# SANTAQUIN IRRIGATION-WATER CONSERVATION STUDY
# PROJECT ID: CEEN_2018CPST_014

**by**

**S H A R K S**
**Alec Van De Graaff**
**Natalie King**
**Rob Anderson**
**Caleb Joubert**

**A Capstone Project Final Report**

**Submitted to**

**Norm Beagley**
**Santaquin City, UT**

**Department of Civil and Environmental Engineering**
**Brigham Young University**

**April 15, 2019**

# Executive Summary

**PROJECT TITLE:** SANTAQUIN IRRIGATION-WATER CONSERVATION STUDY
**PROJECT ID:** CEEn_2018CPST_014
**PROJECT SPONSOR:** Santaquin City, UT
**TEAM NAME:** S H A R K S

Santaquin City has requested a plan to conserve their irrigation water. As the city grows, the water demands are increasing on a limited supply of water. As a city, Santaquin recycles 100% of the wastewater into their irrigation water. Residents use that water to water their lawns, wash their cars, and for other outside water uses. Statistics show that on average, 60% of the water used by a household goes to keeping the grass green. For our project, we have focused on helping the residents reduce their consumption of water by reducing the amount used to water their lawns. Technology companies have created a Smart Meter that can be installed on a sprinkler system that has more enhanced controls on their systems. Spanish Fork has implemented these Smart Meters in hundreds of their homes. The Smart Meter data from Spanish Fork looks very promising and it has led to the conclusion that Santaquin City could also greatly benefit from implementing the Smart Meters.

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# Introduction

The city of Santaquin, UT tasked us with two objectives. The first was to distribute the peak demand of the pressurized irrigation system over a longer period of time. The second objective was to reduce the average use per Equivalent Residential Unit (ERU). In September we met with Norm Beagley, the city engineer of Santaquin City, and Jon Lundell, a staff engineer for the city. Norm and Jon described some of their expectations and which directions they wanted our group to pursue, the primary direction being the potential implementation of Smart Meters. We were also asked to investigate applications of xeriscaping, but we determined this to be outside the scope of our project. For this reason, no information on xeriscaping will be given in this report.

We performed research on Smart Meters and their potential effect on our two objectives. The city of Spanish Fork shared monthly water usage from 2017 and 2018 of homes with Smart Meters as well as control homes without. By running statistical analysis in Excel, we produced results on the water conservancy of Smart Meters. This will be discussed in greater detail later in this report.

In addition to statistical analysis of water saved and peak demand reduction, we utilized GIS software to provide quantifiable results of how Smart Meters affect the aesthetics of lawns. Our project measures and compares levels of greenness of lawns in question. These values being compared are extracted from aerial imagery. As with the statistical analysis, this is discussed further in a later section in this report.

Our findings were reported to the city engineers of Santaquin as well as briefly reported to an audience of other BYU students. All deliverable have been or will be given to the city engineers of Santaquin City.

# Schedule

In our efforts to deliver actionable information to Santaquin City, we developed a timeline that allowed us to work in an efficient and timely manner. Utilizing a critical path with specific milestones and meeting times, we maintained a project that was both on schedule and within budget.

## Milestones

- All data obtained by thanksgiving
- Developed working GIS model to analyze Smart Meters
- Meetings Mondays or Wednesdays at 5:00 pm for fall semester
- Meetings Mondays or Tuesdays for winter semester
- Additional meetings as necessary with Santaquin City
- 30% of total work done by end of fall semester
- 100% of total work done by end of winter semester

These milestones were completed with the project scope in mind and with available resources. These milestones were both achievable and yet made the team stretch in the process. Each milestone was accomplished as a team and were finished through a collaborative effort.

The team met at these times due to scheduling conflicts and availability of the members involved. These meeting times were flexible due to the variability of the team member's schedule's and changed accordingly. Any additional meetings with the Santaquin City were scheduled separately as needed.

## Challenges

During the course of the year, the team encountered several challenges that temporarily put us off schedule. The two main challenges that we faced were using the Spanish Fork data and creating a model using GIS that would be of benefit to the project.

Determining what to do with the data from Spanish Fork was a larger challenge than anticipated because it was in the process of being analyzed during the Fall semester by another capstone team. It was determined that waiting for the final product after their analysis during this semester would be more efficient for our team by simply using the data analysis produced and adapting it to our needs rather than increasing our work load. The acquisition of this data affected our GIS analysis, requiring our points and control points to be recreated to match the addresses corresponding with the data. We adjusted well and still met our milestones before their deadlines.

# Assumptions & Limitations

Some assumptions were made in this project, the most prominent being the comparison between Spanish Fork and Santaquin City. That is, after all, the entire premise of this project. We assumed a similarity in environment and water use between the two cities. Any Spanish Fork savings from using Smart Meters were assumed to apply to Santaquin City. In order to minimize the potential error from making such an assumption, we compared lot sizes. The Spanish Fork data was divided into three lot-size categories and projected onto the number of Santaquin lots within the same size categories.

The biggest limitation we encountered was the accuracy of 2018 Spanish Fork data that was collected after the installation of Smart Meters. The meters were supposedly in place as of June 2018, but they were actually installed throughout the summer months. The June-July 2018 water use data does not accurately reflect Smart Meter use. August and September, however, are more reliable. We made note of this in our results, both in this report and in our presentation to the city engineers of Santaquin City.

Another limitation was the consistency of the imagery used in the GIS project. We had to assume the images taken before and after Smart Meters were taken under identical conditions. This practice is mostly reliable, but any difference would result in a skewed change in greenness of Spanish Fork lawns.

