

# Elasticity of Demand for Water Supply

Status Update to the Executive  
Water Finance Board

State of Utah | Governor's Office of Management and Budget



# Project Objective

- An investigation into Utah residents' price and income elasticity of water demand
  - with particular emphasis on Washington and Kane counties.

# Summary of Scope

- Three components:
  1. Literature review, focusing on peer-reviewed studies in the arid West
  2. Estimate the impact of changes in water demand if water rates were consistent with water rates elsewhere
  3. Changes in the rate of residential and commercial development from different levels of impact fee increases

# Part 1: Literature Review

<i>Study Parameter</i>	<b>Long Term</b>	<b>Household</b>	<b>Increasing Block Rate</b>	<b>Residential Only</b>
Number of Studies	11	15	18	12

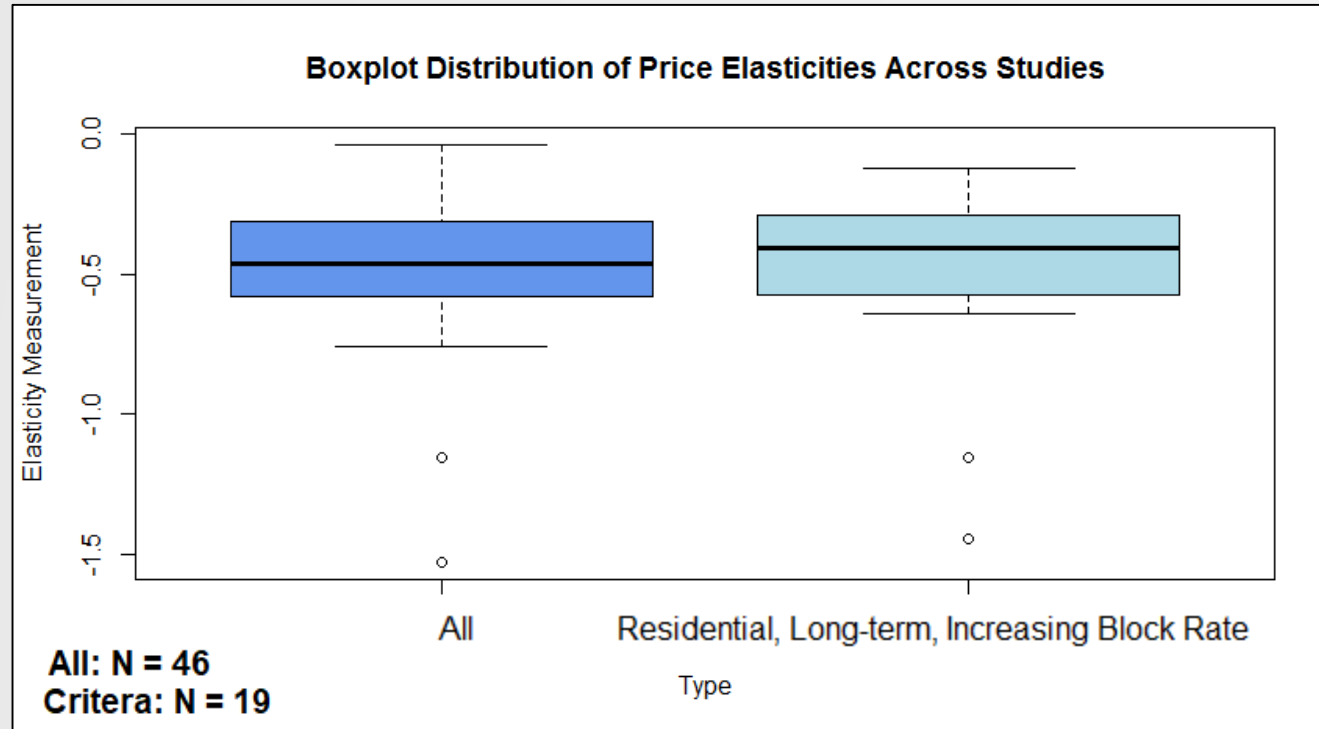
## Key Findings:

- 1) ***Long-term versus Short term Estimates*** – Literature suggests long-term price elasticities tend to be larger than short-run elasticities.
- 2) ***Household versus Aggregate Data*** – Household level data is preferred for residential water demand studies and offer insight into the micro-setting involved with consumer preference.
- 3) ***Water Pricing Rate Structure*** - Models with increasing block rates tend to be significantly more elastic than other structures.
- 4) ***Water Use Types*** – Research notes a significant difference in elasticity estimates between classes of end use (residential, commercial and agriculture).

# Conclusions from the Studies Reviewed

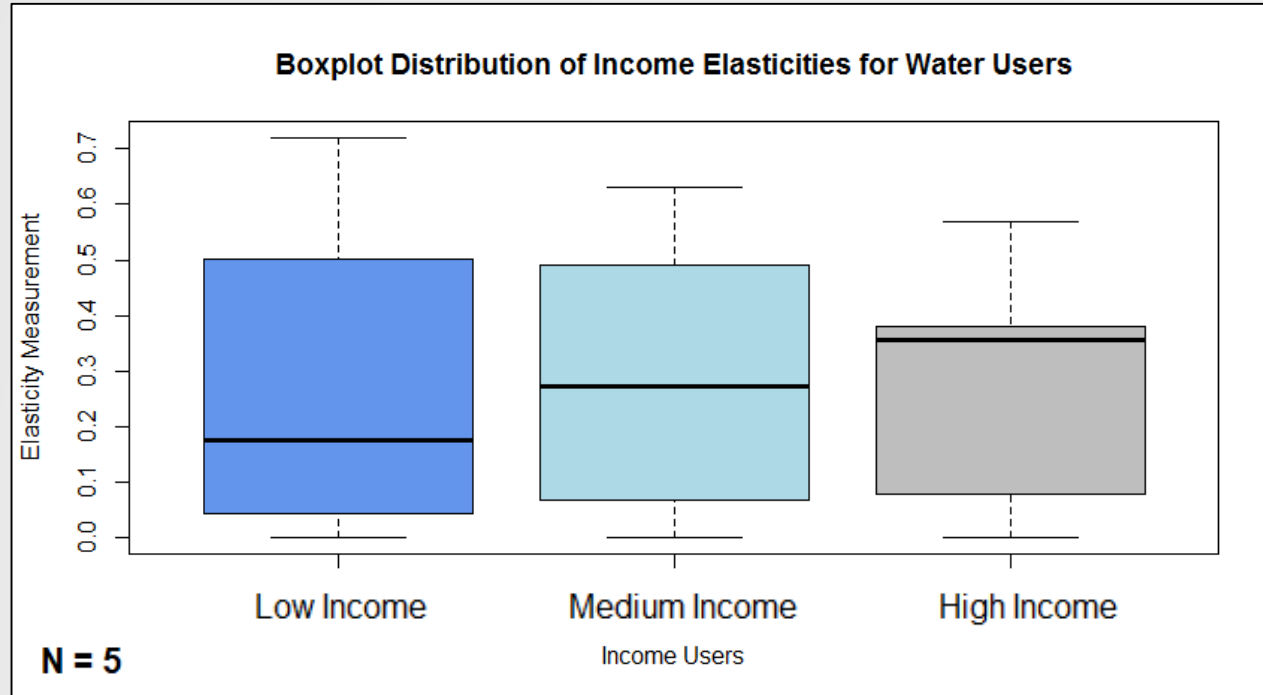
- Price elasticity estimates for residential water demand average around -0.50, but range to as much as -1.16.
- Recent studies of areas similar to Washington and Kane Counties in both demographics and income reflected greater elasticity, at -0.76.

