

West Broad Sustainability

Agenda

- Team Introduction
- Stakeholder Introductions
- Project Overview
- Challenges
- Recommendations
- Questions

The Team



Spencer Tomlinson



Austin Pyle



Andrew Morgan

Stakeholder and Mentor Interactions

- ACC Office of Sustainability
 - Larger Carbon Offset Project
- Dr. Rick Watson
 - Statistical Analysis
- Dr. Dan Everett
 - R Programming
 - Team Oversight
- Dr. Ron Balthazor and Kristen Lear
 - Capstone Organization and Oversight

Project Overview

- Data Collection and Consolidation
- Cost-Benefit Analysis of Plumbing Retrofits
- County Cost Savings Analysis
- Carbon and Energy Savings Analysis



Compiled Water Data

Reading Number	Reading Year	Reading Date	Days in Read Period	Meter Reading	Gallons	CustomerGPD	AverageHouseholdsGPD	Most Efficient GPD	WaterScore	Meter Class	Occupants	Toilets	Retrofit	RetrofitCo
1	2020	1/6/2020	31	32533	2,023	65	142	107	efficient	SFR	3	2	1	423.66
12	2019	12/6/2019	30	30510	1,720	57	142	109	efficient	SFR	3	2	1	423.66
11	2019	11/6/2019	30	28790	1,732	57	143	111	efficient	SFR	3	2	1	423.66
10	2019	10/7/2019	31	27058	2,435	78	144	110	efficient	SFR	3	2	1	423.66
9	2019	9/6/2019	30	24623	1,661	55	147	112	efficient	SFR	3	2	1	423.66
8	2019	8/7/2019	30	22962	1,670	55	147	114	efficient	SFR	3	2	1	423.66
7	2019	7/8/2019	31	21292	1,606	51	149	110	efficient	SFR	3	2		423.66
6	2019	6/7/2019	30	19686	1,408	46	150	114	efficient	SFR	3	2	0	423.66
5	2019	5/8/2019	30	18278	1,295	43	145	114	efficient	SFR	3	2	0	423.66
4	2019	4/8/2019	31	16983	1,459	47	138	108	efficient	SFR	3	2	0	423.66
3	2019	3/8/2019	30	15524	1,746	58	141	110	efficient	SFR	3	2	0	423.66
2	2019	2/6/2019	30	13778	1,961	65	141	111	efficient	SFR	3	2	0	423.66
1	2019	1/7/2019	31	11817	1,872	60	143	112	efficient	SFR	3	2	0	423.66
12	2018	12/7/2018	29	9945	1,980	68	145	111	efficient	SFR	3	2	0	423.66
11	2018	11/8/2018	29	7965	1,414	48	146	113	efficient	SFR	3	2	0	423.66
10	2018	10/10/2018	29	6551	1,546	53	151	111	efficient	SFR	3	2	0	423.66
9	2018	9/11/2018	32	5005	1,769	55	142	110	efficient	SFR	3	2	0	423.66
8	2018	8/10/2018	29	3236	1,503	51	146	112	efficient	SFR	3	2	0	423.66
7	2018	7/12/2018	29	1733	1,363	47	141	107	efficient	SFR	3	2	0	423.66
6	2018	6/13/2018	7	370	370	52	146	111	efficient	SFR	3	2	0	423.66
6	2018	6/6/2018	26	121166	1,316	50	147	110	efficient	SFR	3	2	0	423.66
5	2018	5/11/2018	25	120990	2,094	83	146	113	efficient	SFR	3	2	0	423.66
4	2018	4/16/2018	35	120710	1,496	42	143	112	efficient	SFR	3	2	0	423.66
3	2018	3/12/2018	28		1,646	58	149	114	efficient	SFR	3	2	0	423.66

Compiled Water Data

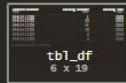
```
4 ---
5 This chunk reads in the data and pulls out day, month, year so that we can filter on those as necessary.
6 ```{r}
7 library(readxl)
8 compiled_water_Data <- read_excel("~/Capstone/data3/compiled water Data.xlsx")
9 compiled_water_Data
10
11 library(lubridate)
12 compiled_water_Data$day <- day(compiled_water_Data$'Reading Date')
13 compiled_water_Data$month <- month(compiled_water_Data$'Reading Date')
14 compiled_water_Data$year <- year(compiled_water_Data$'Reading Date')
15
16 head(compiled_water_Data)
17 ---
```