# Design, Analysis & Results

The data analysis and research of Spanish Fork's Smart Meter project are preliminary, but results look very promising. As a team, we believe that the Smart Meter program could greatly benefit Santaquin City in saving water and reducing the peak demand. In order for Smart Meters to be a viable option for Santaquin City, it needs to benefit the city and the individual residents. To accomplish this task, we looked at a few different viewpoints. First, how much water will Smart Meters save per resident, how will the meters help reduce the peak flow, and will there be any repercussions to residents' lawns? Once those questions were answered, we wanted to give recommendations for where to start implementation. First by looking at the lot sizes in Spanish Fork that benefitted the most and then analyze the best watering schedules Spanish Fork's residents chose from when using the Smart Meters.

**Water Saved Per Resident**

Utah is a desert and has a finite amount of water. For cities such as Santaquin, which is growing rapidly, the water allocated to them is being stretched further and further. Water savings is important to help ensure their supply of water will continue to serve the entire city. Spanish Fork provided the 2017 and 2018 water usage data for over 500 homes with Smart Meter and a control group of about 1400 homes without Smart Meters. 2018 data is assumed to be Smart Meter usage data although the Smart Meters were being placed throughout the summer of 2018, which indicts the data from 2018 does not fully represent Smart Meter benefits. Table 1 below shows the average usages per resident in 2017 and 2018 and their savings from Smart Meters. As noted Smart Meters were being placed all summer, so data from June and July will not be as accurate as August and September. That being said, August had by far the most water savings with more than 11,000 gallons saved per resident. It is likely water savings for June and July would have been greater had Smart Meters been installed before the start of the summer.

*Table 1: Water Savings for Homes With Smart Meters*

| With Smart Meters | 2017 (thousand gallons) | 2018 (thousand gallons) | Water Saved (thousand gallons) |
|---|---|---|---|
| **June** | 37.84 | 34.85 | 2.99 |
| **July** | 40.86 | 36.63 | 4.23 |
| **August** | 36.42 | 25.15 | 11.26 |
| **September** | 18.83 | 19.02 | -0.19 |
| | | Total | 18.29 |

The control group of about 1400 homes without the new meters was created to determine that the significant water savings was not due to the difference in the years 2017 and 2018. Those homes on average also saved water from 2017 to 2018, but only by less than 2 thousand gallons for the whole summer as seen in Table 2.

*Table 2: Water Savings for Homes Without Smart Meters*

| Without Smart Meters | 2017 (thousand gallons) | 2018 (thousand gallons) | Water Saved (thousand gallons) |
|---|---|---|---|
| **June** | 37.78 | 38.93 | -1.15 |
| **July** | 39.35 | 42.44 | -3.1 |
| **August** | 35.25 | 33.86 | 1.38 |
| **September** | 32.01 | 27.3 | 4.71 |
| | | Total | 1.84 |

From the data collected, it indicates that water was not saved in September, which could be an argument against the Smart Meters. When researching the average temperatures and precipitation in Spanish Fork for the two years it tells a different story. The temperature and precipitation data show a temperature increase in September in 2018 and a large decrease in precipitation. The Smart Meters are hooked up to the internet which accounts for changes in the weather. Although it used more water, the Smart Meters benefitted the residents by accounting for the decrease in precipitation and increase in temperature, which would have helped the residents maintain a green lawn longer.

*Table 3: Temperature and Precipitation Data From 2017 and 2018*

| Precipitation (in) | July | August | September | October |
|---|---|---|---|---|
| 2017 | 0.97 | 0.28 | 2.47 | 0.32 |
| 2018 | 0.1 | 1.57 | 0 | 4.39 |
| Temperature (°F) | July | August | September | October |
| 2017 | 78.6 | 75.5 | 63.8 | 51.8 |
| 2018 | 80 | 75.5 | 69.3 | 51.6 |

*Data found from NOAA online source

**Reduction in Peak Demand**

To maintain a pipe system in a city that is growing rapidly, the peak demand cannot increase. That is difficult to do when volume of water needed per day is increasing. One benefit from the Smart Meters is the reduction in the peak demand. It can help regulate watering of lawns to help ensure all residents are not watering their lawns at the same time each night. From Spanish Fork's data, average usage across a few days before and after meters were placed were compared to find the reduction in peak flow. From June 1 to June 3, the average peak was 7.49% of the total daily water. From August 27 to 29, the average peak was 7.11% of the total daily water, which means there was a .4% reduction in the peak. Although that number seems small, it can indicate thousands of gallons of water depending on Santaquin City's daily use in water. Figure 1 shows those daily use comparisons.

