DNV·GL

ENERGY

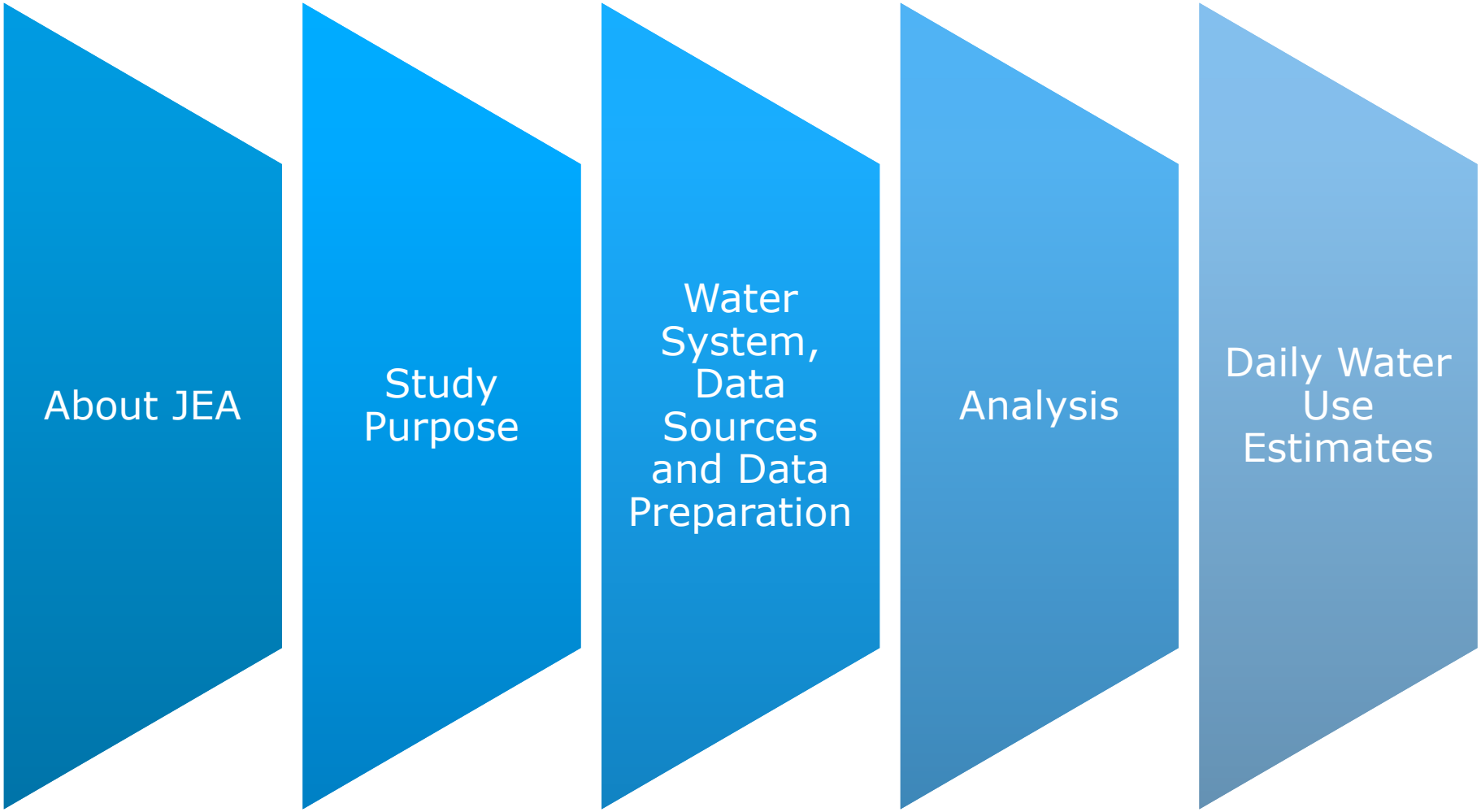
Estimation of Daily Consumption to Production Ratio for the JEA Water System

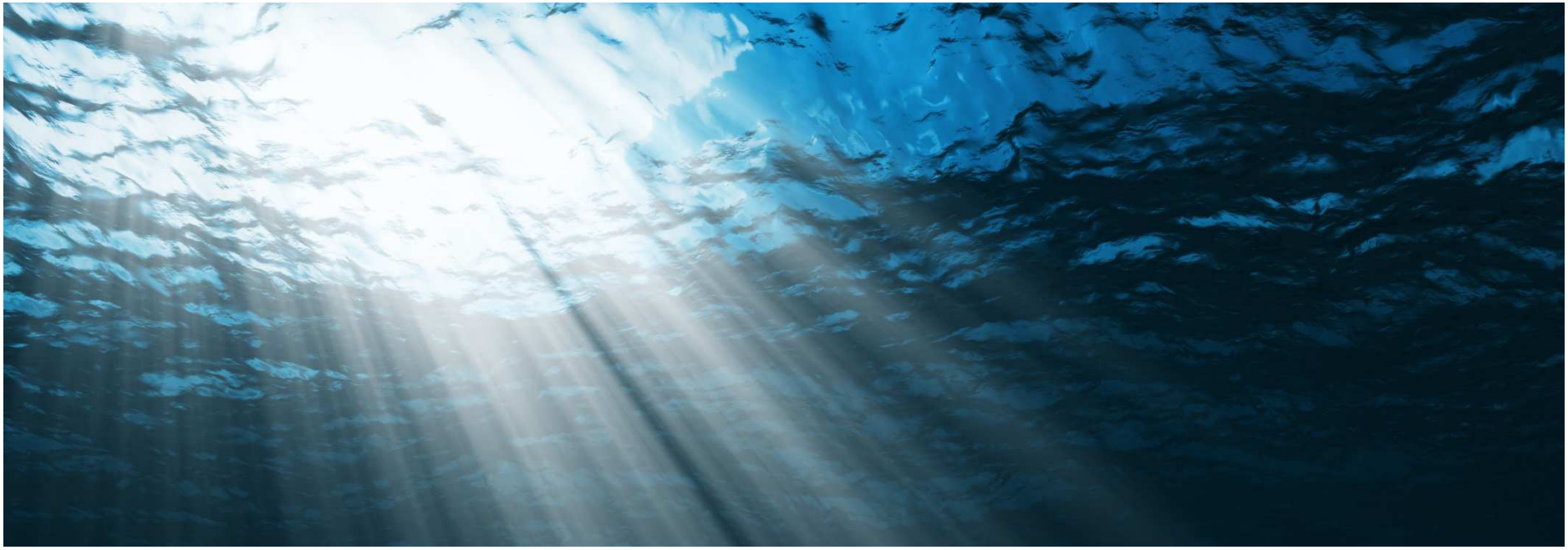
August 24, 2015

Kent Mathis (Manager of Utility Analytics, JEA)
Paula Ham-Su (Sr. Consultant, DNV GL)

SAFER, SMARTER, GREENER

Contents


About JEA
Study Purpose
Water System, Data Sources and Data Preparation
Analysis
Daily Water Use Estimates