tbl_df
597 x 16



R Console



tbl_df
6 x 19

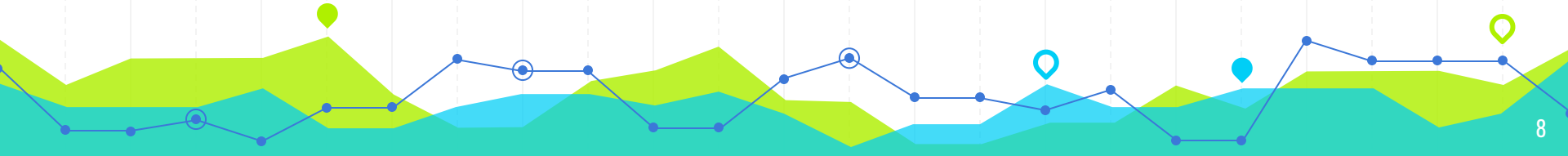
	AverageHouseholdsGPD <dbl>	Most Efficient GPD <dbl>	WaterScore <chr>	Meter Class <chr>	Occupants <dbl>	Toilet <dbl>
	142	107	efficient	SFR	3	
	142	109	efficient	SFR	3	
	143	111	efficient	SFR	3	
	144	110	efficient	SFR	3	
	147	112	efficient	SFR	3	
	147	114	efficient	SFR	3	

6 rows | 9-18 of 19 columns

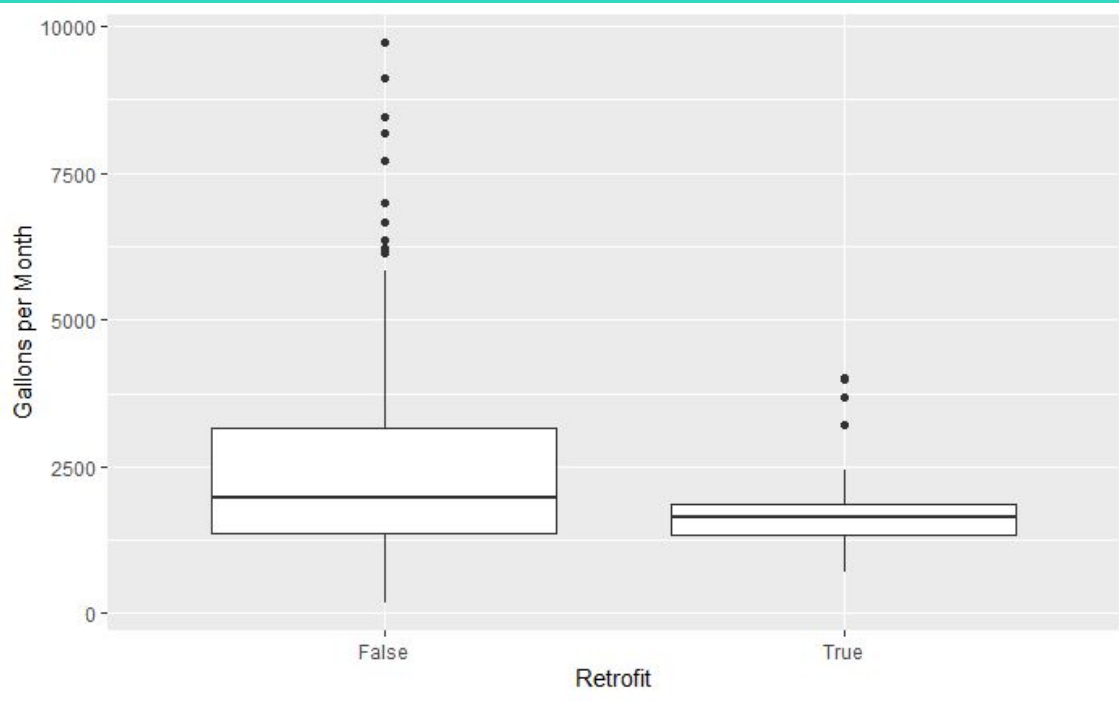
```
18 This chunk builds a difference of means test.
19 ```{r}
20 library(ggplot2)
21 library(dplyr)
22 cwd <- compiled_water_Data %>% filter(Retrofit == 0 | Retrofit == 1) %>% select(Retrofit, Gallons)
23 cwd$RetrofitDiscrete <- case_when(cwd$Retrofit == 0 ~ 'False', cwd$Retrofit == 1 ~ 'True')
24 cwd
25
26 summary(cwd %>% filter(Retrofit == 0) %>% .$Gallons)
27 summary(cwd %>% filter(Retrofit == 1) %>% .$Gallons)
28
29 ggplot(cwd, aes(RetrofitDiscrete, Gallons)) +
30   geom_boxplot() + xlab('Retrofit') + ylab('Gallons per Month')
31 ---
```

Consumer Savings

- Difference of Means Test
- Dollars Saved
- 4 Net Present Value Calculations



Difference of Means Test



There is an average savings of about 534 gallons per month or 6406 gallons per year in homes that have been retrofitted compared to water use prior to retrofit implementation.