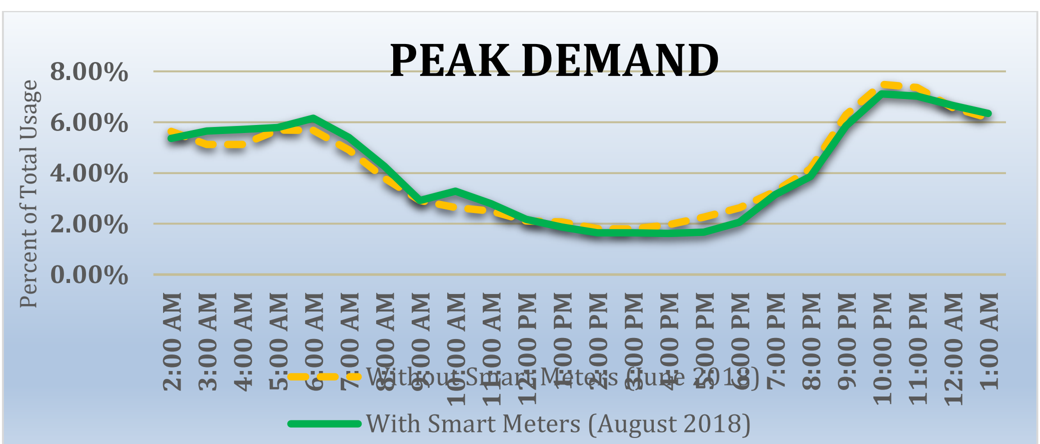



*Figure 1: Daily Water Usage Comparison Before and After Smart Meters*

**Maintaining Greenness in Lawns**

Residents being on board with this project is essential its success. Water is fairly low cost to residents. For Santaquin City's residents it is only 79 cents per 1000 gallons. The savings for the city of 18,000 gallons per resident is huge, but for the residents, that adds up to only $14.45 saved. They will not sacrifice their lawns for less than 15 dollars. As a team, we created a GIS model that quantitatively can estimate the change in greenness of a lawn. To accomplish this a number of steps were taken as shown below.

**Step 1**: Control groups with different metering schedules from Spanish Fork Data were placed on a map in the middle of their lawns

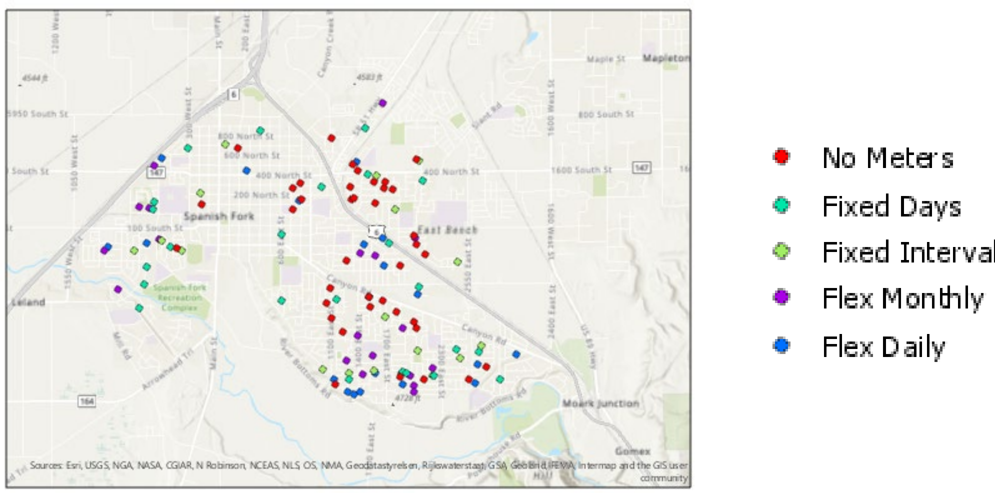



*Figure 2: Control Homes With and Without Meters*

**Step 2**: Those points were buffered with a 5-yard radius to get a sample of their lawns. Those buffered points were intersected with The National Agriculture Imagery Program (NAIP) 2014 and 2016 imagery with Red, Green, Blue bands. The green bands were extracted out so only change in greenness is compared.


*Figure 3: Greenness Spectrum of 5-Yard Samples of Lawns*

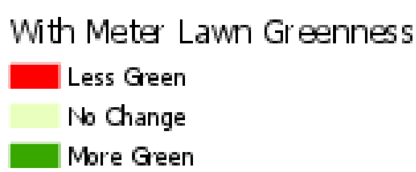
**Step 3**: The greenness from the 2014 pixels was subtracted off the 2016 pixels greenness to get the change in greenness. Comparing these two years before meters were placed could create a range in which greenness change is significant or not. The table below indicates the ranges of significance (0,1,2). If the change is greater than -25 it determined to be significantly less green and the pixel is given a value of 0. Ranges from -25 to 50 are insignificant change with a pixel value 1 and pixels with changes more than 50 is considered significant increase in greenness and given a value of 2.

*Table 4: Reclassification of Greenness Differences*

| Start | End | New |
|---|---|---|
| -200 | -25 | 0 |
| -25 | 50 | 1 |
| 50 | 200 | 2 |
| NODATA | NODATA | NODATA |
| | | |

**Step 4**: To compare the greenness, the model is run and exports the values into a table that sums up the pixels which had a change in greenness.


*Figure 4: Change in Lawn Greenness from 2014 to 2016*




| OBJECTID | LABEL | Value_0 | Value_1 | Value_2 |
|---|---|---|---|---|
| 1 | 0 | 1989 | 0 | 0 |
| 2 | 1 | 0 | 24162 | 0 |
| 3 | 2 | 0 | 0 | 2854 |

*Figure 5: Zoomed in Image of Greenness Change from 2014 to 2016*

The results from 2014 to 2016 shows little change in greenness, as 83% of the data shows no change. This is used a base calculation to get a final result for the greenness of lawns after the meters were placed. The NAIP data for 2018 have not been published yet, which means a final result could not be calculated. The program is set up to run as soon as the data is available.