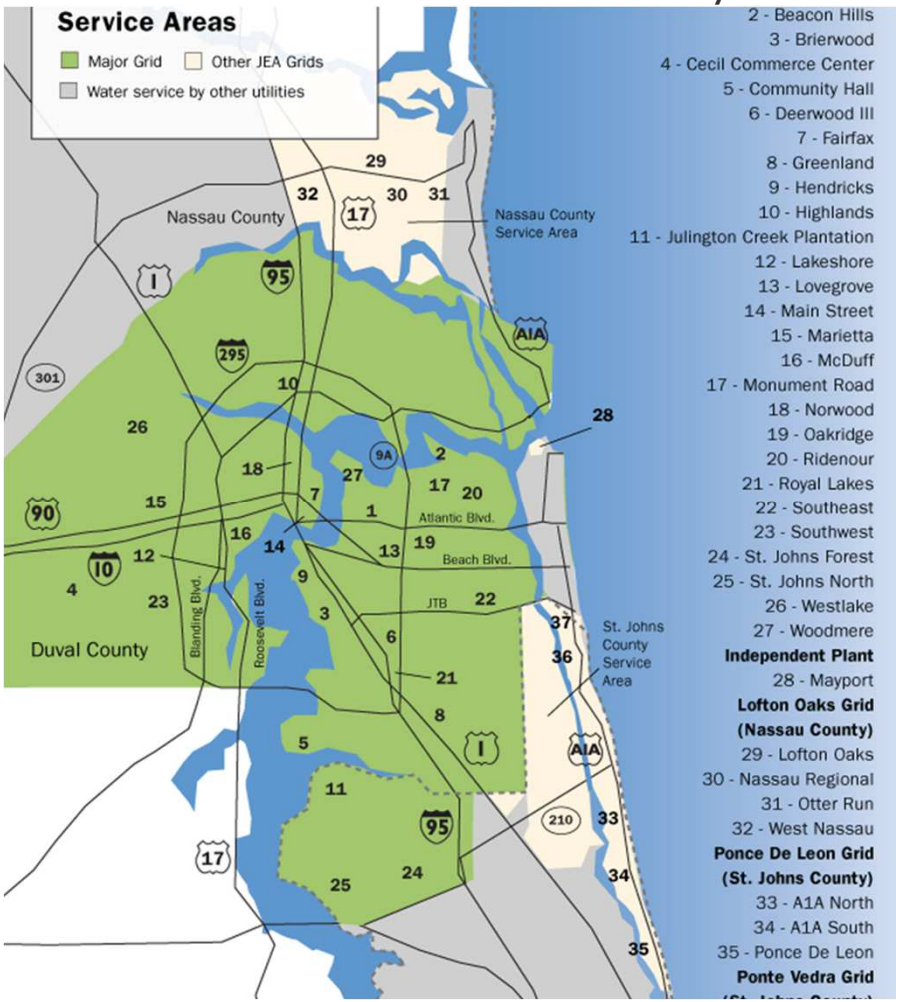
About JEA

About JEA (formerly Jacksonville Electric Authority)

Year Ending September 30, 2014

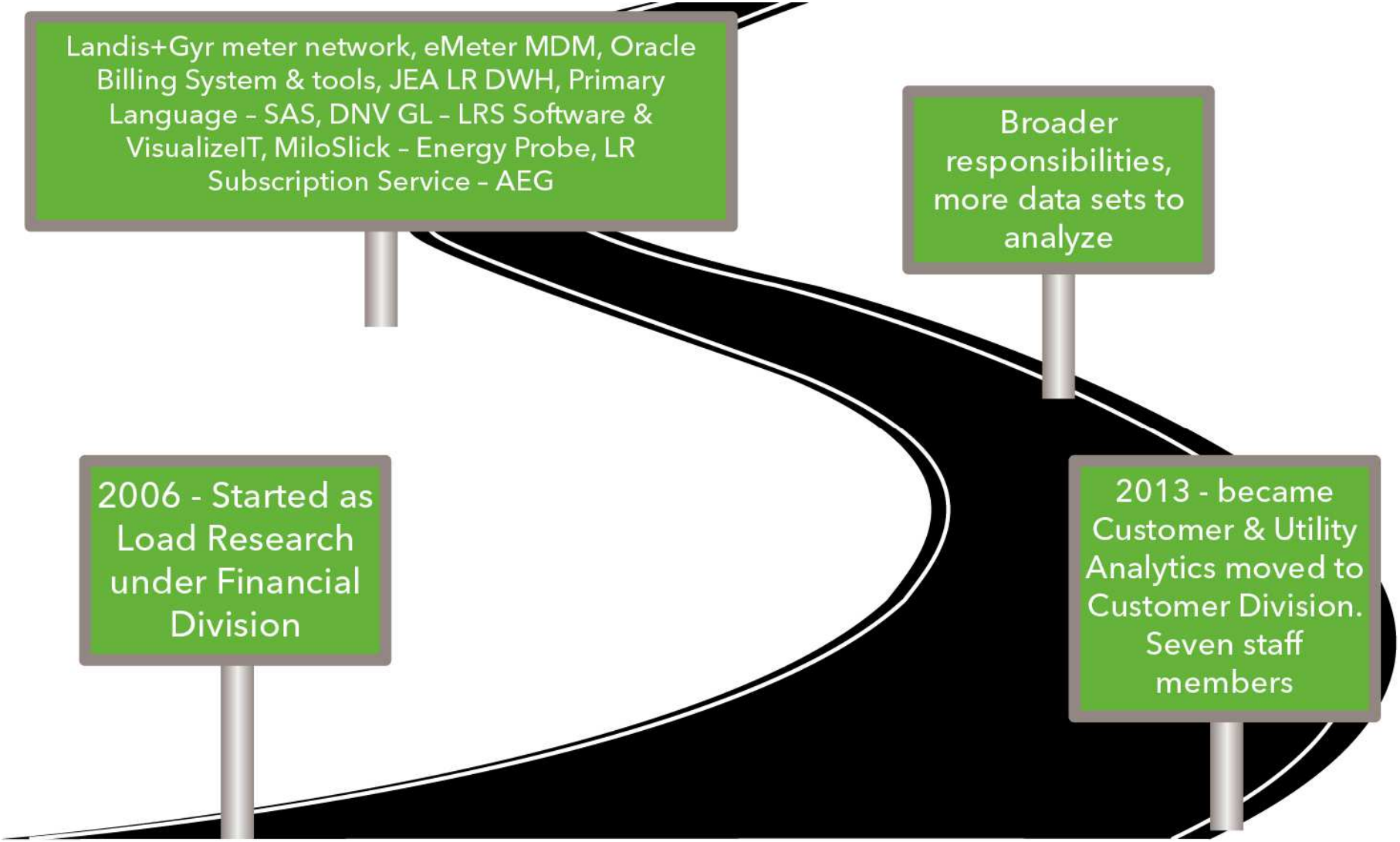
- Not-For-Profit, Community-Owned Utility founded in 1895
- Headquartered in Jacksonville, Florida
- 7th largest Muni in the U.S.
- 900 square mile service territory
- 438,931 Electric Customers
- 321,605 Water Customers
  - $157 Million Annual Revenues
- 247,476 Sewer Customers
  - $223 Million Annual Revenues

JEA Water Service Territory



Map Source: https://www.jea.com/About/Water_Supply

JEA's Load Research Transition



Study Purpose

Study Purpose

The study purpose is to calculate the Consumption to Production Ratio using an alternative methodology.

JEA has used its current C/P ratio methodology for many years.

JEA Executives asked if JEA could do better (challenge the status quo).

The new methodology involves switching from monthly to daily estimates.

This study estimated:

Daily water consumption, using smart meter data.

Consumption to production ratio, using daily water consumption estimates and water pumping ("production") data.

Distribution losses, the counterpart of the consumption to production ratio, is estimated by residual.

Why 'Estimate' the Consumption (C) in the C/P Ratio?

- **Why 'Estimate' the Consumption (C) in the C/P Ratio?**
  - Why not just add up daily consumption values to arrive at a daily 'C'?

- **Answer**
  - Because data is missing from data warehouse (DWH) day-to-day
    - Note: missing data from DWH does not affect billing, since billing data does not come from DWH
  - UA and DNV GL estimated consumption values without any correction
    - It <u>exceeded</u> production for the month analyzed
    - The major Data Quality issue causing this? - Spikes

- **Repairing DWH dataset is necessary to calculate 'C' (for a long-term solution)**

Why do we need an accurate C/P Ratio?

