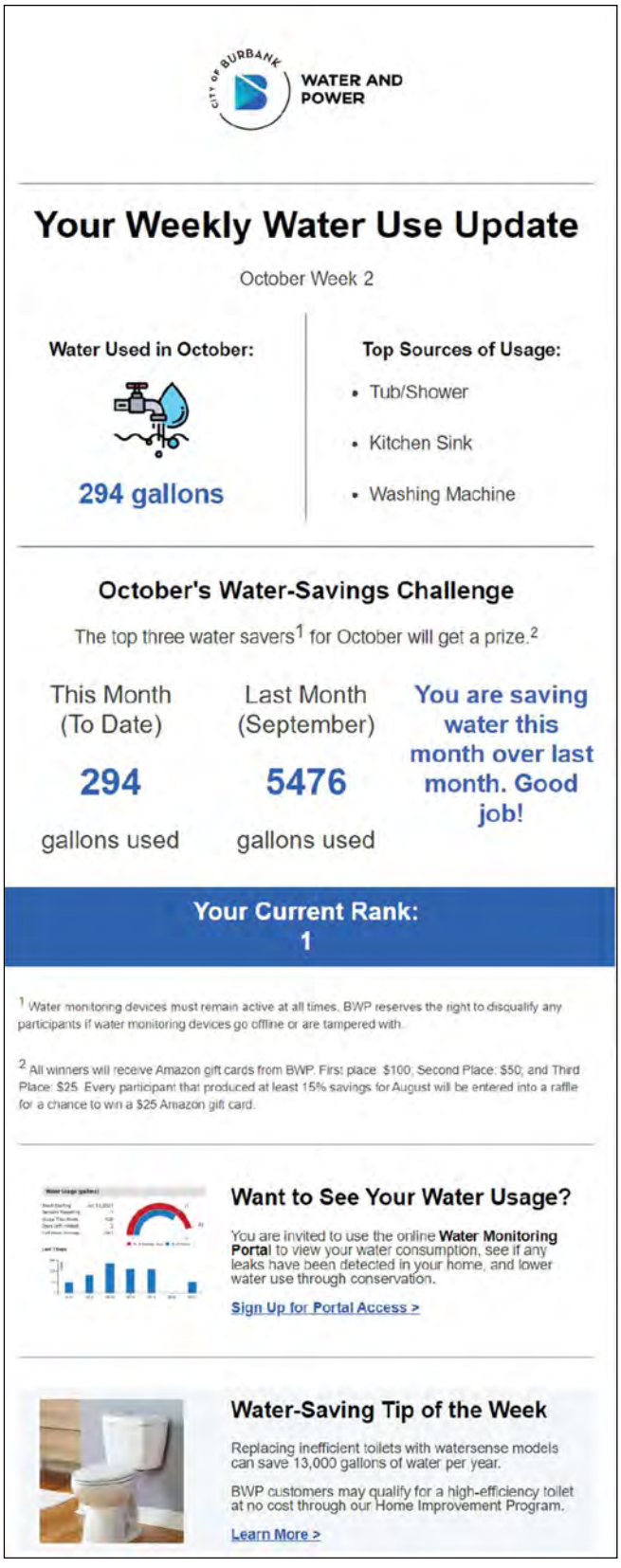
* Projected water use for the last week of September has been included.

Water-Saving Tip of the Week

Installing a water-efficient showerhead could save up to 2,700 gallons of water per year.

BWP offers showerheads to residents at no cost. Visit the BWP lobby at 164 W. Magnolia Blvd to pick one up! The BWP lobby is open Monday through Friday, 8 am to 5 pm.

Figure 12.


CITY OF BURBANK
WATER AND POWER
Your Weekly Water Use Update
October Week 2
Water Used in October:
294 gallons
Top Sources of Usage:
Tub/Shower
Kitchen Sink
Washing Machine
October's Water-Savings Challenge
The top three water savers[1] for October will get a prize.[2]
This Month (To Date)
294
gallons used
Last Month (September)
5476
gallons used
You are saving water this month over last month. Good job!
Your Current Rank:
1
[1] Water monitoring devices must remain active at all times. BWP reserves the right to disqualify any participants if water monitoring devices go offline or are tampered with.
[2] All winners will receive Amazon gift cards from BWP. First place: $100; Second Place: $50; and Third Place: $25. Every participant that produced at least 15% savings for August will be entered into a raffle for a chance to win a $25 Amazon gift card.
Want to See Your Water Usage?
You are invited to use the online Water Monitoring Portal to view your water consumption, see if any leaks have been detected in your home, and lower water use through conservation.
Sign Up for Portal Access >
Water-Saving Tip of the Week
Replacing inefficient toilets with watersense models can save 13,000 gallons of water per year.
BWP customers may qualify for a high-efficiency toilet at no cost through our Home Improvement Program.
Learn More >