**Ideal Lot Sizes for Optimal Water Savings**

The data taken from Spanish Fork and was organized into lot sizes to determine which size would benefited the most. We chose to compare the lot sizes for August and September assuming most of the meters had been placed in those months. The lot sizes of Spanish Fork were categorized into less than a quarter acre, about a quarter acre, and over a quarter acre. The findings show that quarter acre lots are the best by saving about 13.7 thousand gallons of water in August. These are the lots to start implementing the meters on. The water savings for smaller lots were less significant than the quarter acre lots and the sample size for larger lots were too small to acquire an accurate average water savings per household.  Table 3 below summaries the water savings.

*Table 5: Water Savings per Lot Sizes*

| Total saved with meters | Average Water Saved August (1000g) | Average Water Saved September (1000g) |
|---|---|---|
| Larger than 1/4 acre | 4.3 | -11.5 |
| About 1/4 acre | 13.7 | -1.1 |
| Smaller than 1/4 acre | 3.8 | -0.3 |

**Smart Meter Watering Schedules**

There are a number of different schedules the Smart Meters can be placed on to control the sprinklers. When implementing the Smart Meters, Spanish Fork placed a number of residents on each schedule to compare the results. Rachio's meters have four different schedules. Those include Flex Daily, Flex Monthly, Fixed Days and Fixed Interval. Flex Daily Schedules determine when to water dynamically on a zone-by-zone basis; intervals will adjust based on weather conditions and soil moisture estimates (Rachio). Flex Monthly schedules adjusts watering based on historical climate data and will change watering schedule at the beginning of each month to adjust to the new month. Fixed Days allows residents to select the days they wish to water. It will only run on days you set no matter what. Fixed Interval is much the same as the fixed days. It allows residents to pick intervals in which to water their lawns on.

The results are likely fairly preliminary due to not knowing when any of the meters were placed or if residents used any other smart function on their system. As of the current data, the results show fixed days and flex monthly being the best schedules to on. Each of these groups are separated in the GIS model and greenness can be compared for each schedule used.

*Table 6: Water Savings per Schedule*

| Water Savings per 1000 gallons | | | | |
|---|---|---|---|---|
| Jun | Jul | Aug | Sep | Total |
| Control Group 2: Flex Daily | | | | |
| 2.24 | 0.63 | 9.59 | -3.56 | 8.91 |
| Control Group 2: Flex Monthly | | | | |
| -2.54 | 0.62 | 12.93 | 5.26 | 16.26 |
| Control Group 2: Fixed Days | | | | |
| 6.04 | -1.04 | 12.44 | 4.85 | 22.30 |
| Control Group 2: Fixed Interval | | | | |
| -0.70 | -4.09 | 7.43 | -4.35 | -1.70 |

# Lessons Learned

Of the things we learned from this project, only one primary lesson was technical skills. We used GIS software in a creative way and learned new functions of the program. Other than that, the rest of our lessons learned stem from how we work as individuals and as a team on projects.

The most prominent lesson was how to effectively communicate with all parties involved in a project. We realized near the end that it is indeed very beneficial to utilize a mentor. Our mentor for this capstone was Dr. Williams in the BYU Civil Engineering department. He was extraordinarily helpful in giving advice on the direction of our project as well as suggestions on how to communicate with our client. When it came to communication with the client, we were pleasantly surprised to see their genuine interest in our work, even with it being a student project. It opened our eyes to how informed and up-to-date a paying client will want to be.

In all communication settings we found it necessary to keep notes. It is all too easy to attend a meeting, generate action items, and promptly forget those action items upon adjourning. As the school year progressed, our records from all meetings improved.

The final prominent lesson we learned was about goal setting. We found that making our goals idealistic and lofty left us feeling unmotivated because we knew we'd never achieve them. We started seeing greater accountability when our goals, tasks accomplished and time spent, were within reason. This and all the aforementioned lessons will be valuable principles to apply to future projects in our respective careers.

# Conclusions

With the 0.4% reduction in peak demand as well as the significant savings of water in August 2018, preliminary analysis suggests that Smart Meters, when installed, managed, and maintained correctly, decrease the peak demand of a given system. It appears that the Smart Meters conserve water in the system as well by regulating an individual home's water demand and usage. These procedures also suggest that further data can be obtained by these Smart Meters for in-depth statistics and analysis for a more comprehensive water conservation program.

Using these results, it would be clear that integration of Smart Meters into Santaquin City would increase the life span of the current water system and allow the city to maintain the same pressurized line sizes for a few more years. This conclusion is significant for the city, due to its above-average growth rate and current pressurized line recirculation system.

These conclusions are incomplete, however. Due to the installation time period from June to August, no yearly month-to-month comparison could be created and until new imagery data can be obtained, the greenness factor of the lawns in the area is deemed inconclusive. These conclusions are considered preliminary due to the lack of usable data and the early nature of the project in Spanish Fork. Further analysis of the project would be necessary to determine additional factors such as maintenance, product lifespan, troubleshooting, transfer of ownership, and any other unforeseen circumstances.

# Recommendations

Due to the preliminary nature of the Spanish Fork Project as well as the lack of comprehensive data, it is this team's recommendation that Santaquin City wait one year to confirm the merits of this program before installation. During this year, the city will be able to obtain the necessary funding and public support necessary for effective community integration. This time will also allow for the analysis of additional data from Spanish Fork to inform a clearer decision by conducting a yearly month-to-month direct comparison for homes with Smart Meters.