- JEA's use of Floridan Aquifer under Consumptive Use Permit (CUP) issued by the State of Florida (Dept. of Environmental Protection)
- Key CUP requirements:
  - Difference between permit cap and projected demand will be covered with expanded reuse and conservation
  - Water moved from north to south grid using two large river crossings
  - Integrated water management plan (IWMP) will provide controlling information for the CUP
  - South grid withdrawal is capped at 152 MGD
- CUP reinforces JEA's need for daily ratio

DNV·GL

Water System, Data Sources, and Data Preparation

JEA Water System

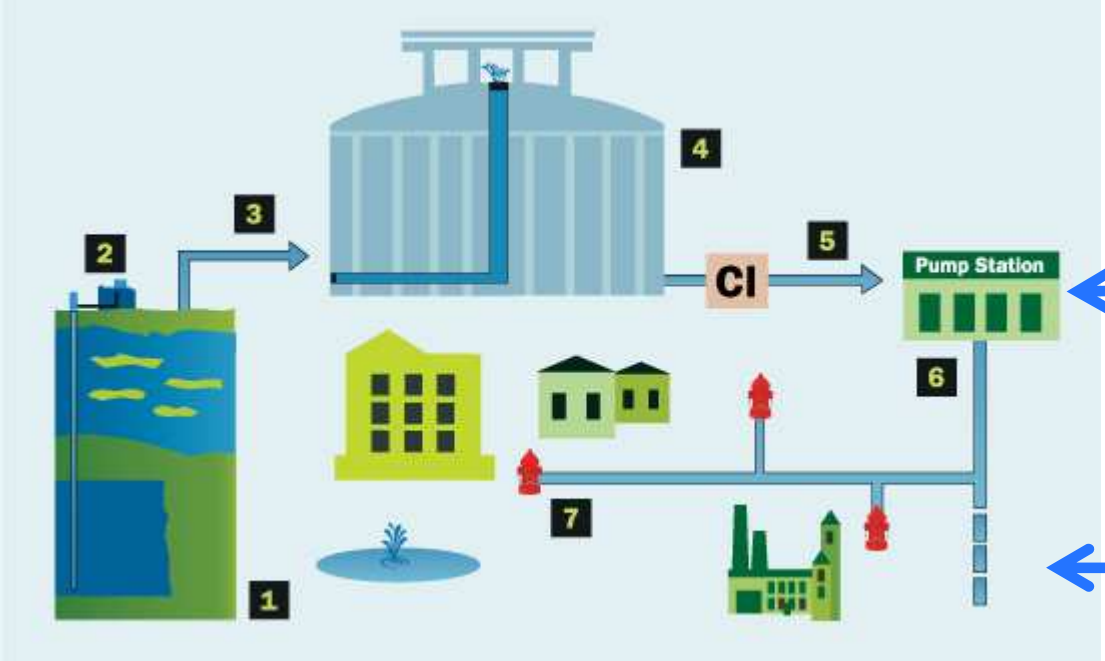
3. Well Headers

4. 37 Water Treatment Plant

5. Transmission

6. Distribution

2. 135 Deep Wells



WATER PRODUCTION

7. Customers

WATER CONSUMPTION

1. Floridan Aquifer

Source: https://www.jea.com/About/Water_Supply/

Data Sources

Direct Register Consumption (DRC) dataset containing daily water data at the Service Point Id (SPID) level, at different levels of resolution.

- 10 Gallons
- 1,000 Gallons
- Cubic Feet
- Approximately 25% of water customers do not have smart meters (i.e., no daily data)
- If a meter breaks down it is replaced by a high resolution meter

SPID-level billing data for all customers

Daily JEA Water Production

Calendar month sales estimates from the Finance Department

SPID to Premise table

Number of Customers by Data Type (Oct. 2014 to Jan. 2015)

Resolution	Count	Percent of Total
Billing Only	50,044	14.6%
Daily, Low Res	65,926	19.3%
Daily, Normal Res	225,808	66.1%
Total	341,778	100.0%

Number of meters does not match number of customers for a number of reasons: the most prevalent is customer churn over the analysis period (customers moving in and out of the same premise).

Example of Daily Data Imputation for a Low Resolution Meter

SPID	READ TYPE	BEGIN_READ_DTTM	UOM	METERED CONSUMPTION	Imputed Daily Average Consumption
123	DAILY	05OCT2014:23:39:23	CCF	0	187
123	DAILY	06OCT2014:23:23:26	CCF	0	187
123	DAILY	07OCT2014:23:54:32	CCF	0	187
123	DAILY	08OCT2014:23:29:50	CCF	748	187
123	DAILY	09OCT2014:23:56:52	CCF	0	187
123	DAILY	10OCT2014:23:30:55	CCF	0	187
123	DAILY	11OCT2014:23:28:17	CCF	0	187
123	DAILY	12OCT2014:23:53:47	CCF	748 (1)	187
123	DAILY	13OCT2014:23:57:58	CCF	0	150
123	DAILY	14OCT2014:23:17:44	CCF	0	150
123	DAILY	15OCT2014:23:58:47	CCF	0	150
123	DAILY	16OCT2014:23:45:37	CCF	0	150
123	DAILY	17OCT2014:23:57:03	CCF	748 (2)	150

(1) This read, dated October 12, is averaged over four days: three days with zero reads (October 9 through October 11) and the day with the low resolution read (October 12)
(2) This read, dated October 17, is averaged over five days: four days with zero reads (October 13 through October 16) and the day with the low resolution read (October 17)

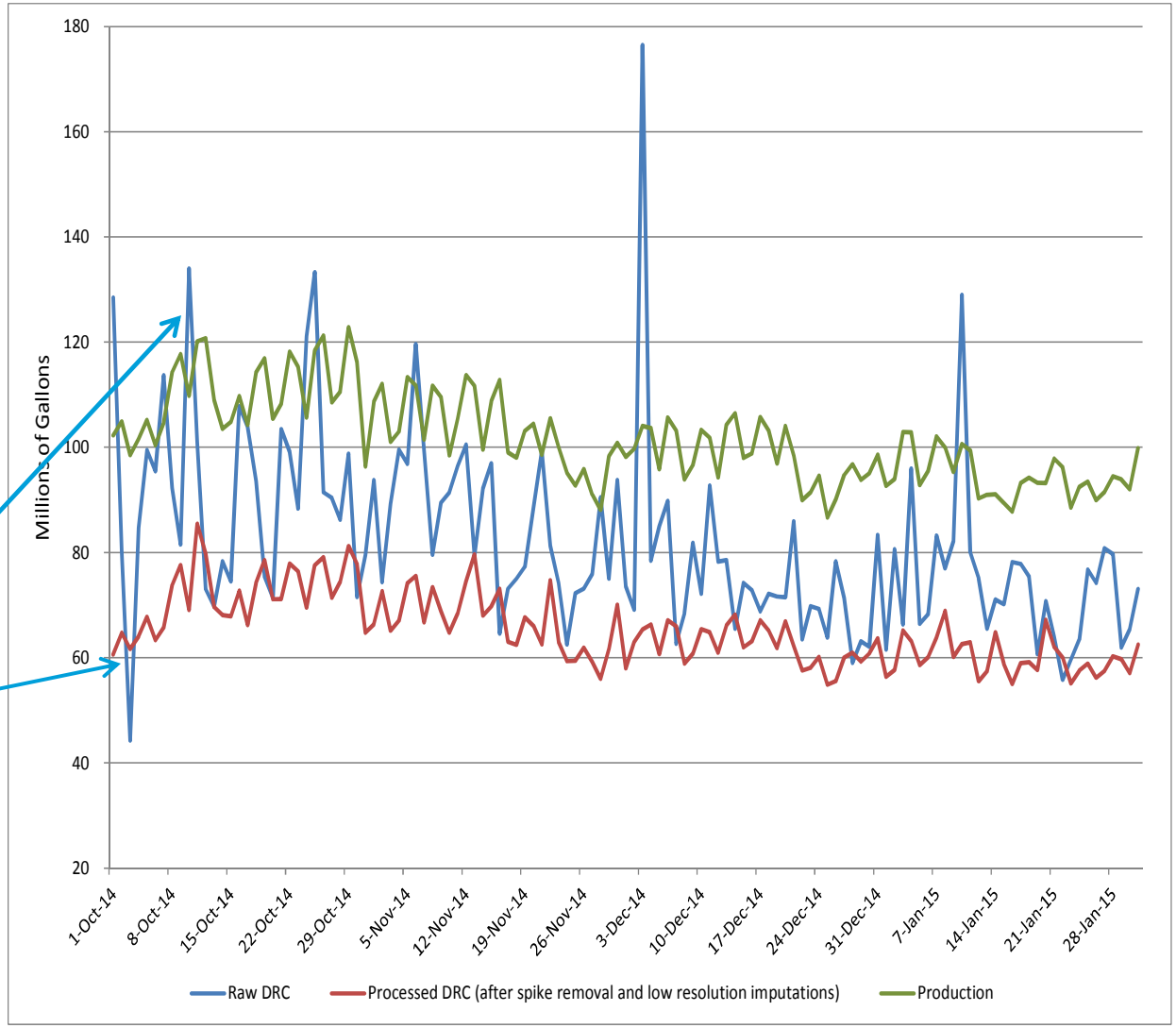
Spike Removal

Spikes are not random. Some classes and some months are more likely to have spikes.