# Price Elasticity Estimates



Values ranged from -1.53 to -0.04 for all data points, and from -1.45 to -0.12 for those that focused on residential, long-term, increasing block rate structure datasets

# Income Elasticity Estimates



Median elasticity measurements across the three groups are 0.17, 0.27, and 0.36, respectively

# Part 2:

## Estimate price and income elasticity

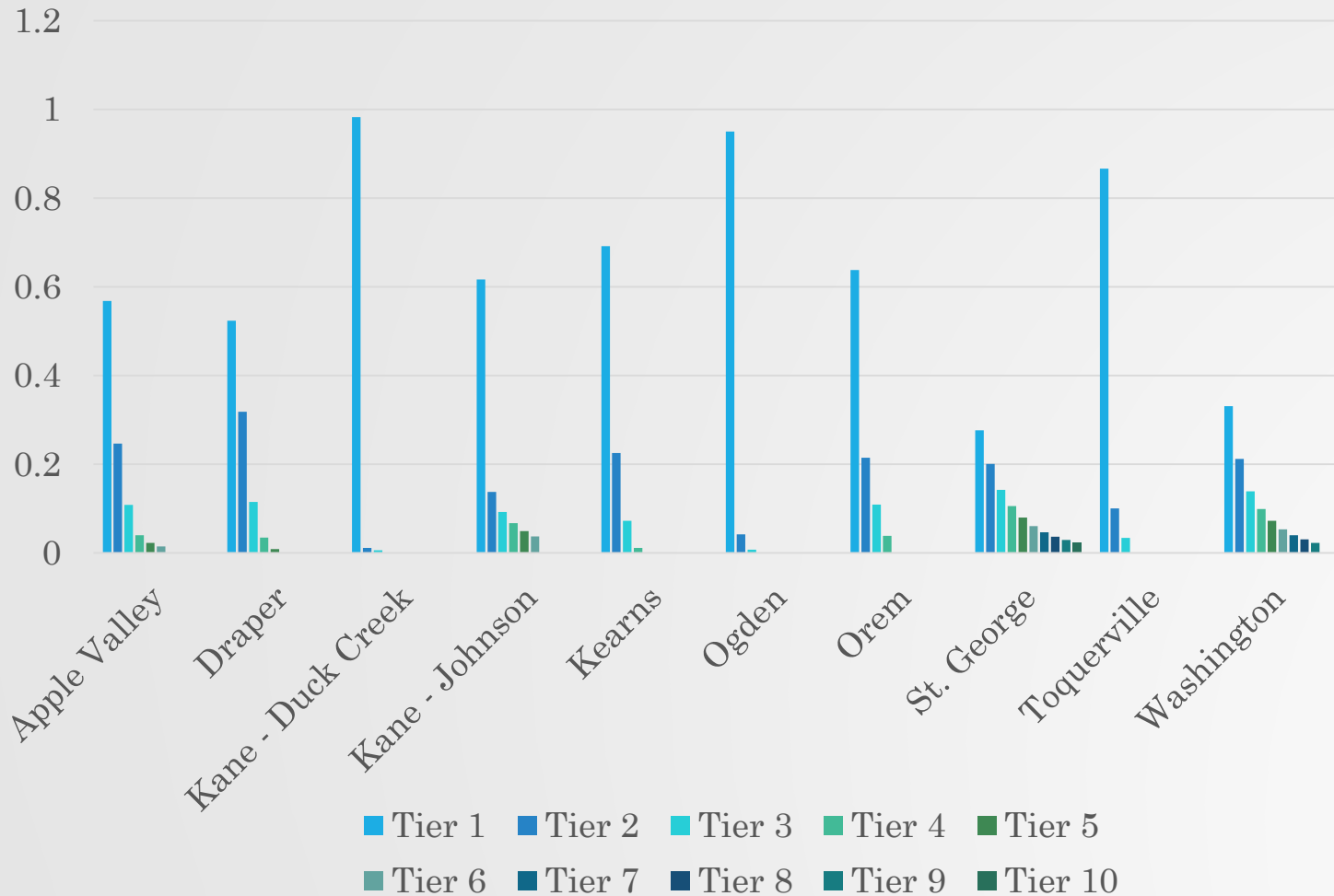
- Multiple steps for this task:
  1. Data collection from utilities across Utah
    - Requested water usage data from 24 utilities
    - Received data from 12 utilities; 10 are usable
  2. Run descriptive statistics to validate data
  3. Test models from literature
  4. Interpret inferences and prepare report



# Data Status

- 1) 10 datasets totaling over 92,000 households have been validated** - Provides household level data, which is preferred for modeling residential water demand studies. Totals about 3 million records (36 months for each)
- 2) Water Pricing Rate Structure** – All datasets include increasing block rates, however some are structured with little difference between tiers (may reflect insignificant differences in consumption behavior).
- 3) Water Use Types** – Datasets include different classes of end use (residential, commercial and industrial) but are predominantly single family residential.