Santaquin City requested details on how to acquire state grants to purchase Smart Meters. Funding is made available by different organizations for projects that will conserve water. The Central Utah Water Conservancy District (CUWCD) is one of these organizations and is the only one we were able to communicate with. CUWCD offers grants for cities in their region to apply for. The grants are available on a first come first serve basis and just require a few things to be considered. The cities need to submit a proposal that includes project scope, project cost, time line, and projected water savings. Usually, CUWCD will have a meeting with a representative of the city, before the proposal is submitted to go over what information they need. That can be done in person or over the phone. Once CUWCD receives the proposal, they review it and award a dollar amount based on the project and the expected water savings.

Also requested by Santaquin City is a technical addendum on viable Smart Meter options. This information is provided in the Appendix of this report (pg. 26-35).

# Appendix A

References:

Precipitation and Temperature Data from NOAA
CLIMATOLOGICAL DATA UTAH JUNE 2018 VOLUME 120 NUMBER 06 ISSN 0364-5592 GHCND Ver: 3.25-upd-2018102018
https://www1.ncdc.noaa.gov/pub/orders/IPS/IPS-F7A0E226-BA10-4BF9-B996-75920E6C13CC.pdf
CLIMATOLOGICAL DATA UTAH JULY 2018 VOLUME 120 NUMBER 07 ISSN 0364-5592 GHCND Ver: 3.25-upd-2018110519
https://www1.ncdc.noaa.gov/pub/orders/IPS/IPS-57EB22F1-5AED-44FC-8583-8AF8AD3E8F15.pdf

CLIMATOLOGICAL DATA UTAH AUGUST 2018 VOLUME 120 NUMBER 08 ISSN 0364-5592 GHCND Ver: 3.25-upd-2019012821
https://www1.ncdc.noaa.gov/pub/orders/IPS/IPS-6031D737-926A-4DD2-9D19-453024710C6E.pdf

CLIMATOLOGICAL DATA UTAH SEPTEMBER 2018 VOLUME 120 NUMBER 09 ISSN 0364-5592 GHCND Ver: 3.25-upd-2019021019
https://www1.ncdc.noaa.gov/pub/orders/IPS/IPS-9FB2E273-203D-4D2A-AA27-5ECAB1BE2EC2.pdf

CLIMATOLOGICAL DATA ANNUAL SUMMARY UTAH 2017 VOLUME 119 NUMBER 13 ISSN 0364-5592 GHCND Ver: 3.24-upd-2018040904
https://www1.ncdc.noaa.gov/pub/orders/IPS/IPS-40B3185A-EDE1-4466-BF9A-2685D2D8CAC2.pdf

Rachio Website
https://support.rachio.com/hc/en-us/articles/115010541468-How-do-I-create-a-watering-schedule-

**Robert Marshal Anderson**

(209)-840-1984
Email: robbman1@gmail.com

## *Education:*

**B.S. In Civil and Environmental Engineering (Emphasis in Water & Env.)**: *Awarded Dec 2019*
**Minor Mathematics**
**Brigham Young University**

- Relevant coursework: Soil Mechanics, Advanced GIS, Environmental Engineering, Hydraulics
- Head Captain of Concrete Canoe Team
- Involvement with Student Engineering Technology College Board and ASCE Student Chapter
- Experience as GS-06/07
- 4-5 years of construction experience

***Skills/Achievements:***

- Advanced coding knowledge in VBA
- Intermediate experience html and Matlab
- Basic coding knowledge Python, R, Java
- Lead 160 missionaries in planning, organization and training in Milwaukee Wisconsin Mission
- Eagle Scout

## *Work Experience:*

**Teaching Assistant 'Computational Methods'** *Brigham Young University*
**Duties, Accomplishments and Related Skills:** *Current (3rd semester)*
- Teaching and grading advanced assignments in excel, VBA, html, and word.
- Coding in Python, R, and JavaScript 2-5 hours/week

**Supervisor:** Dr. Norm Jones

**Intern- Westech Engineering** *Salt Lake City Utah*
**Duties, Accomplishments and Related Skills:** *May 2018 - Aug 2018*
- Optimized bid analysis and sizing program for biological processes
- Assisted Project management budget and client coordination
- Engineered hydraulic calculations for various digester processes.

**Supervisor:** Brad Hansen

# Natalie King

(385) 249-8171 539 South 900 West, Pleasant Grove UT, 84062 nataliebagley21@gmail.com

**OBJECTIVE** Seeking to learn and grow in the field of civil engineering. Looking forward to contributing with my hard work, problems solving skills, and enthusiasm.

**SKILLS**

**Software**

- Trained on GIS, AutoCAD, Excel, SAP, Revit, and R statistics

**Courses**

- Taken classes in Structural Analysis, Fluid mechanics, Transportation, Hydraulics, GIS, Soil Mechanics. Along with Calculus, Linear Algebra, and Differential Equations
- Currently taking Hydrology, Steel design, and Capstone

**EDUCATION**

**B.S. CIVIL AND ENVIRONMENTAL ENGINEERING** September 2013- December 2019
Brigham Young University Provo, UT

- 3.5 GPA
- University academic scholarship recipient
- Officer in ASCE BYU student chapter over all the activities
- Competitor in the ASCE Rocky Mountain Conference

**EXPERIENCE**

**IRA A. FULTON COLLEGE OF ENGINEERING** January 2019-Present
**Teaching Assistant for Soil Mechanics** Provo, UT

- Enhance student learning through facilitating soil labs each week
- Assist students in understanding soil mechanic concepts
- Facilitate writing groups for students to improve their writing skills