The Residential and Multi-Family classes account for 96% of the spikes.

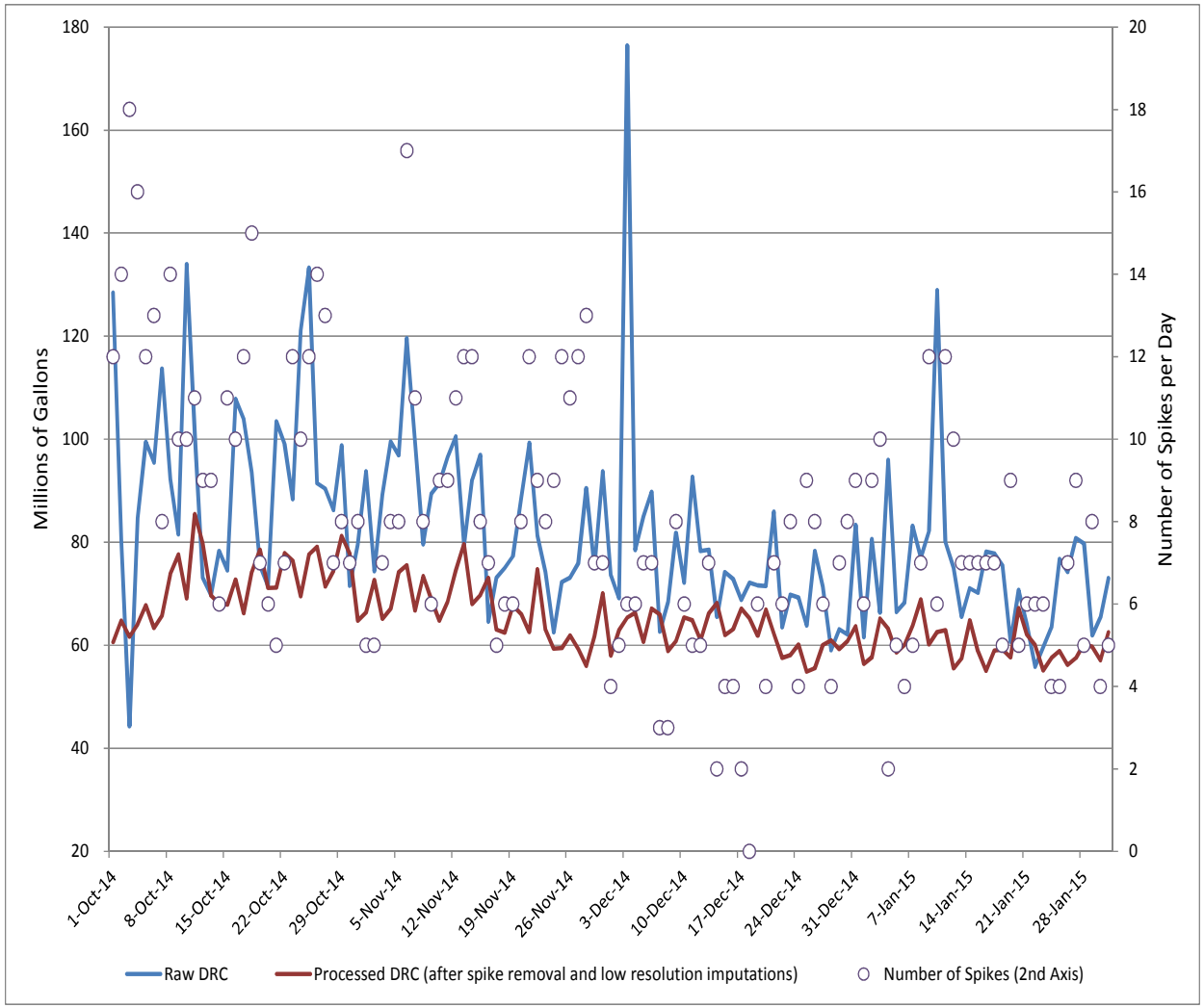
Raw DRC (before spike removal) can be higher than Production

Low Resolution Imputation can result in Processed DRC higher than Raw DRC



Spike Removal

- Only 299 SPIDs (of nearly 292,000) had a spike
- There were only 970 spikes removed:
  - 326 in October
  - 268 in November
  - 170 in December
  - 206 in January
- Number of spikes per day: between 0 and 18



Spike Removal

- JEA uses manual spike removal for billing. This cannot be used in an automated process.

- The spike cutoffs were determined by examining the distribution of the daily reads of individual SPIDs with the highest maximum reads, and were implemented at the rate code level.

- The cutoffs implemented for October, 2014 to January, 2015 are as follows:

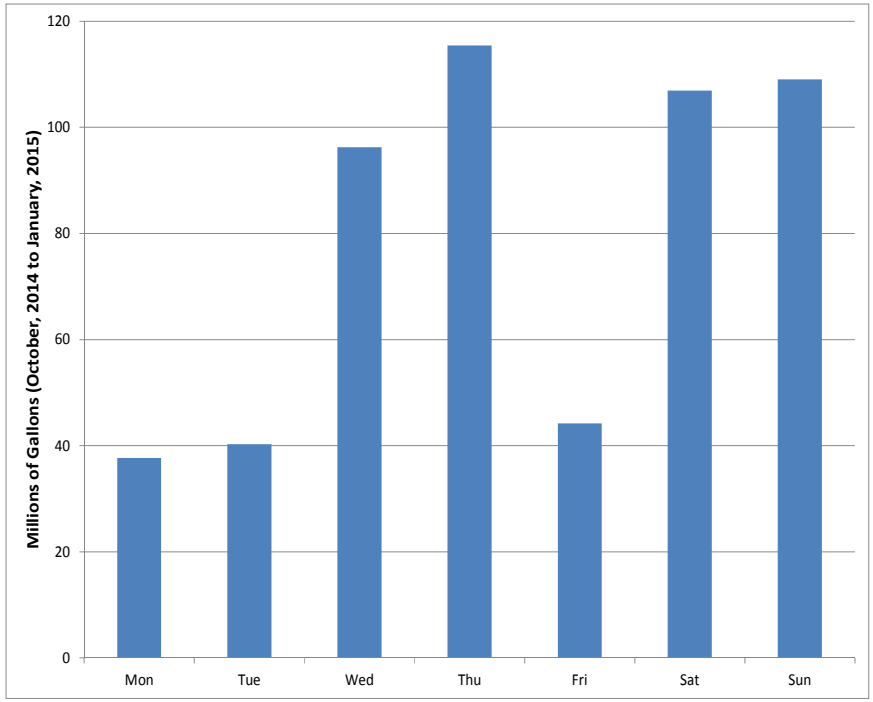
Residential (RESWTR)	Multifamily (MULTIWTR)	Commercial (COMWTRC)	All other rate codes
Daily gallons > 20,000	Daily gallons > 900,000	Daily gallons > 5,000,000	Daily gallons > 8,000,000

Analysis

Can we use day-of-week water use patterns to allocate monthly bills from irrigation accounts that do not have daily data ?