# Analysis: Distribution of Consumption



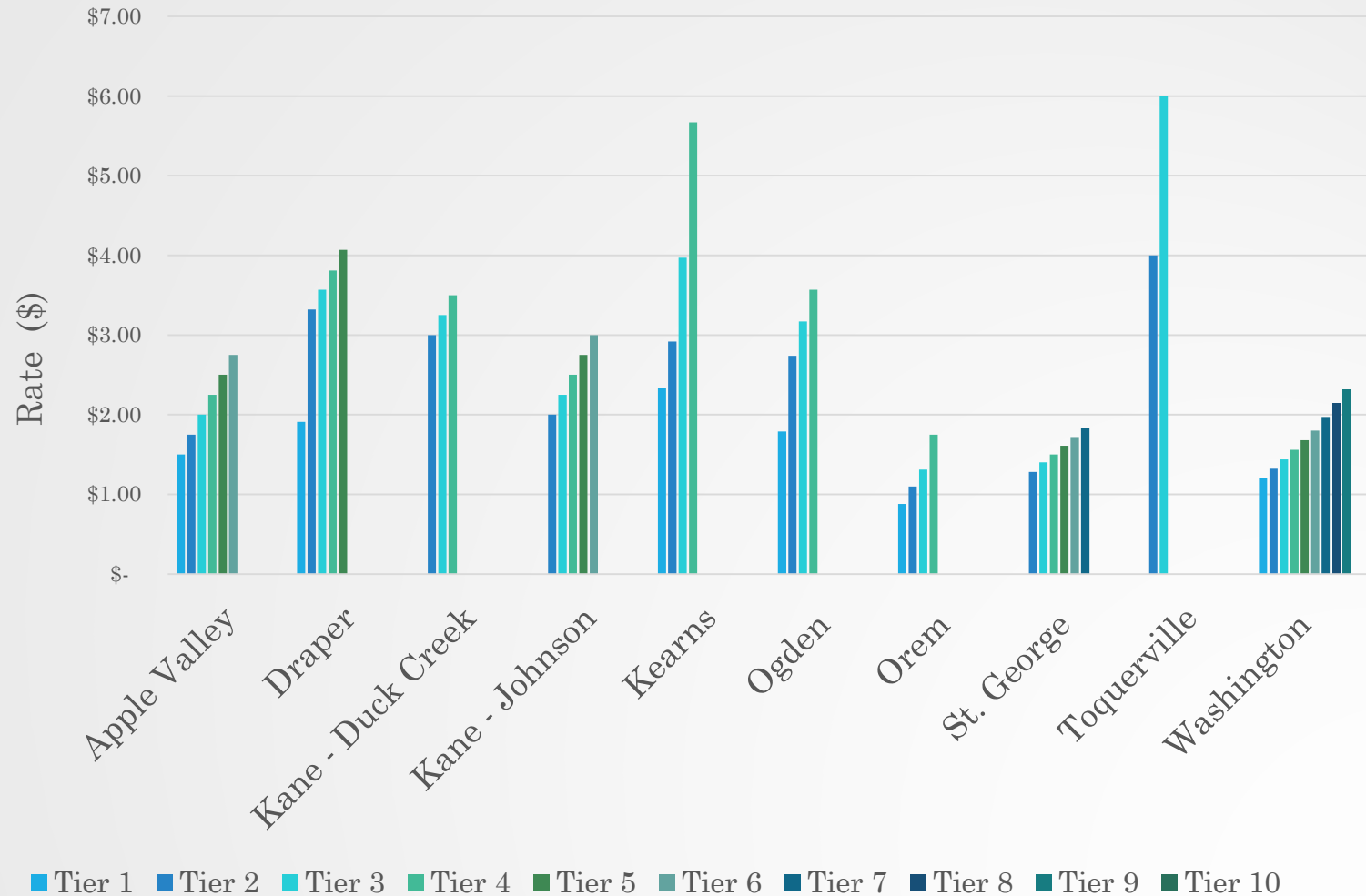
- The number of tiers varies throughout the selected Utah Areas and ranges from 3 to 10.
- As block rate increases, consumption decreases
- Three communities, St. George, Toquerville, and Ogden employ summer rate structures. While St. George's rate changes per tier for the summer months, Ogden and Toquerville's gallon limit changes during that time



Distribution Of Consumption Across Different Tiers In The Selected Utah Locations

# Analysis: Rate Tiers

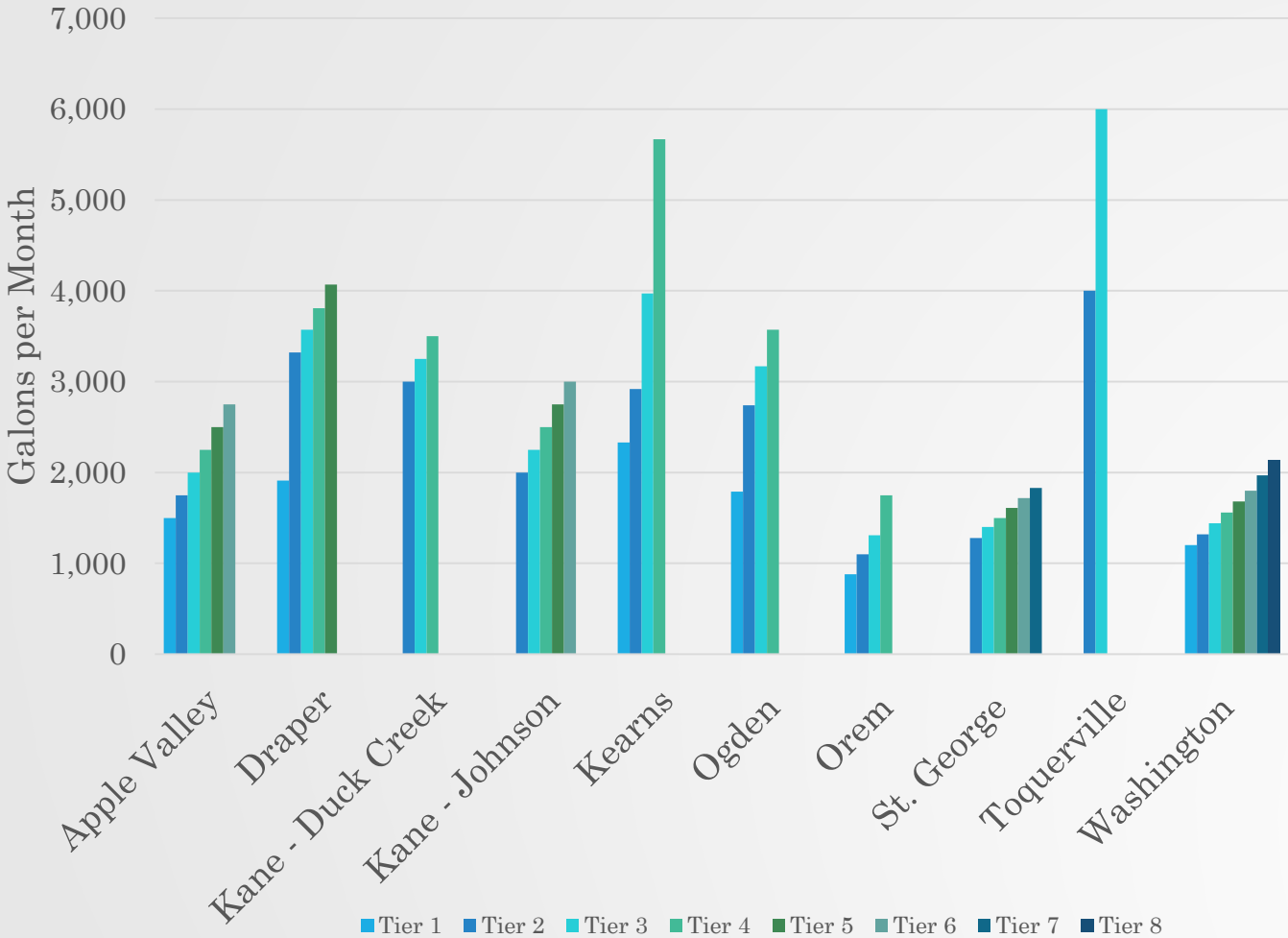
- Toquerville, Johnson Canyon, and St. George areas use base rate as their “tier 1”, where consumers can use up to a specific amount of gallons prior to being charged per kgal
- Some selected areas employ a consistently valued IBR, while others utilize a higher threshold between the lowest and higher tiers