**ACUTE ENGINEERING** May 2018-December 2018
**Student Engineer** Provo, UT

- Engineered light frame custom and commercial homes
- Provided solutions for building errors and modifications
- Quality checked manufacturers drawings and layouts for design and functionality

**BYU STORE** August 2015- May 2018
**Tracking & Inventory Manager** Provo, UT

- Analyzed prior year holiday purchases, created process, resulted in no out-of-stocks following holiday
- Troubleshooting ecommerce international and domestic shipping problems
- Managed $0.5MM in annual inventory purchasing

**BALTIMORE MARYLAND MISSION, CHURCH OF JESUS CHRIST OF LATTER-DAY SAINTS** December 2014- August 2015
**Volunteer Representative** Baltimore, MD

- Led volunteers through quantitative goal setting, new teaching/contact methods, and by increasing team member morale
- Managed and trained 20 volunteers through one on one training and workshops

**PERSONAL**

I love to read, learn, and be creative. I also love to play sports including soccer, skiing, and ultimate Frisbee.

## Caleb D. Joubert

(619) 792-0391
joubertcaleb@gmail.com

**Education**

Civil Engineering Major
Brigham Young University, Provo, UT — 2012-2014, 2016-Present

**Experience**

Field Technician/Traffic Intern: Horrocks Engineers – May 2018-Current

- helped collect and analyze data for traffic impact studies
- wrote sections of reports for clients
- represented the company when meeting with clients
- edited plans in AutoCAD and ArcGIS
- analyzed intersections with Synchro

Custodian: Brigham Young University — January 2014-April 2014, September 2016-April 2017

- set up events
- cleaned restrooms, offices, businesses, and ballroom floors
- did anything else required to improve the general appearance and maintenance of the Wilkinson Student Center

Full-Time Missionary: The Church of Jesus Christ of Latter-day Saints, Louisiana Baton Rouge Mission — 2014-2016

- proselyted in 6 cities in the Southern Louisiana Parishes
- trained 1 new missionary
- studied and became fluent in Spanish

**Skills**

- experience with ArcGIS, AutoCAD, Synchro, VBA, Office Programs
- fluent in Spanish
- able to communicate with all levels of management and employees

# Alec Van De Graaff

BS in Civil Engineering, *Brigham Young University*, Provo, UT
Graduate April 2020

- BS cumulative GPA: 3.46
- Emphasis in Water Resources

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**EXPERIENCE**

**Asset Management Intern***, Central Utah Water Conservancy District,* Orem, UT
May – August 2018

- Worked with engineers and other professionals to prepare for bare ground replacement estimation
- Created, attributed, and edited 750+ assets in an online registry database
- Assisted owner in review of consultant-prepared design drawings and specifications
- Assisted in the inspection of dams and facilities of the Duchesne, UT water treatment plant
- Attended and prepared notes for construction meetings associated with the North Fork Siphon Replacement Project
- Worked with GIS analyst to create a spatial service with geographical information of District assets
- Wrote and edited technical documents outlining operation and maintenance procedures

**Co-Founder & Business Owner***, Dates Outdoors,* Provo, UT
June 2018 – Present

- Co-developed and continue to operate a tandem bike rental business
- Practice excellent customer service through punctuality and clear customer communication
- Collaborate and set monthly publicity goals with two other business owners

**Student Manager***, BYU Creamery,* Provo, UT
January 2016 – July 2017

- Promoted to manager after two months of being hired
- Interviewed and hired new employees, closed Creamery one to two nights per week, maintained custodial standards, coordinated with other departments, and trained and supervised new hires
- Acted as a consultant for new managers

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**SKILLS/EXTRACURRICULAR ACTIVITIES**

- International Study Abroad (Indonesia)
- Familiar with Word, ArcGIS Pro, Excel, PowerPoint, Visio, Revit, Acrobat
- BYU ASCE Officer (2017-2018)
- BYU Concrete Canoe Paddling Captain (2018-2019)

DATA SHEET

# iPERL Smart Water Meter

## Electromagnetic Flow Measurement System

Sensus iPERL® smart water meters are designed to capture both lost water and lost revenue. The innovative magnetic technology delivers unmatched low flow registration and minimal pressure loss. With no moving parts, iPERL maintains its accuracy over a 20 year lifetime and is equipped with smart water alarms – delivering the intelligence you need to quickly resolve issues in the field.

### CAPABILITIES

- The iPERL meter has an operating range of 0.11 gpm (0.025 $m^3$/hr) to 55 gpm (12.5 $m^3$/hr)—it even starts to register flow as low as 0.03 gpm (0.007 $m^3$/hr).
- Sizes include: 5/8" (DN 15mm), 3/4" (DN 20mm) and 1" (DN 25mm)
- iPERL can be installed horizontally, vertically or diagonally.

### BENEFITS

- Maximize investment with iPERL's magnetic technology, which delivers a 20-year accuracy warranty, with no repairs
- Get smart water alarms to detect issues such as leaks, reverse flow, empty pipe, etc.
- Improve low flow accuracy to drive additional revenue

### Industry Leading Performance

The patented measurement technology of the iPERL water meter provides enhanced accuracy at both low and high flows. Over a 20-year lifespan, your iPERL will measure just as accurately as the day it was installed.

### Solid State Magnetic Technology

By avoiding the use of a mechanical measuring element inside the flow tube, metering performance is linear over the entire flow range – ensuring no reduction in accuracy at any flow rate over the life of the meter. The iPERL meter uses our patented remanent magnetic field technology – requiring far less energy and delivering superior accuracy.