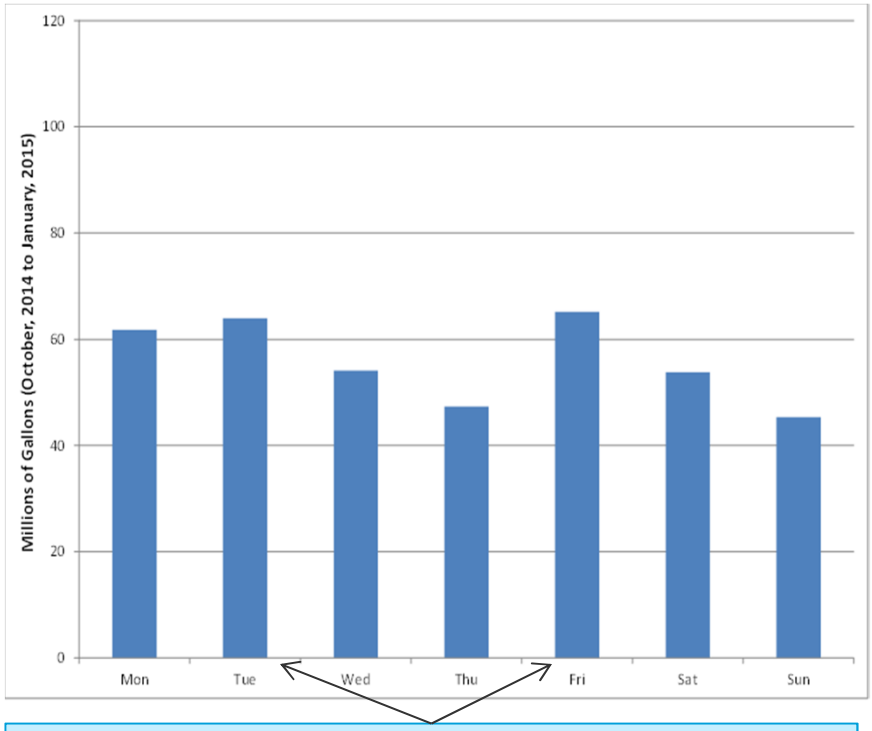
It became apparent that the Residential sector's compliance with day-of-week ordinances is clearly visible and can be used to allocate water use, but the Commercial sector's pattern is weaker.

Residential



Irrigation for even addresses is on Wednesday and Friday. Odd addresses, Thursday and Sunday.

Commercial



Commercial irrigation days are Tuesday and Friday.

Can We Use Data From Electric Smart Meters to Allocate Billed Water Use for Accounts That Do Not Have Water Smart Meters?

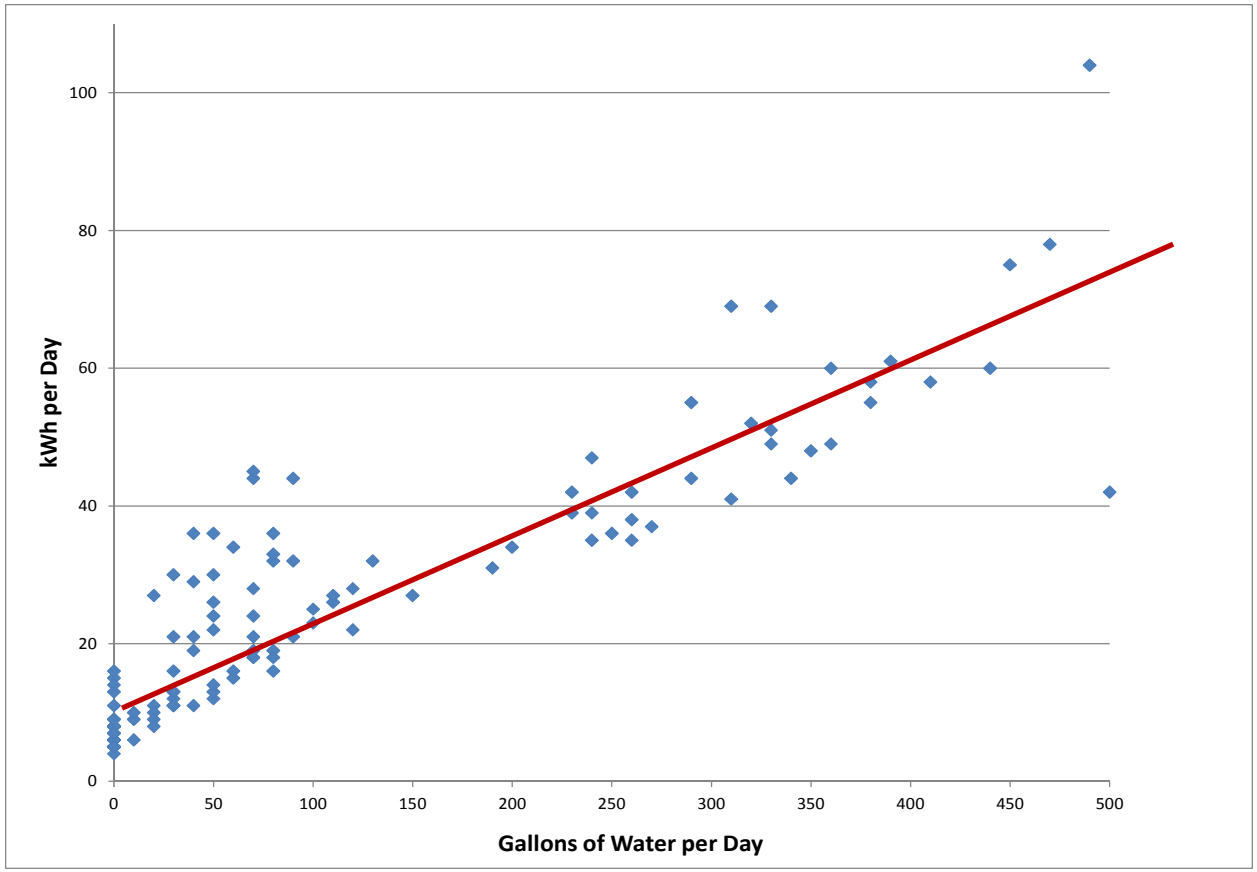
JEA

DNV·GL

This is why we thought we might

This is an example of a good linear relationship between water and electricity use. Not all premises are this well-behaved.

Small commercial customer:
electricity metered in increments of 1 kWh, water in increments of 10 gallons



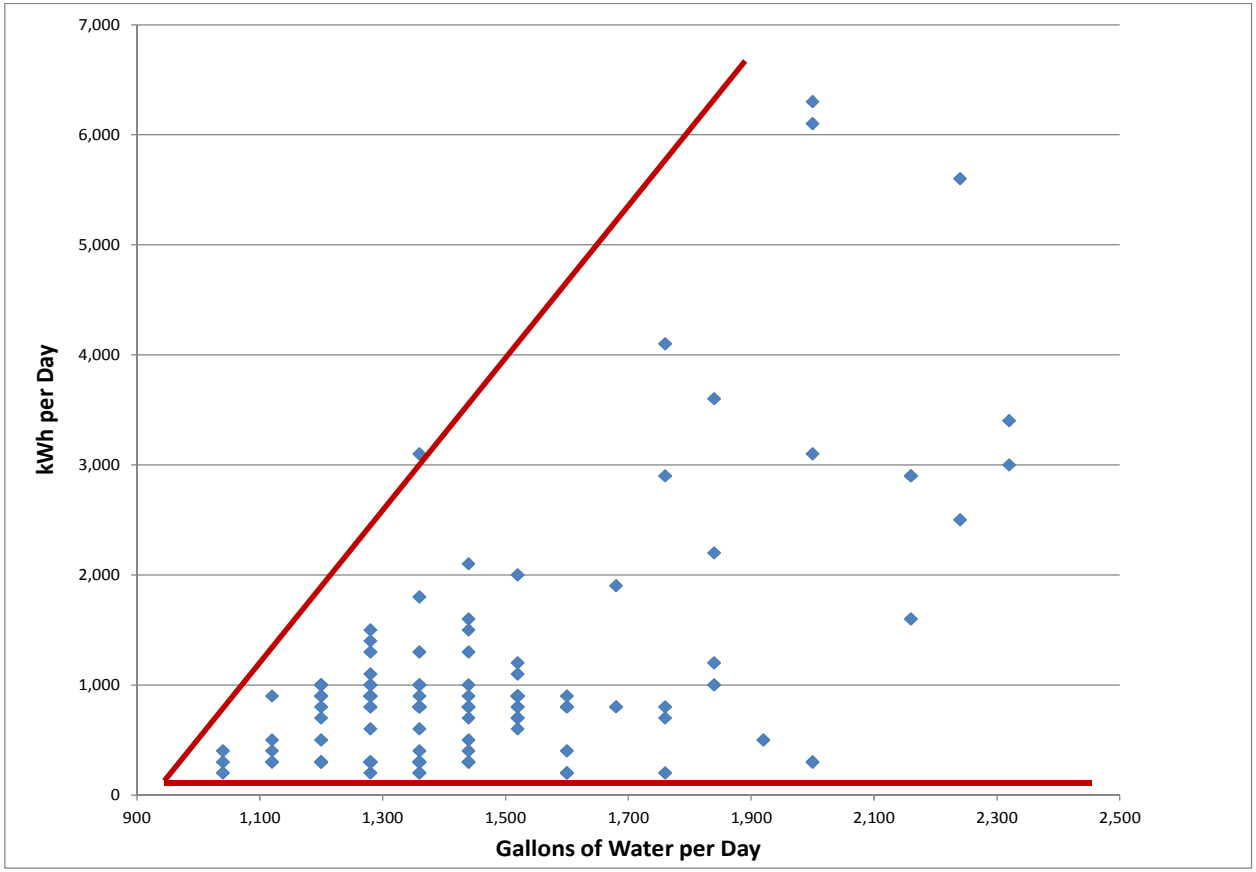
This is why we could not do it for this project