STUDY

BWP performed statistical analysis for each participating multi-family property management company to measure the impact of H2know devices through a before-and-after paired comparison of water usage patterns to evaluate water savings resulting in implementing the pilot study. This analysis primarily assesses the effect of monitoring and new water insights to reduce consumption. BWP utilized multi-family buildings' historical water consumption data to create baseline consumption data and compared it to consumption data after installing the water monitoring devices. A paired t-test was conducted at the 95 percent confidence level to determine if there was a significant difference between the mean water consumption volumes during the two periods. The results from the study will be used to evaluate the effectiveness of the water usage monitoring device.

BWP conducted a second statistical analysis to assess how increased engagement and custom insights and recommendations would change water usage patterns. In this analysis, BWP compared daily usage using H2know data for a group of residents who signed up for the Water Savings Challenge versus those who did not participate in the Water Savings Challenge. BWP analyzed H2know data for both groups across two property management companies during the same period. A paired t-test was conducted at the 95 percent confidence level to determine if there was a significant difference between the mean water consumption volumes for the two resident groups. The results from this analysis will be used to evaluate the effectiveness of increased engagement and custom insights from the H2know device.

Property Management Company No1.

The selected multi-family buildings for the first project are managed by a nonprofit community housing developer that provides affordable housing and supportive services to low-income and moderate-income households in Burbank.

Property Management Company No1 offers fixed rent rates based on household income. Residents are required to complete an annual income certification process to certify their eligibility for affordable housing. The Property Management Company No1 has Activity Centers, where its residents can access essential services, such as a free after-school program, low-cost summer camp, educational workshops, health services, and more.

The statistical analysis measured the impact of installed H2know devices on indoor water use patterns. The basic methodology was as follows: residential units of multi-family properties received the installation of the H2know device. After installing H2know devices, BWP gathered the water use data for 28 apartment units for three billing periods. After obtaining the water use data, BWP used a paired t-test analysis to evaluate the water consumption for each end user in the pre-installation and post-installation periods. The study allowed us to calculate the impact of the H2know device installations.

BWP conducted a paired two sample for means t-test at the 95 percent confidence level to determine if there was a significant difference between the mean water consumption volume comparing the pre-installation (baseline period) and the post-installation periods. The test resulted in the P-Value that was less than 0.007, as shown in Table 1, clearly indicating a statistically significant difference between the two mean water consumption volumes at the 95 percent confidence level. Thus, BWP concluded that installing the H2know devices at Property Management Company No1 substantially reduced water usage.

To conduct the paired two sample for means t-test, BWP used the three-month water consumption data from five water meters of Property Management Company No1. The baseline period was from August 2021 to October 2021, and the post-installation period was from August 2022 to October 2022. BWP compared the pre-installation water consumption data to the post-installation period water consumption data.

BWP disaggregated water use events using WaterSmart Software to analyze the indoor and outdoor water consumption data for Property Management Company No1. The analysis indicated that the water volume utilized for irrigation stayed the same during the pre-installation and post-installation periods.

Furthermore, one apartment unit was unoccupied from August 30, 2021, to December 1, 2021, and another was unoccupied from August 19, 2021, to November 1, 2021, resulting in lower water usage for the Property Management Company No1 during the baseline period. BWP did not account for the reduced water usage resulting from the two apartment unit vacancies in the study.

During the baseline period, from August 2021 to October 2021, mean monthly water consumption for five water meters at the property management company No1 dropped from 69 hundred cubic feet (HCF) to 52 HCF per meter after the installation of the H2know devices, as indicated in Table 1. This water consumption reduction translates to a monthly water use reduction of 85 HCF across all the water meters servicing the property management company No1 and 1,020 HCF of annual water savings. This consumption reduction also translates to mean monthly water consumption dropping from 12.3 HCF per multi-family property unit to 9.3 HCF per multi-family property unit, resulting in 3 HCF of mean monthly water savings per multi-family property unit.

Table 1.

t-Test: Paired Two Sample for Means		
	Variable 1	*Variable 2*
Mean (HCF)	69	52
Variance	3889.49	1775.64
Observations	15	15
Pearson Correlation	0.975	
Hypothesized Mean Difference	0	
df	14	
t Stat	2.82	
P(T<=t) one-tail	0.007	
t Critical one-tail	1.761	
P(T<=t) two-tail	0.013	
t Critical two-tail	2.145	

Water and Natural Gas Savings

To calculate the annual water and natural gas cost savings, BWP used an average rate of $3.779 per HCF of water and the current (November 2022) gas baseline rate for the Burbank service area of $1.47 per Therm.