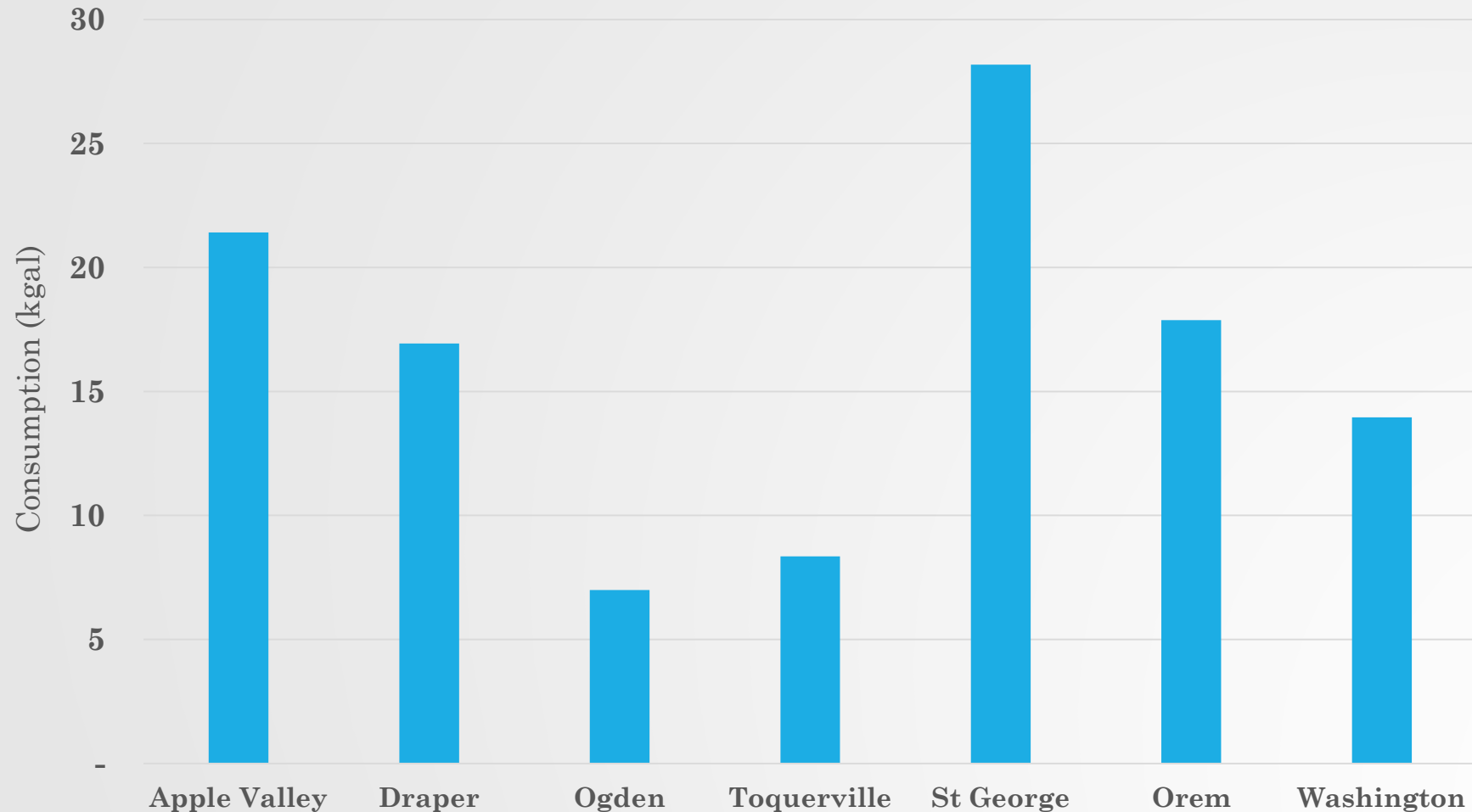
Rate Tiers Across Communities

# Analysis: Rate Tiers

Consumption Tiers Across Communities

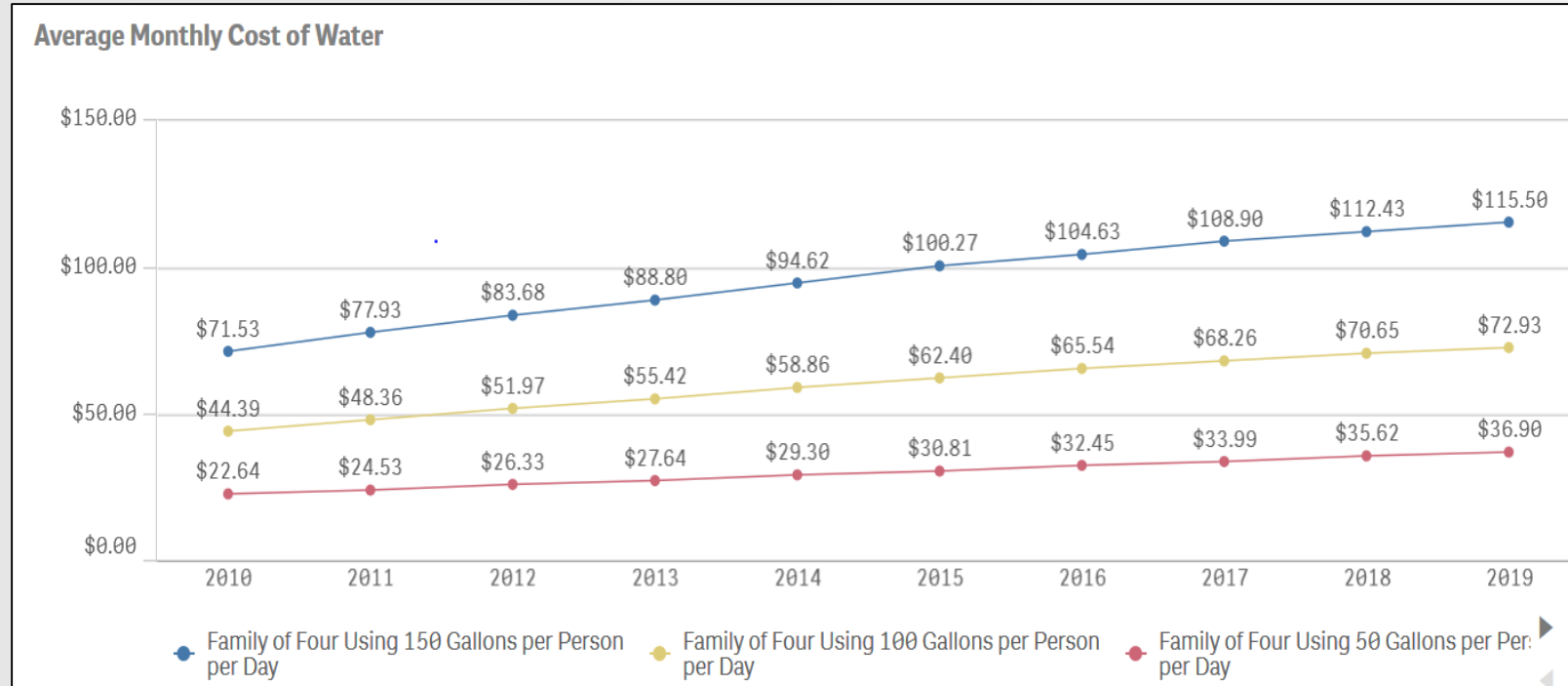


# Analysis: Residential Consumption



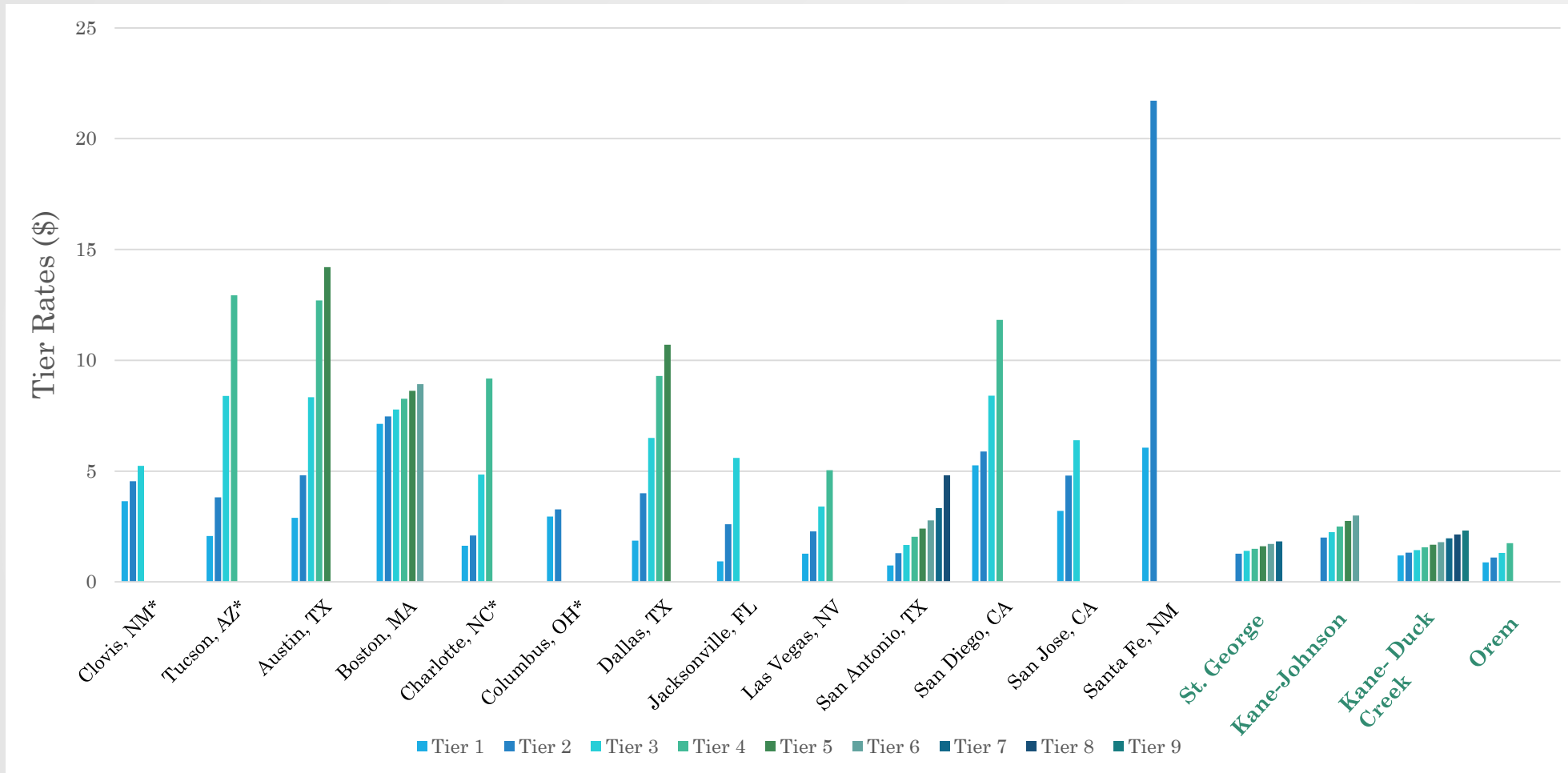
Average residential consumption across the study areas identified;  
average bill about \$40.

# Findings: National Average Cost of Water



Average Monthly Cost Of Water, 2019, Across 30 U.S. Metro Areas  
 Average Utah consumption would drive >\$100 bill at average U.S. rates  
 Currently, average across utilities in study - \$40