This is an example of heteroscedastic* relationship between water and electricity use. We can model this relationship, but this was not within the scope of this project.

* Heteroscedasticity refers to the circumstance in which the variability of a variable is unequal across the range of values of a second variable that predicts it.

Large commercial customer:
electricity metered in increments of 100 kWh, water in increments of 80 gallons

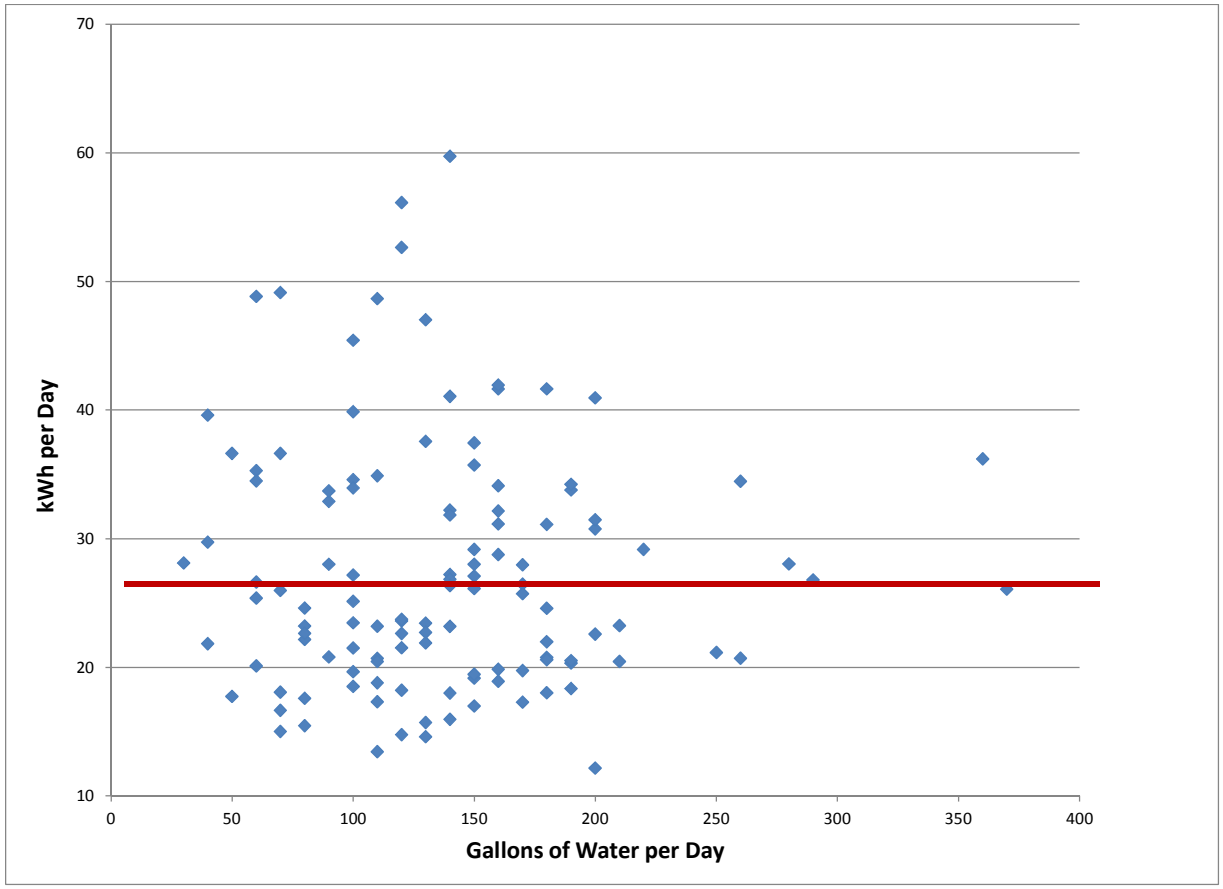
Definition source: Google.com definitions.



For some customers there is simply no relationship between Water and Electricity use

Example of no relationship between water and electricity use.

Multi-family customer:
electricity metered in increments of 1 kWh, water in increments of 10 gallons



Definition source: Google.com definitions.

Limited value of the kWh-gallons relationship for this project

kWh could not predict water use in the customer classes that needed it the most (for example, a multi-family building water meter may be associated with a common area electric account – in this case, there is no relation between the use of water and energy)

There is a relationship between water and energy that can be explored for other uses

Two Methods to Compensate for Customers That Do Not Have Daily Water Reads

Compensating for customers that do not have daily water reads is the last step in the daily water sales estimation process. There are several methods available. We focused on two approaches.

The compensation is for:

(1) Customers that do not have water smart meters and are read monthly

(2) Customers that have a missing daily meter read or that had it removed from the dataset due to data quality issues

Two Methods Tested to Compensate for Missing Daily Reads

Daily Average from Calendarized Bills

- Allocate bills to calendar months based on number of billing days
- Use the calendar month average when a daily read is missing for either reason
- Better at accounting for large customers not on daily reads