The achieved water savings resulted in reduced hot water use and natural gas savings. A full accounting of this energy and water cost savings requires several data inputs, including the demographics of household occupants, installed fixtures and appliances, water heater energy use, a mix of hot and cold water at the point of use, and cost of energy.

However, in 2019 the Environmental Protection Agency (EPA) estimated that heating of water required approximately 0.87 cubic feet of natural gas per gallon of hot water for a natural gas-fired water heater. Furthermore, the estimated energy consumed per gallon of water heated for 2019 is 0.0008638 MCF (one thousand cubic feet) per gallon, and 1 MCF of natural gas is 10.307 Therms. In addition, in residential homes, overall hot water usage is 39.6 percent of total indoor water use.

Table 2 shows calculated natural gas savings, and Table 3 shows calculated water savings associated with the Pilot Project implementation.

Table 2.

Total Annual Water Savings for Property Management Company No1, HCF	Total Annual Hot Water Savings, HCF	Total Annual Gas Savings, Therms	Total Annual Customers' Gas Cost Savings, $
1,020	403	2,690	$3,950

Table 3.

Total Annual Water Savings for Property Management Company No1, HCF	Burbank Water Rate per HCF	Total Annual Water Cost Savings for Property Management Company No1
1,020	$3.779	$ 3,809

The total annual water and natural gas savings resulting from the H2know device installation and Pilot Project implementation for Property Management Company No1 is $7,765.

Property Management Company No2.

The selected multi-family buildings for the second project are managed by a property management company that provides sleek and eco-stylish apartment units filled with inspiring living spaces. The apartment building where BWP implemented the Pilot Project is in the modern Media District address, providing world-class apartment living in Burbank.

The statistical analysis measured the impact of installed H2know devices on indoor water use patterns. The basic methodology was as follows: residential units of multi-family properties received the installation of the H2know device. After installing H2know devices, BWP gathered the water use data for 50 apartment units for three billing periods. After obtaining the water use data, BWP used a paired t-test analysis to evaluate the water consumption for each end user in the pre-installation and post-installation periods. The study allowed us to calculate the impact of the H2know device installations. The property uses recycled water for landscape irrigation, and all three water meters servicing the multi-family buildings supply potable water for indoor water consumption only.

BWP conducted a paired two sample for means t-test at the 95 percent confidence level to determine if there was a significant difference between the mean water consumption volume comparing the pre-installation (baseline period) and the post-installation periods. The test resulted in the P-Value that was less than 0.391, as shown in Table 4, indicating no statistically significant difference between the two mean water

consumption volumes at the 95 percent confidence level. Thus, BWP concluded that installing the H2know devices at Property Management Company No2 didn't substantially reduce water usage.

To conduct the paired two sample for means t-test, BWP used the three-month water consumption data from three water meters servicing Property Management Company No2. The baseline period was from August 2021 to October 2021, and the post-installation period was from August 2022 to October 2022. BWP compared the pre-installation water consumption data to the post-installation period water consumption data.

During the baseline period, from August 2021 to October 2021, mean monthly water consumption for three water meters at the Property Management Company No2 dropped from 270.3 HCF to 264.5 HCF after the installation of the H2know devices, as shown in Table 4. This water consumption reduction translates to a monthly water use reduction of 5.8 HCF across all the water meters servicing Property Management Company No2 and 70 HCF of annual water savings. Even though the consumption reduction is statistically insignificant, it translates to a mean annual water consumption reduction of 1.4 HCF per multi-family property unit.

Table 4.

t-Test: Paired Two Sample for Means		
	Variable 1	*Variable 2*
Mean (HCF)	270.33	264.54
Variance	14292.51	12862.95
Observations	9	9
Pearson Correlation	0.864	
Hypothesized Mean Difference	0	
df	8	
t Stat	0.285	
P(T<=t) one-tail	0.391	
t Critical one-tail	1.859	
P(T<=t) two-tail	0.783	
t Critical two-tail	2.306	

Resident Engagement Analysis

The Water Savings Challenge was a campaign for all residents with an H2know device. BWP invited Residents from both property management companies to participate. Twenty-six residents opted to join in the challenge. The analysis compared the 26 participating residents with 13 who were invited to participate but did not participate in the Water Savings Challenge. BWP included those 13 residents in the control group.

The statistical analysis measured the impact of increased engagement and custom insights from H2know on indoor water use patterns. After obtaining and analyzing the water use data, BWP used a paired t-test analysis to evaluate the water consumption for each end user in the Water Savings Challenge group versus the control group.

The period from September 1, 2022, to September 30, 2022, was used as the baseline usage for both groups. The average usage for the Challenge group during this period was 6.1 HCF per participant, and the average use for the control group was 4.4 HCF per resident.