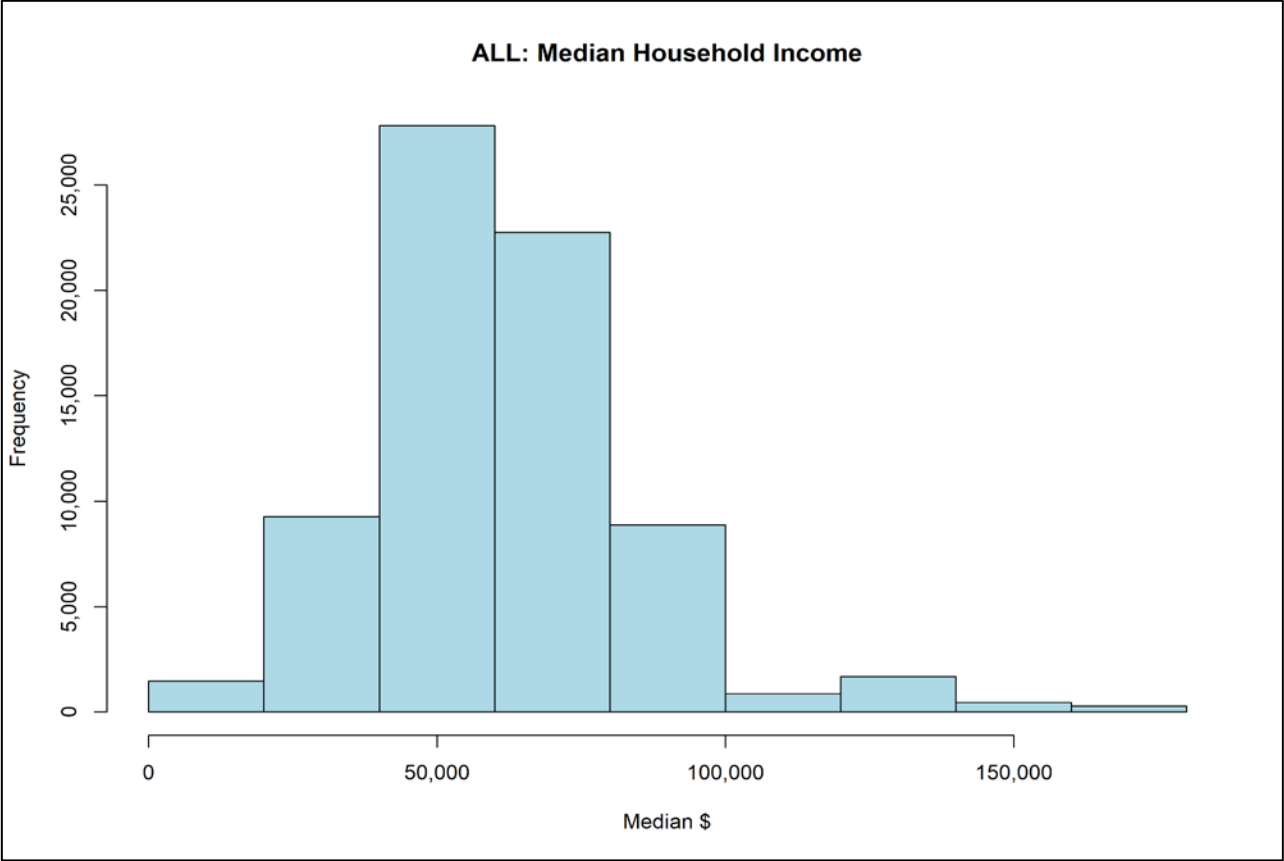
# Findings: National Tier Rates



Comparison of Tier Rates Across U.S. Cities

# Demographic Data: Median Household Income

- Histogram Of Median Household Income For Overall Dataset

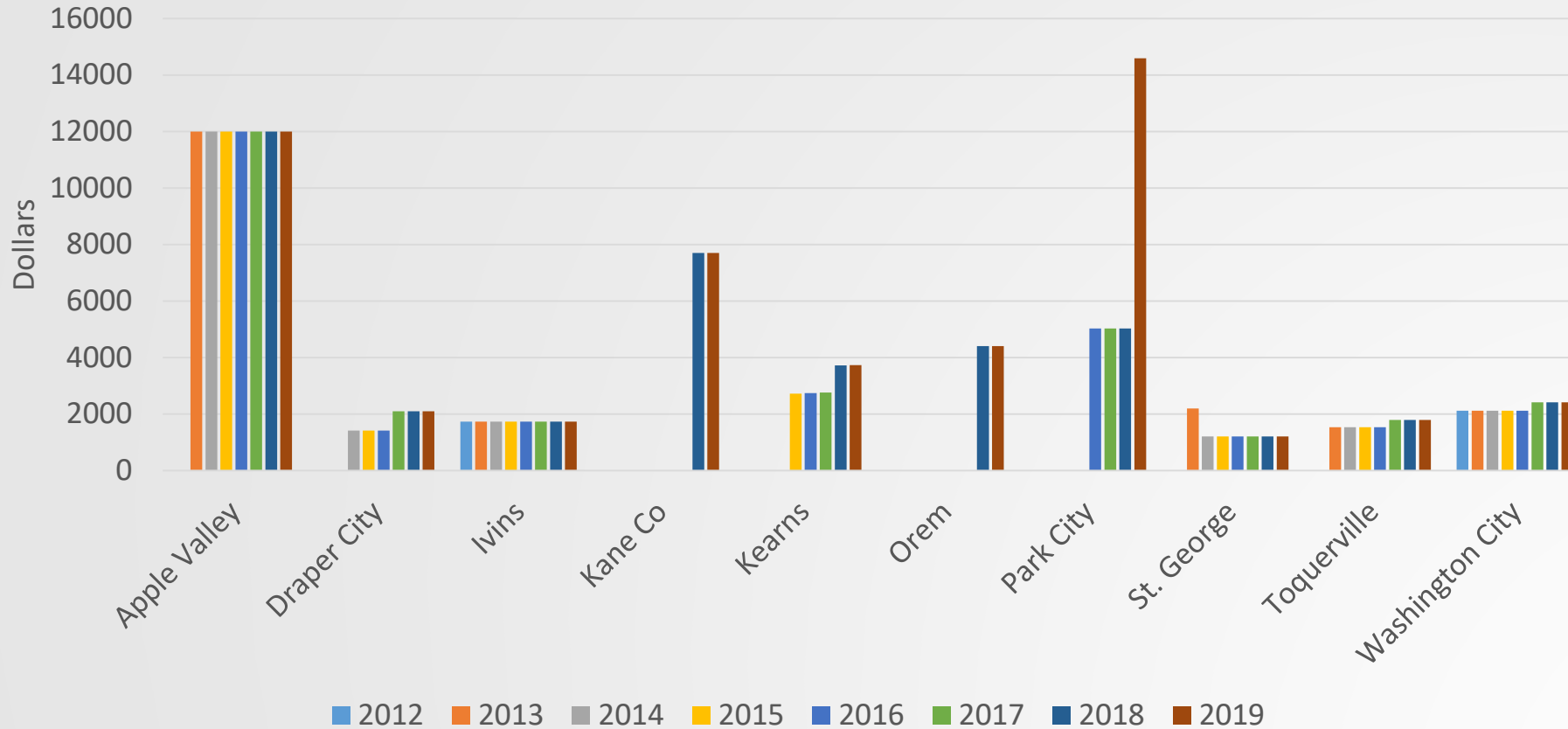




# Part 2: Impact Fee Data Analysis

- Data requested from 24 utilities; received from 11
- Key Points:
  - 1) Rates** – Impact Fee Schedules have changed increased only slightly, if at all, in the last 6-7 years at the utility level(St. George reduced its rates in 2012)
  - 2) Counts** – Community impact fee receipts are driven by existing population (and intrinsic rates of growth). St. George exhibited the greatest fees collections by count.
  - 3) Receipts** – Because of higher fee schedules, Park City and Orem compete with St. George in terms of total impact fee receipts