Dollars Saved

- Annual Sewage Bill Savings - \$41.25
- Annual Water Bill Savings - \$36.58
- Total Annual Savings - \$77.83



What is Net Present Value (NPV)

NPV- a figure that represents the sum of the *discounted* values of future costs and savings minus the initial sunk cost in the present.

- Why? : Inconsistent Values of Money Over Time

$$\text{NPV} = \sum (\text{CF}_t / (1+r)^t) - \text{initial investment cost}$$

CF=cash flow, r= interest rate, t=year

NPV

Average Retrofit Cost with a 30 Year Lifespan (1.55% Municipal Bond Rate)

Year	0	1	2	3	4	5	6	7	8
Retrofit Cost	-285.74								
Annual Sewage Bill Savings		41.25	41.25	41.25	41.25	41.25	41.25	41.25	41.25
Annual Water Bill Savings		36.58	36.58	36.58	36.58	36.58	36.58	36.58	36.58
Total Annual Savings		77.83	77.83	77.83	77.83	77.83	77.83	77.83	77.83
NPV:	\$1,570.23								

Net Present Value
\$1,570.23

NPV

Average Retrofit Cost with a
10 Year Lifespan
(0.96% Municipal Bond Rate)

Year	0	1	2	3	4	5	6	7	8
Retrofit Cost	-285.74								
Annual Sewage Bill Savings		41.25	41.25	41.25	41.25	41.25	41.25	41.25	41.25
Annual Water Bill Savings		36.58	36.58	36.58	36.58	36.58	36.58	36.58	36.58
Total Annual Savings		77.83	77.83	77.83	77.83	77.83	77.83	77.83	77.83
NPV:	\$453.00								

Net Present Value
\$453.00

NPV

Highest Retrofit Cost with a 30 Year Lifespan (1.55% Municipal Bond Rate)

Year	0	1	2	3	4	5	6	7	8
Retrofit Cost	-532.12								
Annual Sewage bill savings		41.25	41.25	41.25	41.25	41.25	41.25	41.25	41.25
Annual Water Bill Savings		36.58	36.58	36.58	36.58	36.58	36.58	36.58	36.58
Total Annual Savings		77.83	77.83	77.83	77.83	77.83	77.83	77.83	77.83
NPV:	\$1,323.85								

Net Present Value
\$1,323.85

NPV

Highest Retrofit Cost with a
10 Year Lifespan
(0.96% Municipal Bond Rate)

Year	0	1	2	3	4	5	6	7	8
Retrofit Cost	-532.12								
Annual Sewage bill savings		41.25	41.25	41.25	41.25	41.25	41.25	41.25	41.25
Annual Water Bill Savings		36.58	36.58	36.58	36.58	36.58	36.58	36.58	36.58
Total Annual Savings		77.83	77.83	77.83	77.83	77.83	77.83	77.83	77.83
NPV:	\$206.62								

Net Present Value
\$206.62

County Savings

- Total Costs Include: Energy (water/waste) costs, Taxes, Supply/Generation charges, Delivery Cost, Distribution/Transmission components, Demand Charges, Combined Benefit Charges, etc.
- Energy Cost 10¢ per KwH



Treatment Plant and Reclamation Facility Savings

Total Gallons Per Year	Total Cost	Dollars/Gallon	Dollars Saved Per Year For One Retrofitted House
4682560000	2,162,331.17	0.000461783975	2.958033446

Beacham Water Treatment Plant Dollars Saved Given Average 6406 Gallons Reduced Per Year Per Household

Total Gallons Treated	Total Cost	Dollars Per Gallon	Dollars Saved Per Year for One Retrofitted House
4433370000	6302002.95	0.001421492668	9.105605832

Cedar Creek, Middle Oconee, North Oconee Reclamation Facilities Dollars Saved Given Average 6406 Gallons Reduced Per Year Per Household