BWP used two evaluation periods to assess the impact of the Water Savings Challenge. Evaluation Period No1 compares October 1, 2022-October 30, 2022, to September 1, 2022-September 30, 2022. Evaluation Period No2 compares the period from August 11, 2022, to September 30, 2022, to the period from October 1, 2022, to November 25, 2022.

Using the two time periods helped BWP understand if there was a change effect of the program over time. The change in water usage from the baseline periods to the two analysis periods is provided in Table 5. As the time period increases, there are additional savings.

As noted in the statistical analysis below, there is a significant difference in the water usage for the Water Savings Challenge Group. However, there is not a significant difference for the Control Group.

There are two impact calculations for each evaluation period. The first is a strict difference between the two calculated differences to understand the incremental effect of resident engagement. This is -8.6 percent and -38.7 percent for Evaluation Period No1 and Evaluation Period No2, respectively. However, since the water usage between the analysis period and baseline period is not statistically significant for the control group, 0 difference may be used. If the difference is 0 for the control group, the impact of resident engagement is -17.8 percent for Evaluation Period No1 and -20.6 percent for Evaluation Period No2. The study results show that the incremental impact of higher engagement is approximately 20 percent, as shown in Table 5.

Table 5. Total HCF and Percent Difference

	Evaluation Period No1		Evaluation Period No2	
Group	**9/1/22-9/30/22**	**10/1/22-10/30/22**	**8/11/22-9/30/22**	**10/1/22-11/25/22**
Challenge Group	160 HCF	131 HCF -17.8%	245 HCF	194 HCF -20.6%
Control Group	58 HCF	52 HCF -9.2%	81 HCF	96 HCF 18.1%
Impact (Difference)		-8.6%		-38.7%
Impact (Significant)		-17.8%		-20.6%

BWP conducted a paired two sample for means t-test at the 95 percent confidence level to determine if there was a significant difference between the mean water consumption volume comparing the Water Savings Challenge and control groups for the two evaluation periods. The tests resulted in water consumption comparisons being statistically significant at the 95 percent confidence level for the Water Savings Challenge Group but not for the control group. The test resulted in the P-Values in Table 6. Thus, BWP concluded that increasing engagement with custom insights and gamification could further reduce water usage.

Table 6.

Group		**10/1/22 - 10/30/22**	**10/1/22 - 11/25/22**
Challenge Group	P(T<=t) two-tail	0.0038	0.0091
	P(T<=t) one-tail	0.0019	0.0046
Control Group	P(T<=t) two-tail	0.5059	0.3682
	P(T<=t) one-tail	0.2529	0.1841

Assuming that 80 percent of residents have H2know devices and 60 percent of residents engage in the program, BWP used the same cost parameters from Tables 2 and 3 to estimate that the total projected annual water and gas savings are over $3,000 for Property Management Company No1 and nearly $7,000 for Property Management Company No2.

The estimated annual savings values are shown in Table 7.

BWP defines participation by the number of residents who sign-up for access to reports, contests, and similar engagement tools. In the pilot program, approximately 67 percent of eligible residents participated in the engagement program.

Table 7.

Property Management Company	Projected Annual Water Savings	Projected Annual Gas Cost Savings	Projected Annual Water Cost Savings	Projected Annual Total Cost Savings
No1	405	$1,570	$1,531	$3,101
No2	904	$3,505	$3,415	$6,920

ADDITIONAL OPPORTUNITIES

Water Leak Detection

H2know classifies all water usage to the fixture at one-second increments. Fixture types that are identified in this program include showers, toilets, lavatory faucets, kitchen faucets, washing machines, and dishwashers. This granularity creates an opportunity for actionable leak detection insights.