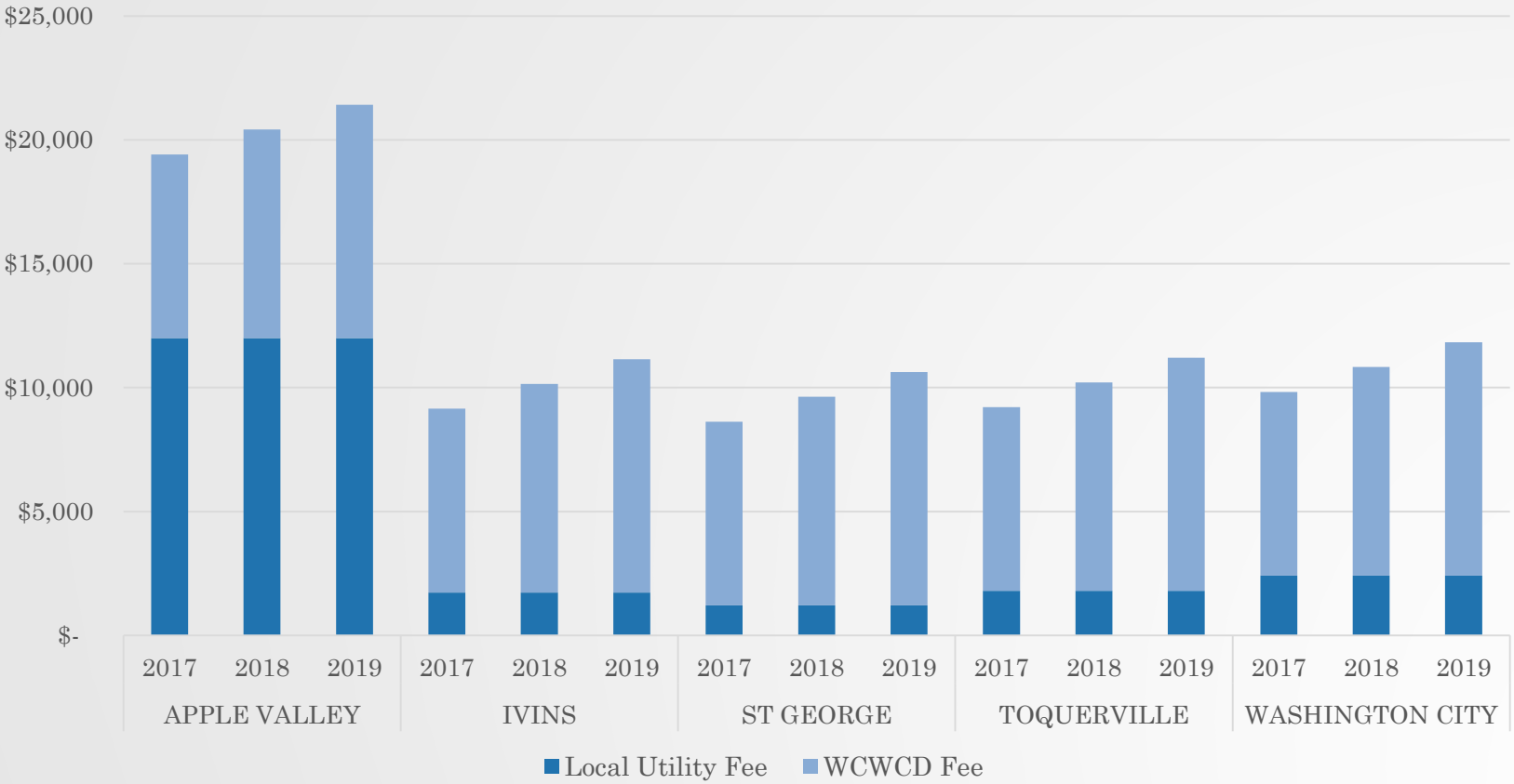
# Impact Fee Data -- Rates



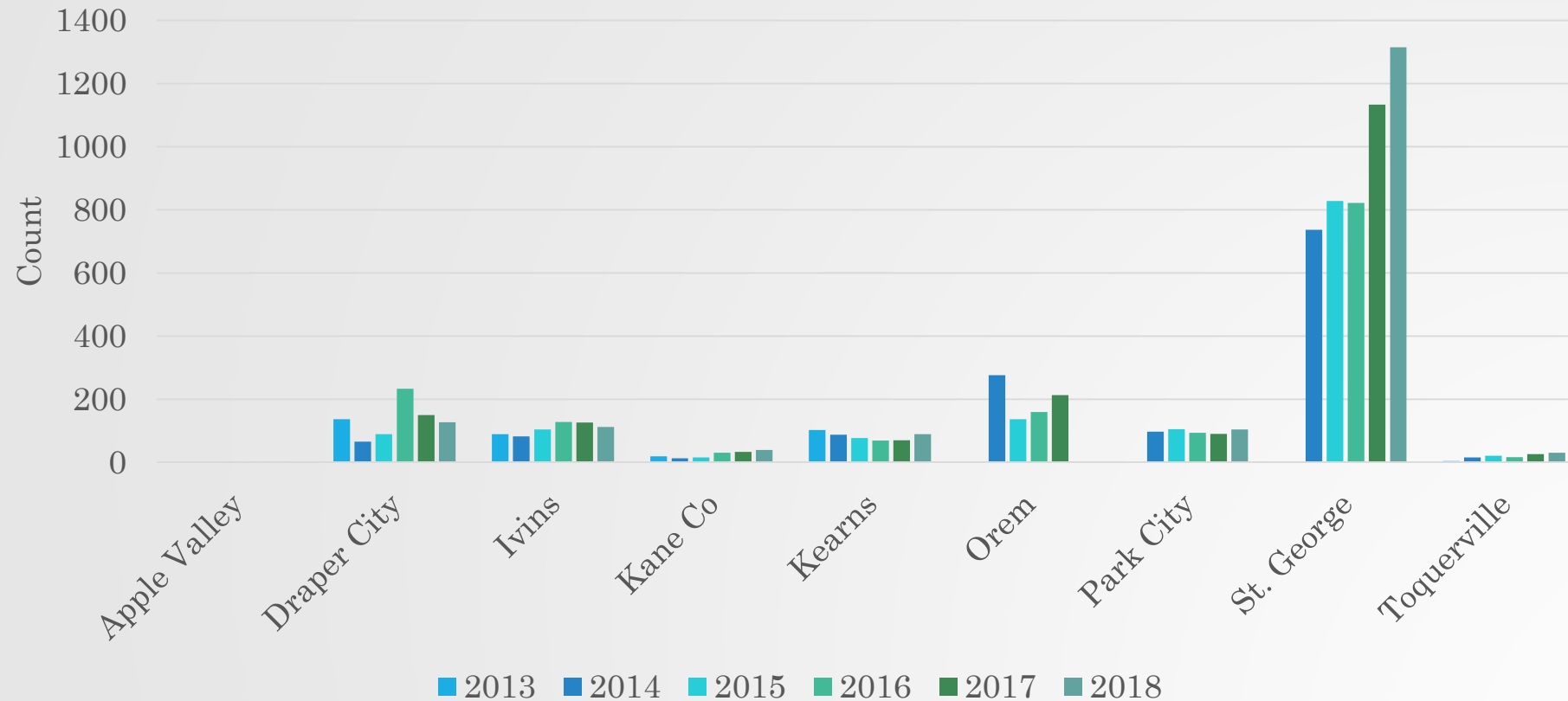
## Rate By Year Across Community.