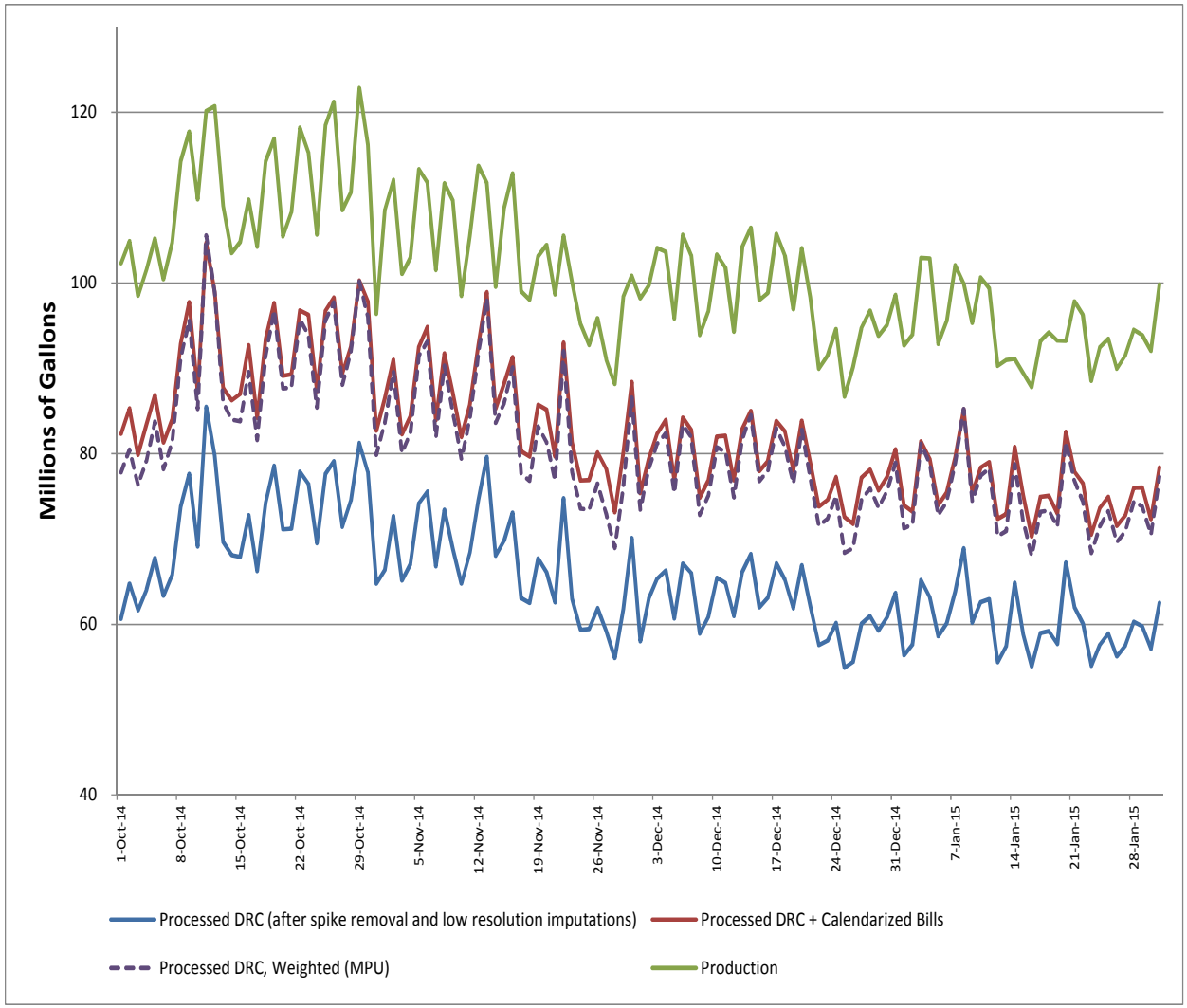
Mean-per-Unit Weight

- Obtain the average by rate schedule (Residential, Commercial, Res Irrigation, Non-Res Irrigation, etc.)
- Multiply the average by the number of customers in the rate schedule
- Better for fast turn-around of estimates – does not require billing data

Daily Water Use Estimates

Final Estimated Daily Water Use vs. Water Production (October 1, 2014 to January 31, 2015)

- Clean daily data
- Estimate of daily water use (clean daily data, plus calendarized daily data for customers with no smart meters)
- An alternative estimate of daily water use (clean daily data, weighted with MPU weights)
- Water Production – how much water went thru the JEA system each day

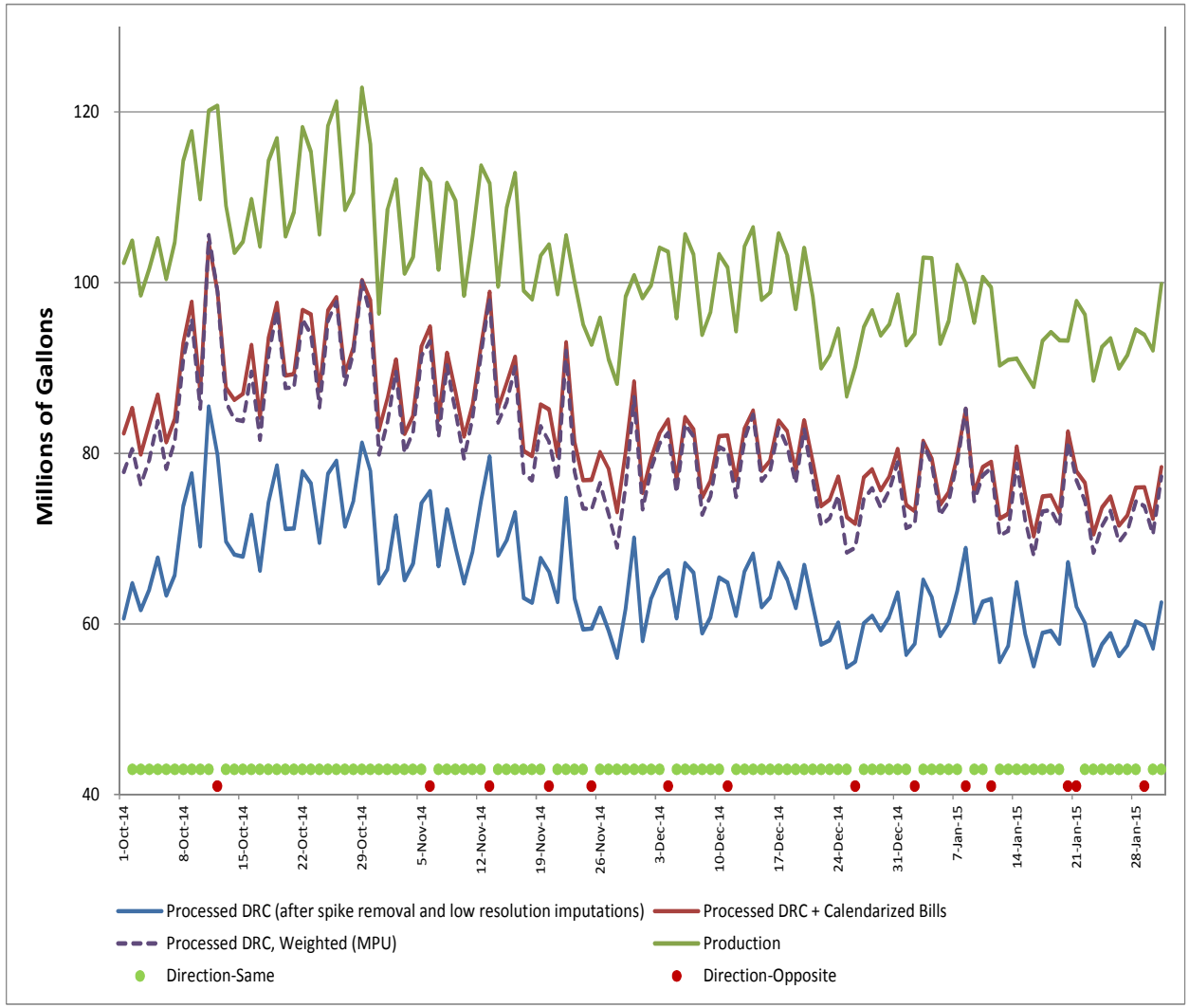


DNV·GL

Final Estimated Daily Water Use vs. Water Production (October 1, 2014 to January 31, 2015)

- The green dots at the bottom of the graph show that water production data (green line) and the estimated daily water use (red line) are moving in the same direction (108 green dots)
- The red dots show that water production and the estimated daily water use are moving in opposite direction (14 red dots)

The difference between water production (the green line) and water use (the red line) are distribution water losses