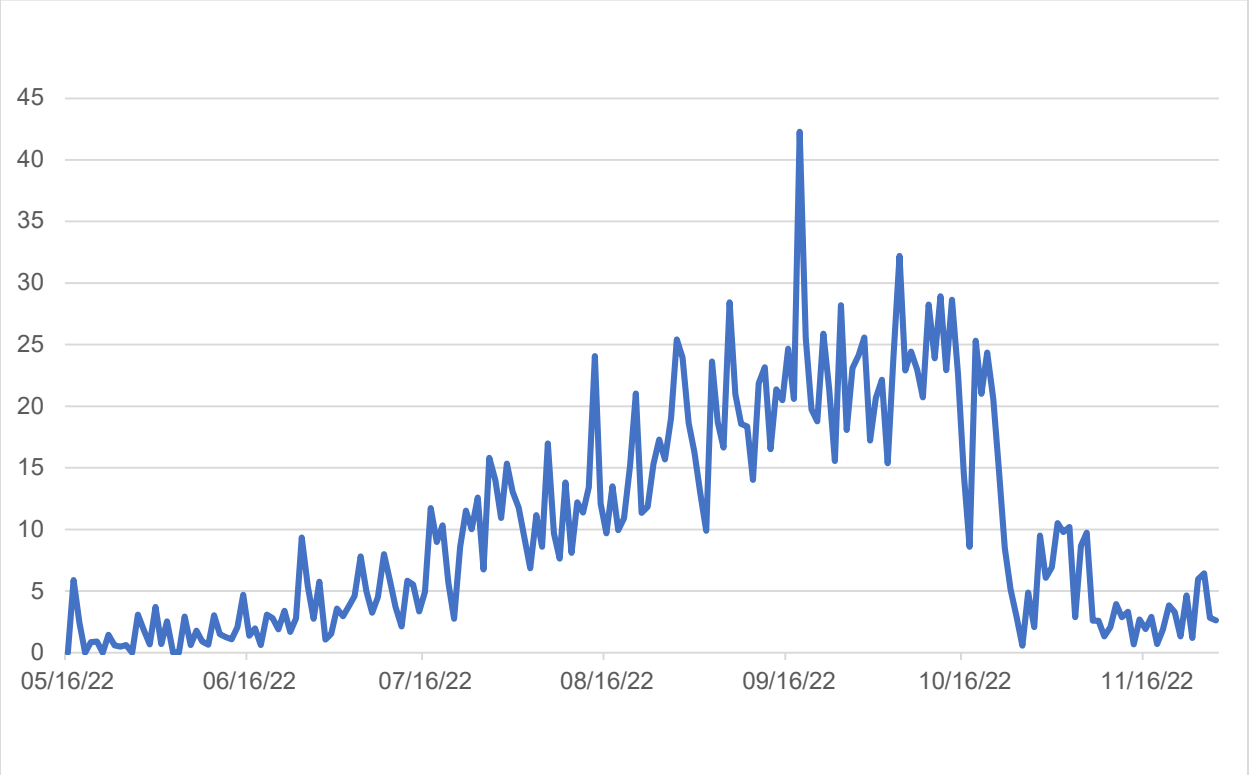
During the pilot period, a leak was identified in a toilet in one of the units of a building with Property Management Company No2.

- On October 11, 2022, H2know leak detection system identified unusual water use in the residential unit
- On October 19, 2022, H2know confirmed a persistent water event 17 seconds in length, every 20 minutes
- On October 19, 2022, Property Management Company No2 was notified of a leaking toilet in a specific unit
- On October 20, 2022, the maintenance staff of Property Management Company No2 found a leaking toilet and repaired the leak

The leaky toilet generated at least 24 incremental daily gallons at its peak. The estimated monthly water savings from identifying and remediating this single leaking toilet is 600 gallons, considering that the leak remained undetected.

Figure 13 shows gallons of water wasted per day for the identified leaky toilet.

Figure 13.



It is possible to exploit and identify several additional insights and opportunities for conservation and water savings. These insights may be used in resident engagement programs or infrastructure improvements. The Pilot Project findings indicated that the water use varies by the following dimensions:

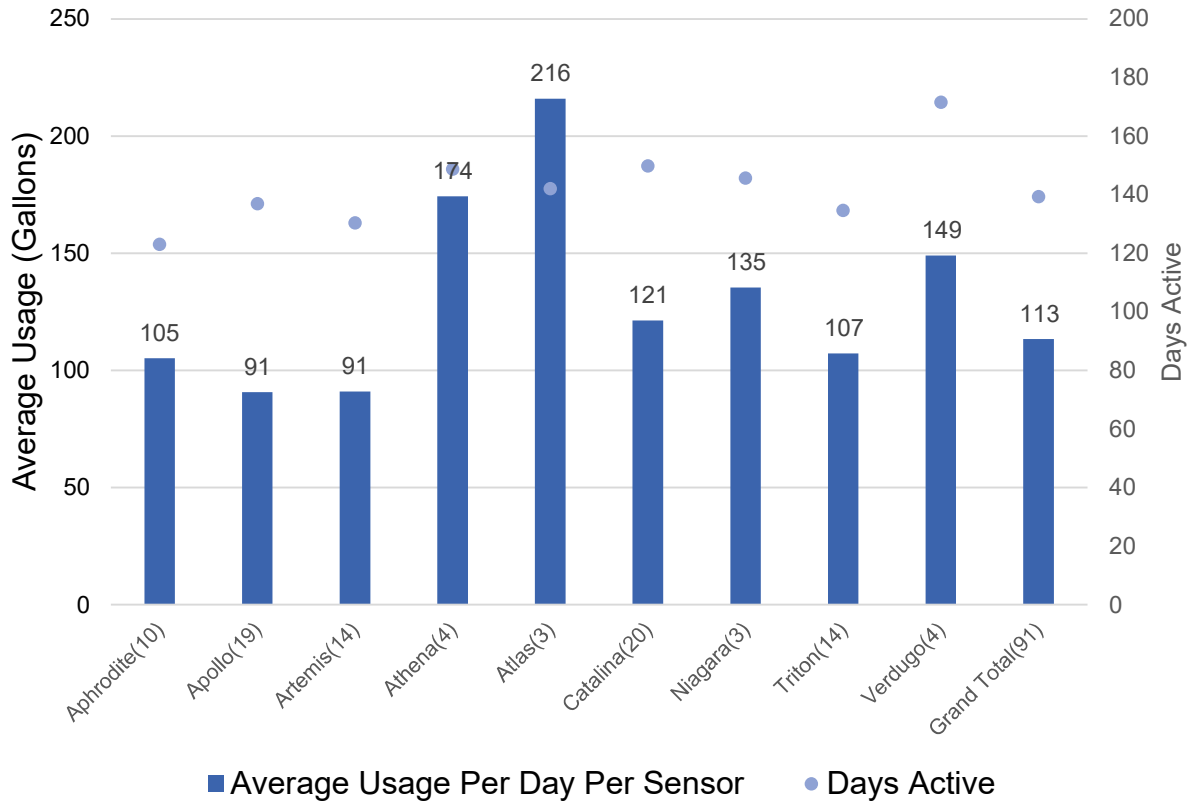
- Unit size and floor plan
- Day of week
- Time of day

Water Use by Unit Size and Floor Plan

There is a wide range of usage by residential unit floor plans for Property Management Company No2, as shown in Figure 14. This usage likely correlates to the size of the residential units and occupancy. The residential units vary from one-, two-, and three-bedroom apartments and between 820 to 1,480 square feet.

The Aphrodite (one-bedroom and 856 square feet) and Apollo (one-bedroom and 821 square feet) floor plans have the lowest water use. The Atlas (two-bedroom and 1,390 square feet) and Athena (three-bedroom and 1,484 square feet) floor plans have the highest water use. Understanding the variability of water use by various residential unit sizes can also help identify custom conservation recommendations.

Figure 14. Average Daily Usage per H2know Device by Location



Water Use by Day of Week

Figure 15 shows that water use is the highest on Friday and generally decreases between Monday and Thursday. Understanding the drivers of water use on Friday can help identify strategies to reduce consumption.