- While some communities have undertaken gradual increases, others have taken a different approach.

# Impact Fees – Local Utility and WCWCD



# Impact Fees – Numbers of Receipts

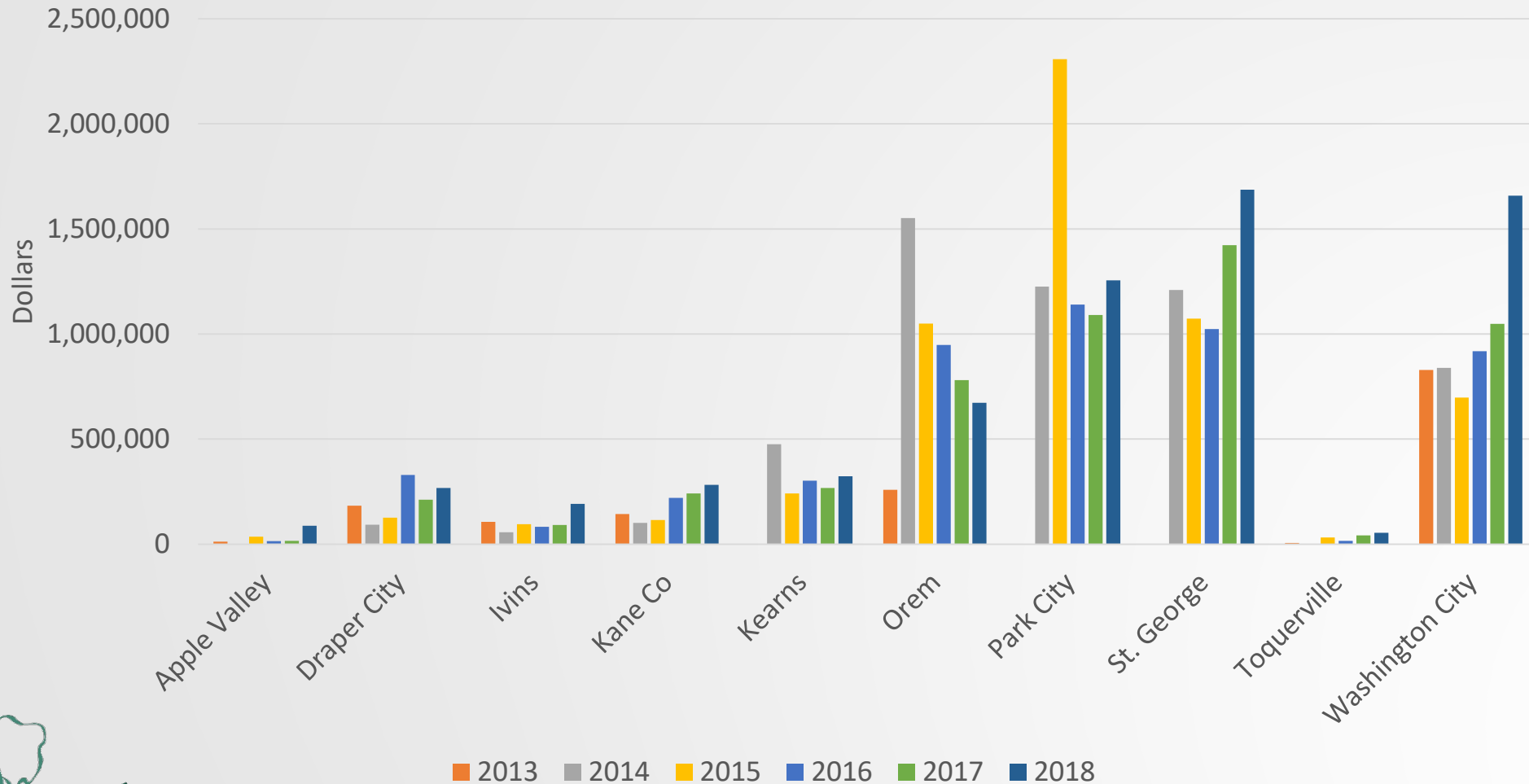


## Annual Count Of Impact Fees Assessed By Community

- For the majority of communities, new development contributing fees has been stable

# Impact Fees

## Impact Fee Collections by Year across Communities



# Part 3: Preliminary Model and Results

- **Price & Income Elasticity**
- Early model runs appear to support regression modeling at household level with existing data
  - Ordinary Least Squares (OLS) model appears feasible as starting point to estimate price and income elasticity<sup>1</sup>
  - More sophisticated models also being tested to isolate effects of pricing tiers
    - Instrumental Variables (IV) Model to address endogeneity of price under block rate structure

1 Chang et al., 2017; Rothfeder, 2014; Yoo et al., 2014; Hansen & Narayanan, 1981; Central Utah Water Conservancy District, 1995; Dalhuisen et al., 2003

# Early Results: Elasticity of Water Demand

- Early overall results indicate that, on average, the average rate of the tiers observed by household per month appears to have a significant, negative relationship with consumption
  - As rates increases, consumption decreases, consistent with literature
- Early regression results show that, as median household income increases, consumption decreases at a decreasing rate.
  - This finding is generally accepted due to a higher level of income being associated with higher living standards, and therefore, higher water demand
- Overall results show inverse relationship between education and consumption, but results across utilities show differences in this effect.
  - Mixed results, also consistent with literature

# Early Results: Effects of Impact fees on rate of development

- Preliminary model (OLS) results suggest a statistically significant and negative relationship between the Percent change in impact fees and the number of collections (i.e. newly approved development) the following year.
  - Somewhat counter to expectations, but early results
- Additional testing is underway to assess whether there are significant differences among the 11 communities with respect to the numbers of impact fees collected and the rates themselves.



# Next Steps

- Price & Income Elasticity of Water Demand
  - Finalize model selection and analysis
  - Milestone date: September 20 for draft results
- Effect of Impact Fees on Rates of Development
  - Finalize model, analysis and inference
  - Milestone date: September 20



Questions...

Thank you!

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