### Alarms

Quick resolution of field issues is made possible with smart water alarms including leak detection, reverse flow, empty pipe, magnetic tamper and low battery. When integrated with our FlexNet® communication network, remotely gathering and transmitting data has never been more reliable or profitable.

### Construction

The iPERL meter body is made of composite alloy and contains no metal material. Inside the meter body is an electronic register and a measuring device that is comprised of a composite alloy flow tube. Embedded in the flow tube are coated silver electrodes. iPERL utilizes these to measure the fluid velocity through the flow tube – enabling less power consumption and predictable meter performance. The iPERL meter has a 20-year accuracy warranty and a 20-year battery life guarantee.

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WDS-10006-04

DATA SHEET

# iPERL Smart Water Meter

## Electronic Register

The 9-digit hermetically-sealed electronic register with LCD display was designed to eliminate dirt, fog and moisture contamination in pit settings. The large, easy-to-read display includes AMR digits, direction of flow, units of measure and smart water alarms. The AMR digits and units of measure are fully programmable. The register also provides integrated customer data logging.

## AMI / AMR Compatibility

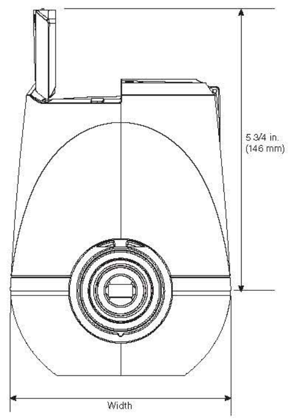
Sensus iPERL meters are compatible with common AMR/AMI systems, including the Sensus FlexNet® communication network.

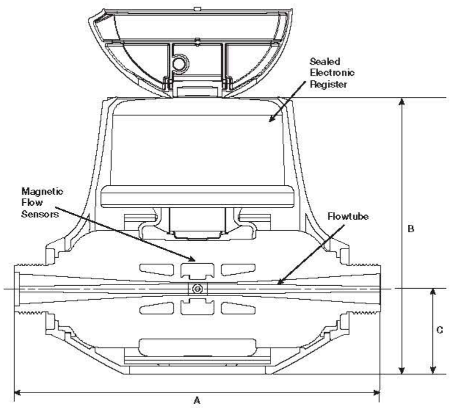
## Conformance to Standards

The iPERL meter far exceeds the most recent revision of ANSI/AWWA Standard C-700 and C-710 for accuracy and pressure loss requirements. All iPERL meters are NSF/ANSI Standard 61 Annex F and G compliant and tested to AWWA standards.

## Tamper Resistant

The integrated construction of the iPERL water meter prevents removal of the register to obtain free water. The magnetic tamper and low field alarms will both indicate any attempt to tamper with the magnetic field of the iPERL meter.




## Dimensions and Net Weights

| Size | A (lay length) | B | C | Spud Ends | NPSM Thread Size | Width | Net Weight |
|---|---|---|---|---|---|---|---|
| 5/8" (DN 15 mm) | 7-1/2" (190 mm) | 6-1/10" (155 mm) | 1-3/4" (44 mm) | 5/8" (15 mm) | 3/4" (19 mm) | 4-1/2" (114 mm) | 3.1 lb. (1.4 kg) |
| 3/4"S (5/8" x 3/4") (DN 20 mm) | 7-1/2" (190 mm) | 6-1/10" (155 mm) | 1-3/4" (44 mm) | 3/4" (20 mm) | 1" (25 mm) | 4-1/2" (114 mm) | 3.1 lb. (1.4 kg) |
| 3/4" (DN 20 mm) | 9" (229 mm) | 6-1/10" (155 mm) | 1-3/4" (44 mm) | 3/4" (20 mm) | 1" (25 mm) | 4-1/2" (114 mm) | 3.2 lb. (1.5 kg) |
| 1" (DN 25 mm) | 10-3/4" (273 mm) | 6-1/10" (155 mm) | 1-3/4" (44 mm) | 1" (25 mm) | 1-1/4" (32 mm) | 4-1/2" (114 mm) | 3.3 lb. (1.6 kg) |

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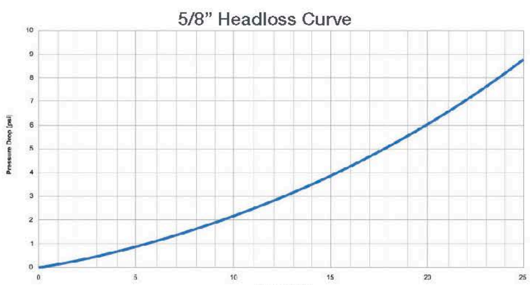
DATA SHEET