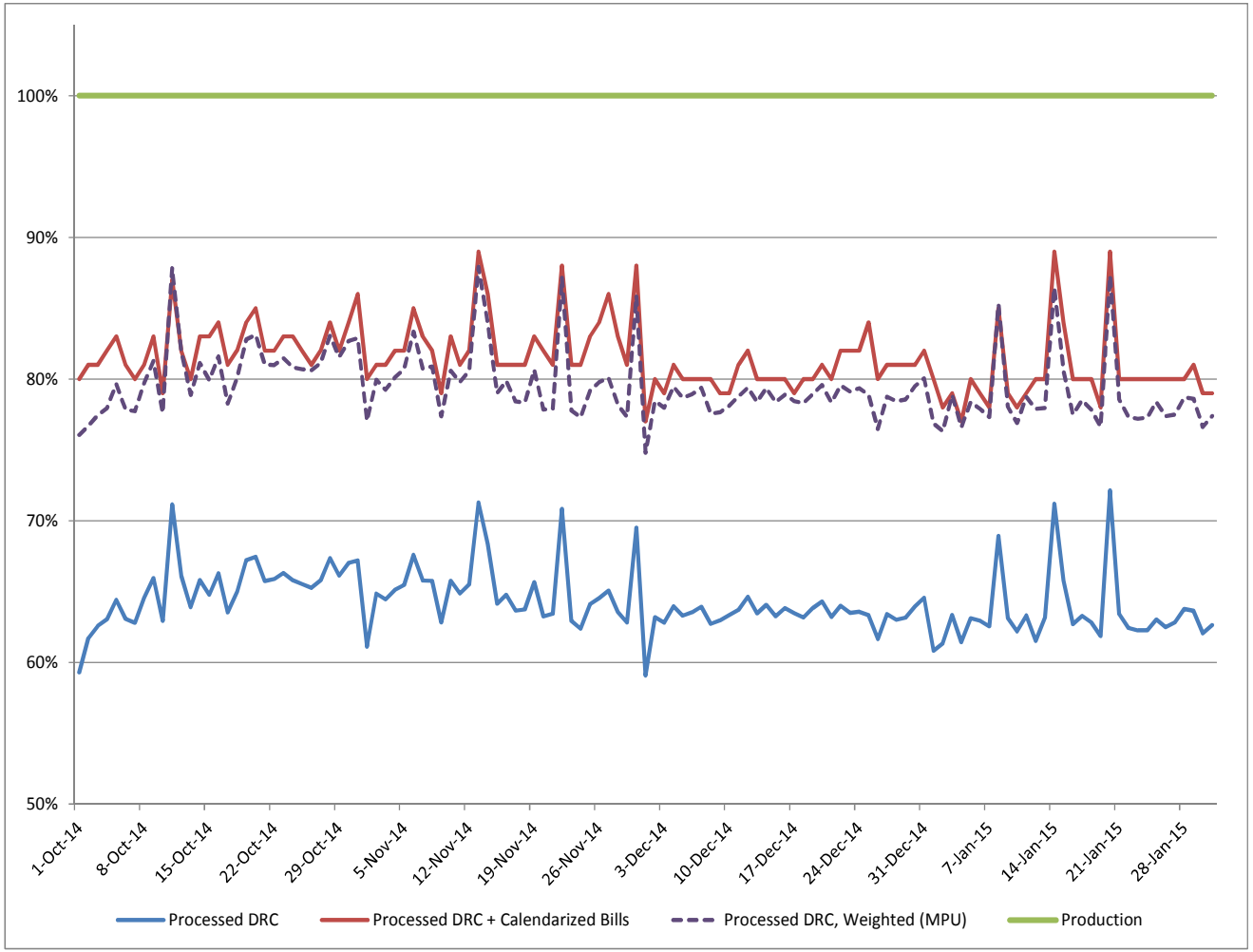
DNV·GL

Final Estimated Daily Water Use as Percent of Water Production (October 1, 2014 to January 31, 2015)

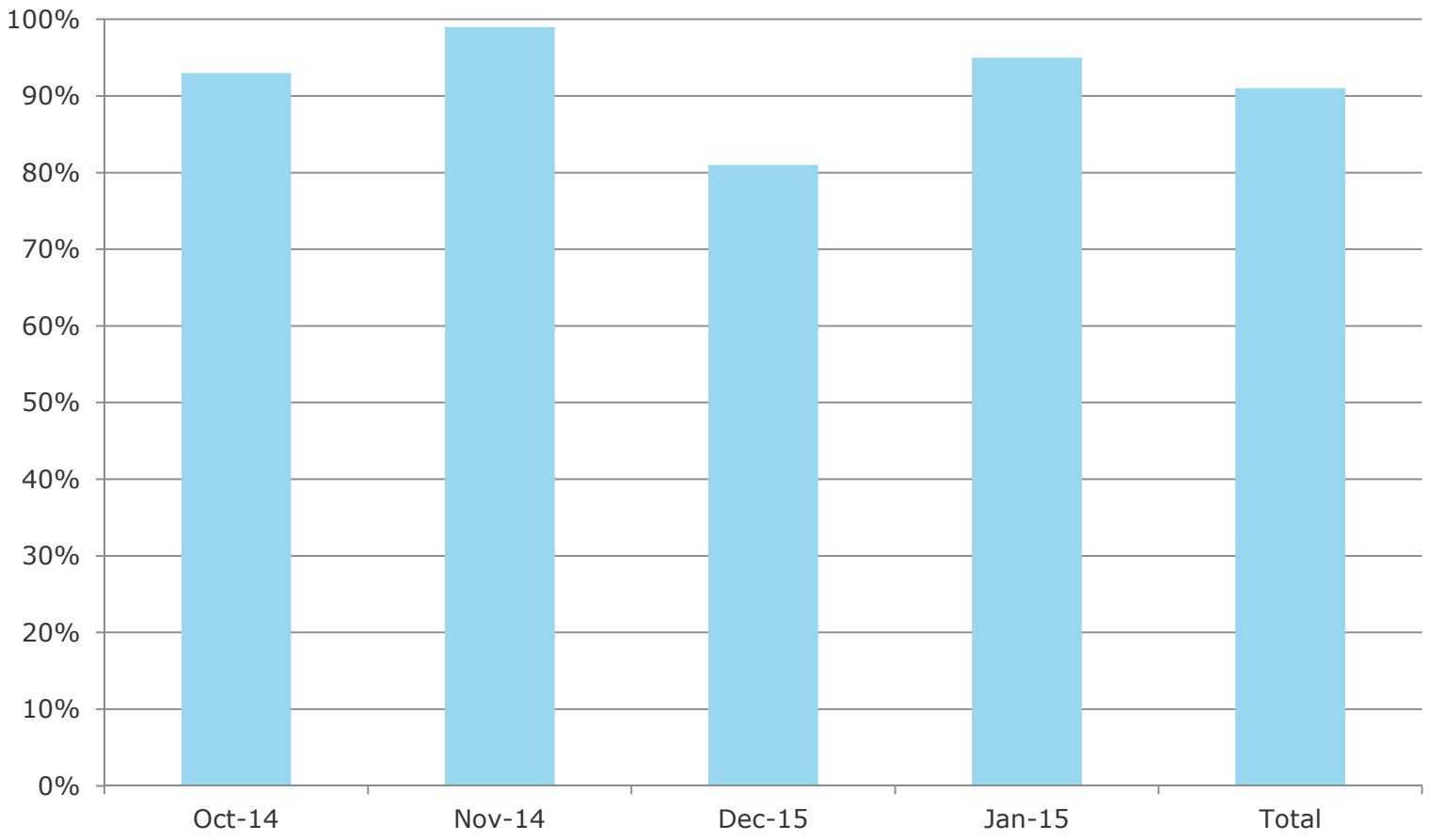
This graph shows water production at the 100% line, and estimated daily water use as a percent of water production.

Estimated water use fluctuates between 77% and 89% of water production.

This means that estimated distribution losses fluctuate between 23% and 11% of water production.



Sum of Daily Estimates as a Percent of Official Monthly Estimates



The Final Product: Consumption/Production Ratio

A process that can be automated to:

- Identify and remove spikes
- Produce daily water consumption estimates by customer class for all customers, even those that do not have daily reads
  - Allocate monthly residential irrigation water use based on day of the week
  - For other customer types, allocate monthly water use based on daily averages OR mean-per-unit weights

Useful by-products:

- Possible use of daily data to maximize irrigation ordinance schedule efficiencies.
- The water / kWh relationship can be explored further and may be useful for other initiatives such as determining vacancies.

Possible Next Steps

Discuss results & next steps with JEA water specialists: Meter Quality/Testing, JEA internal meters, interchange meters, losses, theft & production

Thoroughly test the methods developed in this study and ideas from JEA internal discussions using other time frames:

- Spike detection and removal
- Billing data calendarization and average to estimate missing data

Improve DWH: Implement data quality controls before data enters

- Data Availability – data needed is obtainable
- Data Quantity – number of observations, variables or history
- Data Completeness – percent of available data that exists
- Data Correctness – stored data is true to real value

Automate this process to produce daily C/P ratio in the shortest time possible after each day

Thank You

Kent Mathis
Manager, Utility Analytics
JEA

Paula Ham-Su
Senior Consultant
DNV GL – Energy

www.dnvgl.com

SAFER, SMARTER, GREENER

DNV·GL