Carbon Offset

- 1.01 lbs CO2 Emissions per KWH
- 0.002 KWH Consumed per Gallon (Treatment)
- 0.004 KWH consumed per Gallon (Reclamation)
- Average 6406 gallons of water saved per retrofit annually



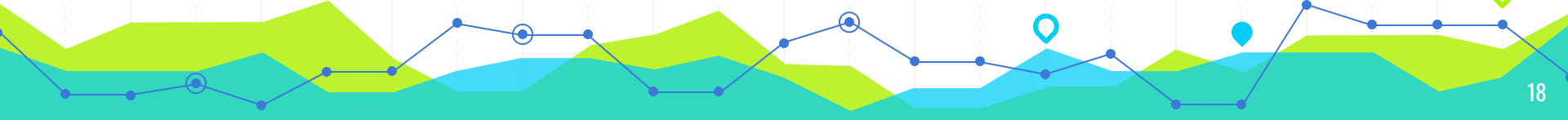
(One Tree Can Sequester 48 lbs of CO2 Per Year)

Total Gallons Per Year	Total KWH Per Year	lbs CO2 Averted Per Year
4682560000	10273840	14.19498844
Total Gallons Per Year	Total KWH Per Year	lbs CO2 Averted Per Year
4433370000	18,968,051	27.68052525

Treatment (Beacham)

Reclamation (Cedar Creek, Middle and North Oconee)

- Average 14.2 lbs CO2 emissions averted per retrofit annually (Water Treatment)
- Average 27.7 lbs CO2 emissions averted per retrofit annually (Reclamation)

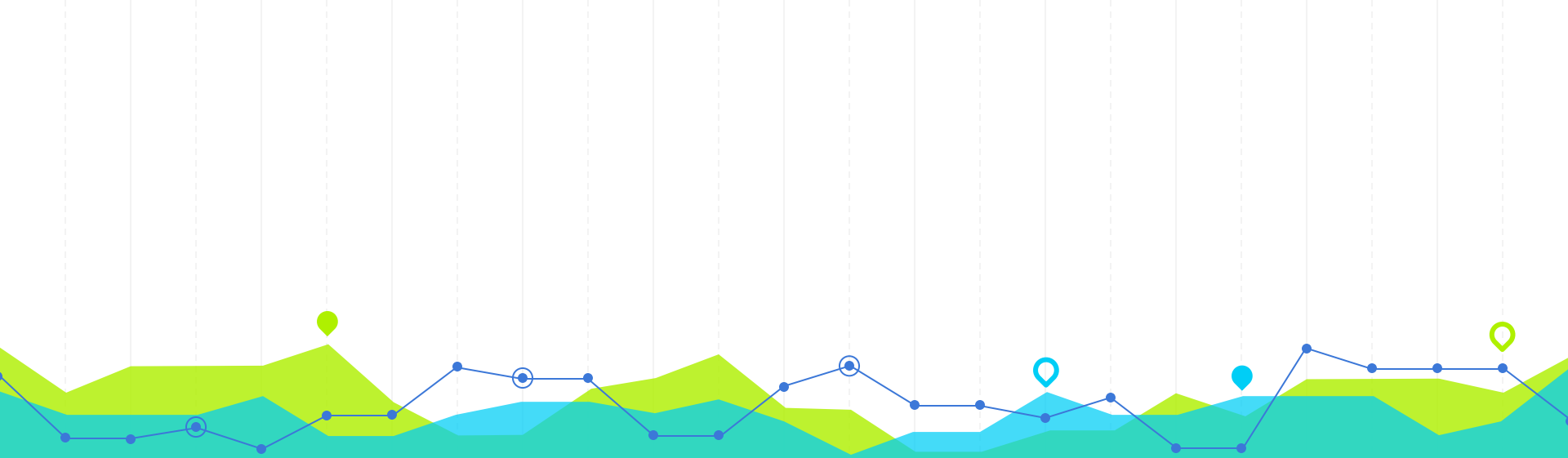


Challenges

- Data Acquisition
 - Confidential data must be gathered at Sustainability Office
 - Increased data variety needs to be acquired by stakeholders for more optimal modeling
- Unreliable/Unobservable variables (# of Occupants, # of Toilets)
- Programming troubleshooting (R, Excel)
- Inability to meet in person for the second half of semester

Recommendations

- “Pay As You Save” program in West Broad neighborhood
 - Homeowners can’t afford sunk cost immediately
 - Could pay off retrofit cost to county over time
- Measurement of “number of occupants”
 - Would allow estimates for gallons saved per retrofit to vary by household



Questions?