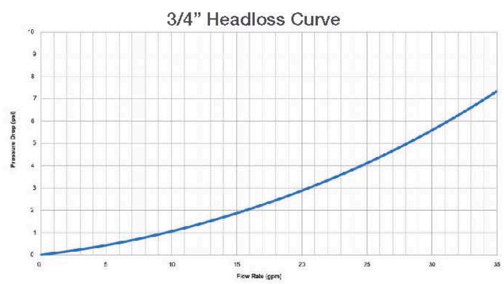
# iPERL Smart Water Meter

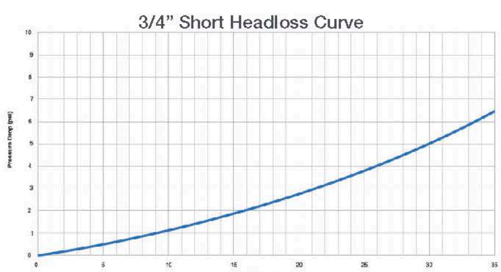
## Specifications

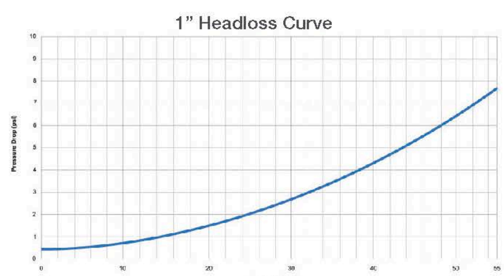
| | |
|---|---|
| Service | Measurement of potable and reclaimed water.<br>Water operating temperature range of 33°F (0.56°C) -80°F (26.7°C) |
| Starting Flow | 5/8" (DN 15mm) size: 0.03 gpm (0.007 m³/h)<br>3/4" (DN 20mm) size: 0.03 gpm (0.007 m³/h)<br>1" (DN 25mm) size: 0.11 gpm (0.025 m³/h) |
| Low Flow Range (±3%) | 5/8" (DN 15mm) size: >0.11 gpm (0.025 m³/hr) to <0.18 gpm (0.041 m³/hr)<br>3/4" (DN 20mm) size: >0.11 gpm (0.025 m³/hr) to <0.18 gpm (0.041 m³/hr)<br>1" (DN 25mm) size: >0.3 gpm (0.068 m³/hr) to <0.4 gpm (0.09 m³/hr) |
| Normal Water Operating Flow Range (±1.5%) | 5/8" (DN 15mm) size: 0.18 to 25 gpm (0.04 to 5.7 m³/hr)<br>3/4" (DN 20mm) size: 0.18 to 35 gpm (0.04 to 8.0 m³/hr)<br>1" (DN 25mm) size: 0.4 to 55 gpm (0.09 to 12.5 m³/hr) |
| Maximum Operating Pressure | 5/8" and 3/4" size: 200 psi (13.8 bar)<br>1" size: 175 psi (12.1 bar) |
| Measurement Technology | Solid state electromagnetic flow |
| Register | Hermetically sealed, 9-digit programmable electronic register; AMR/AMI compatible; iPERL register programmable using the UniPro® communicator and FieldLogic™ software |
| Materials | External housing – Thermal plastic; Flowtube – Polyphenylene sulfide alloy; Electrode – Silver/silver chloride; Register cover – Tempered glass |
| Alarm Defaults | Alarm Duration – 90 days; Leak Duration before alarm is triggered – 24 hours; Datalog Interval – 1 hour; Alarm Mask |

## Headloss Curves

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8601 Six Forks Rd, Ste 700
Raleigh, NC 27615
1-800-638-3748
sensus.com

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Rachio Support › Getting Started › Rachio 3

# Rachio 3 Compatibility and Tech Specs

Sarah M.

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# What's new with Rachio 3?

Rachio 3 offers many great improvements over our previous controllers:

- Supports dual band Wi-Fi (2.4 GHz & 5 GHz)
- Easy-press connectors are easier to install than ever and support 14-22 gauge wires
- Rachio 3 Smart Sprinkler Controller

# What's in the Rachio 3 box?

- Rachio 3 Smart Sprinkler Controller
  - Weight: 1.05 lbs
  - Dimensions: 9.1" x 5.5" x 1.4"
- Power Supply with 6-ft Cord
- Mounting Hardware
  - 4 screws (1-3/4" in length)
  - 4 drywall mounts (1/4" diameter)
- Quick Start Guide

# App Compatibility

- The Rachio mobile app is available on iOS 10.3+ and Android 4.4+. Web app is available on most internet browsers.

## Wi-Fi Connection

- Requires 2.4 or 5 GHz wireless network signal available at the installation location

## Power Requirements

The Rachio controller must be connected to the AC power adapter included. DC Transformers are not supported.

- Power Supply: External Transformer
- (6-ft cord - 2.1mm x 5.5mm Female barrel plug)
- Transformer input: 120 VAC ~60Hz 300mA
- Transformer output: 24 VAC 1000mA

Zone output (24 VAC): Compatible with 24VAC Solenoids

## Wire Compatibility

Rachio 3 supports 14-22 gauge wires.

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## Hardware Compatibility

Rachio 3 is compatible with:

- Rachio Wireless Flow Meter
- Master valve / pump relay
- 3rd Party Sensors
  - Rain Sensor: Wired & Wireless Normally Closed (NC) sensors
  - Soil Sensor: Wired & Wireless Normally Closed (NC) sensors

## Integrations

- Rachio 3 works with Nest, Amazon Alexa, Apple HomeKit, Google Assistant, and others.

## Zones/Model Numbers

- 8-zone (Model: 8ZULW-C)
- 16-zone models (Model:16ZULW-C)

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- 2-year limited warranty.

# Optional Outdoor Enclosure

Outdoor installations require an outdoor enclosure to protect your controller.

- Compatible with Rachio Outdoor Enclosure (Generation 2)
- Operating temperature: -13°F to 140°F

**Was this article helpful?**

YES NO

Have more questions? Submit a request

## Comments

0 comments

Article is closed for comments.

## Articles in this section

- What can you do with your Rachio 3?
- Rachio 3 Smart Sprinkler Controller and Smart Water System FAQ
- Rachio 3 Quick Start Guide

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- Congratulations on your new home build with Rachio 3 Smart Sprinkler Controller
- Rachio 3 Compatibility and Tech Specs