Figure 15. Average Daily Water Usage in Gallons for All Properties

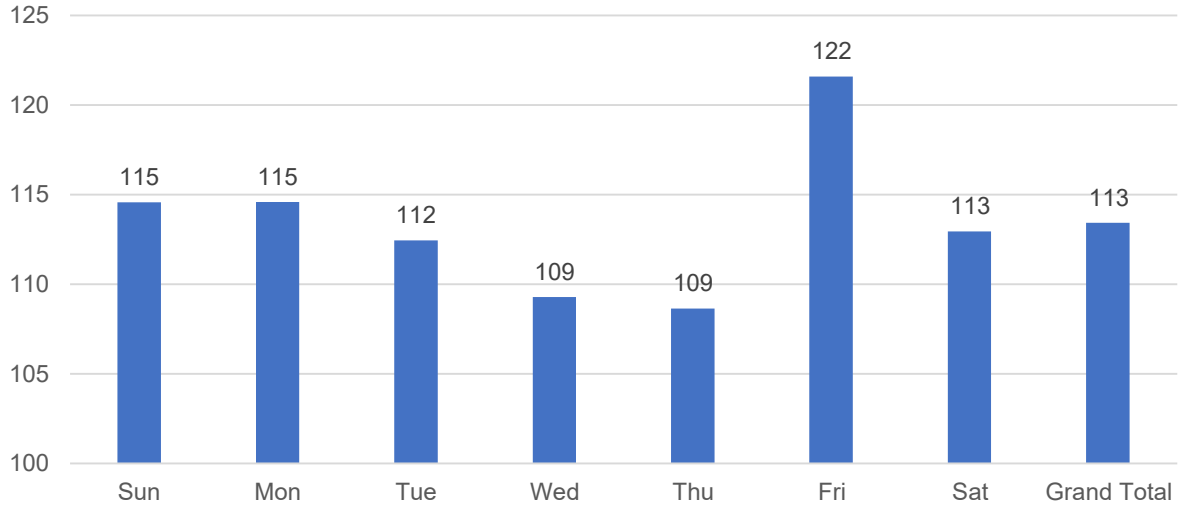
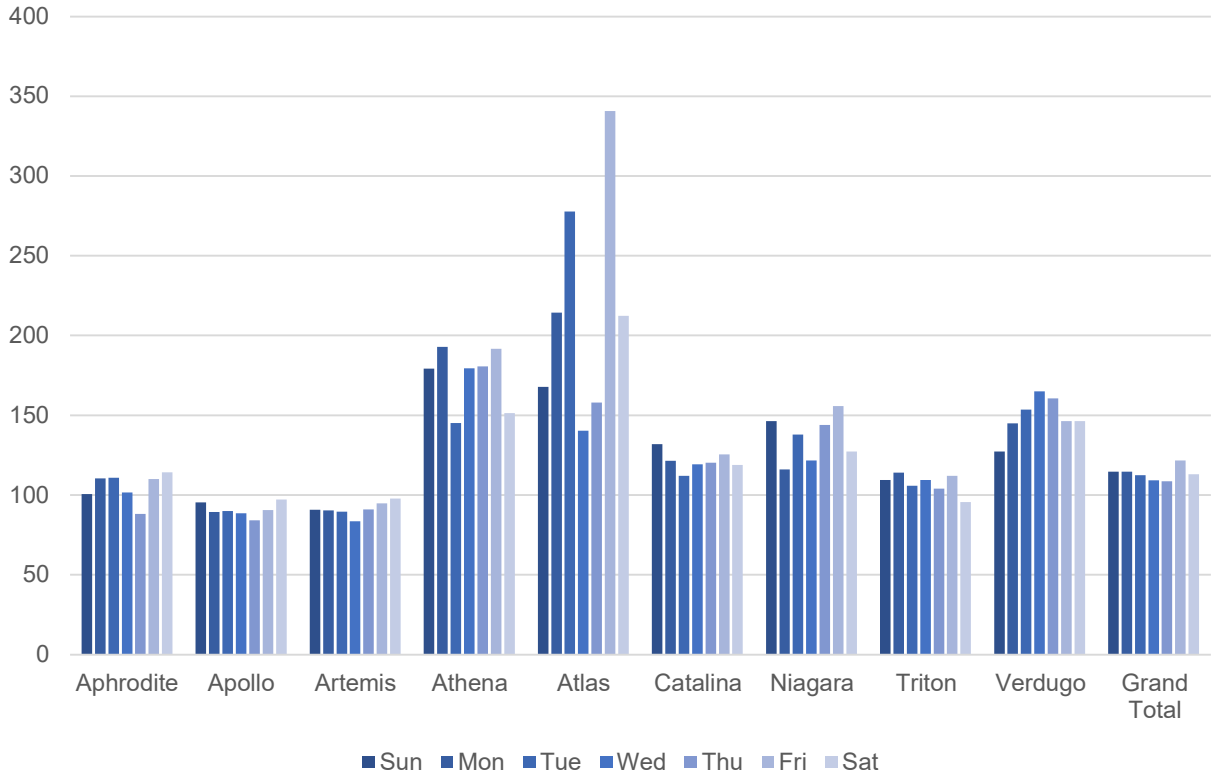


Figure 16 shows water use variation by property size and floor plan by day of the week.

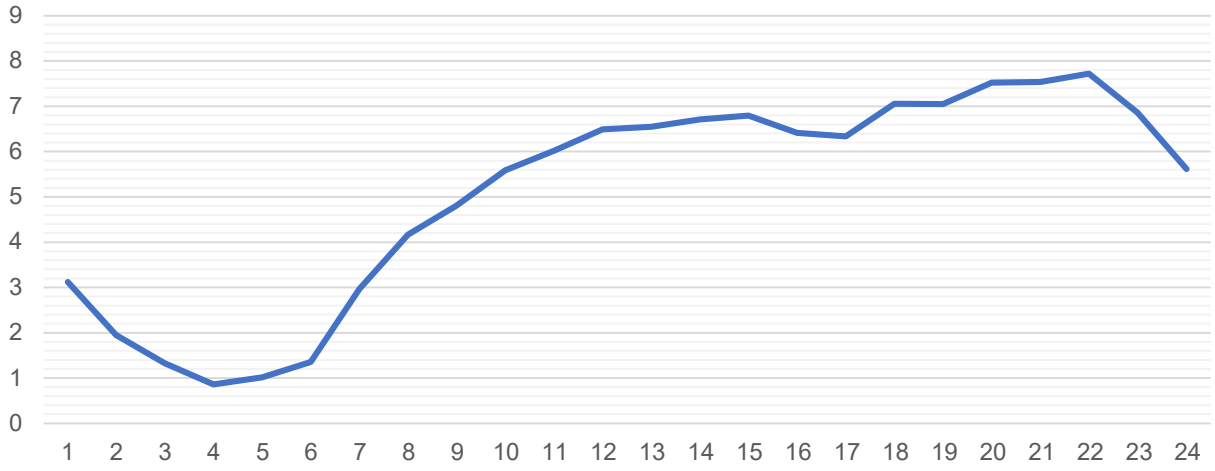
Figure 16. Average Daily Water Usage in Gallons by Day of Week and Unit Size and Floor Plan



Water Use by Time of Day

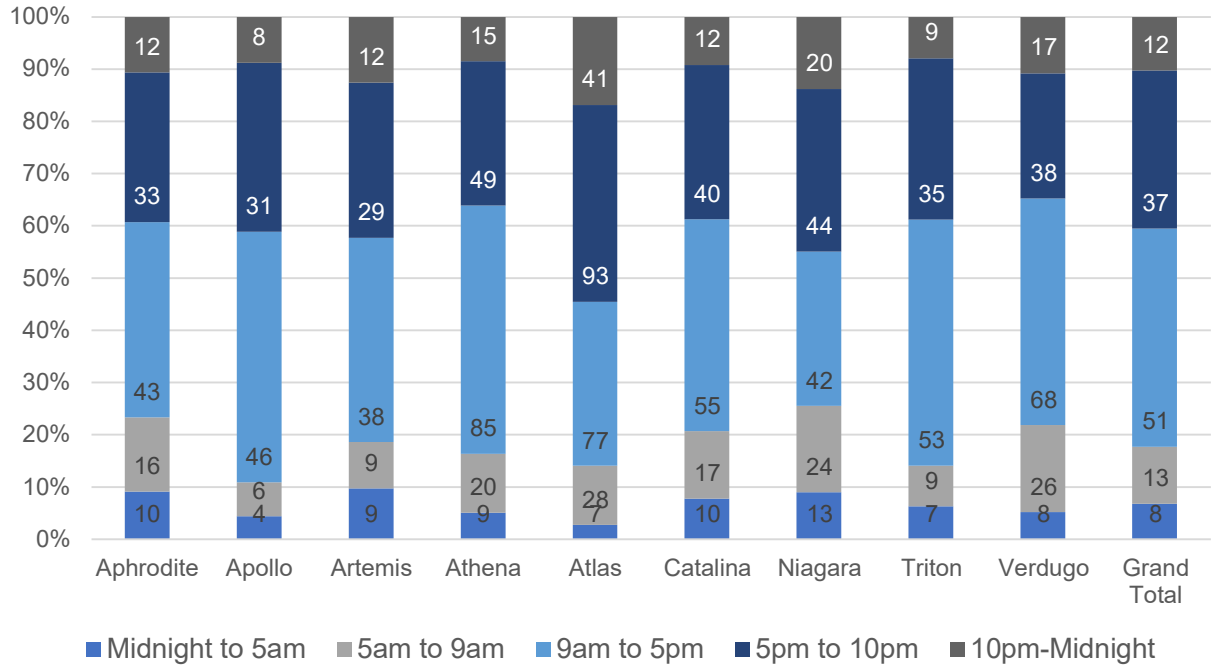
Time of day is another way to analyze the data with H2know to identify water savings opportunities. The chart in Figure 17 shows that water use peaks across all properties between 8 PM – 10 PM in the evening hours.

Figure 17. Average Daily Water Usage in Gallons by Hour for All Properties



In addition, daily water usage varies significantly by the property, floor plan, and within each unit type. Figure 18 shows, that the H2know device may allow conservation recommendations to be tailored to specific times of day that demonstrate higher levels of water use than other similar units.

Figure 18. Percent of Daily Water Usage by Time of Day



CONCLUSION

The results from this study indicate that installing water monitoring devices may reduce water and energy consumption in master metered multi-family properties. The results of this study provide evidence of the effectiveness of H2know devices and engagement programs.

Furthermore, installing water monitoring devices in older apartment properties might be more effective than in newer apartment buildings. Savings levels may also vary across the population of buildings in the study. Apartment buildings with higher-income residents may achieve lower savings than buildings with lower-income residents.

The study concludes that even though apartment buildings are brimming with untapped water conservation potential, implementing targeted programs considering differences in demographic and socio-economic factors can help facilitate conservation.

REFERENCES

1. Methodology and Assumptions for Estimating WaterSense® Annual Accomplishments (Updated June 2020) (epa.gov) https://www.epa.gov/sites/default/files/2017-03/documents/ws-aboutus-accomplishments-methodology.pdf
2. DeOreo, W. B. and P. W. Mayer. 2000. The End Uses of Hot Water in Single-Family Homes from Flow Trace Analysis.