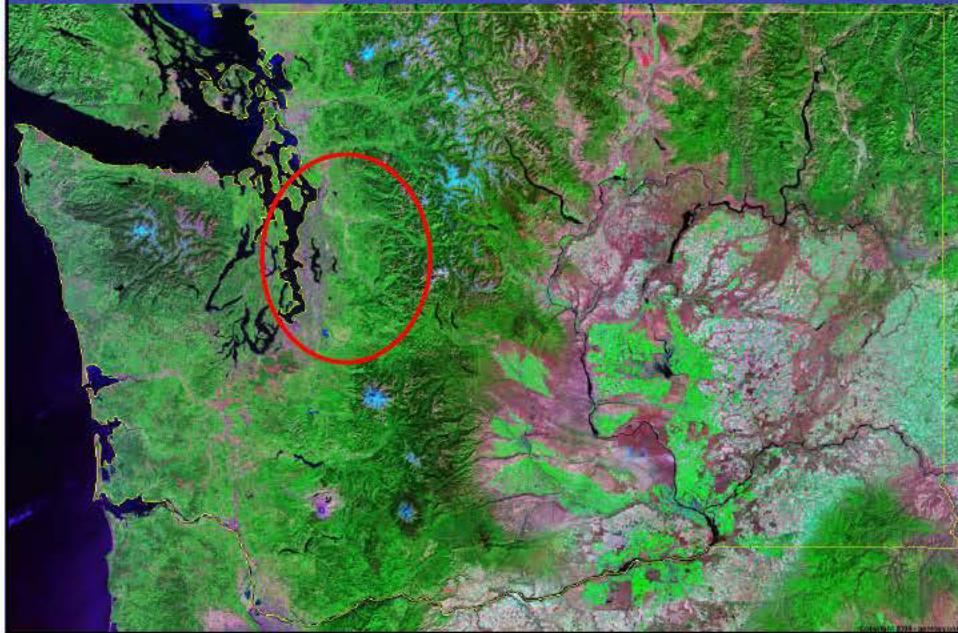


Forecasting Water Demand in Seattle

Presented to the
DCDC and the ASUCEESP
Tempe, Arizona
May 11, 2012
by
Bruce Flory, Principal Economist
Seattle Public Utilities



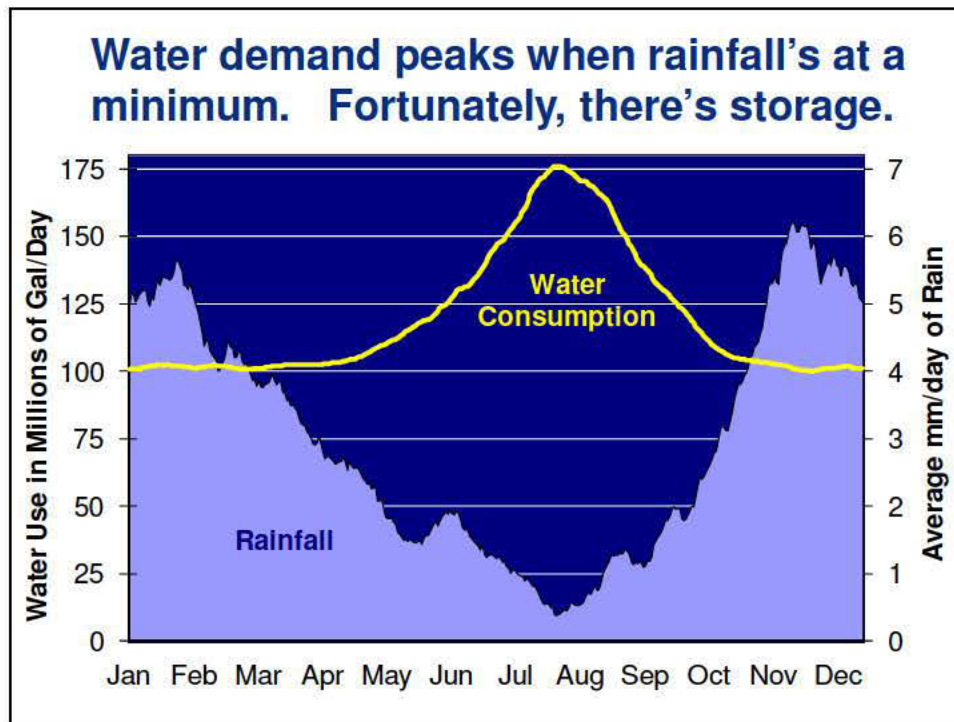
Seattle and the Cascade Mountains



Seattle Regional Water System

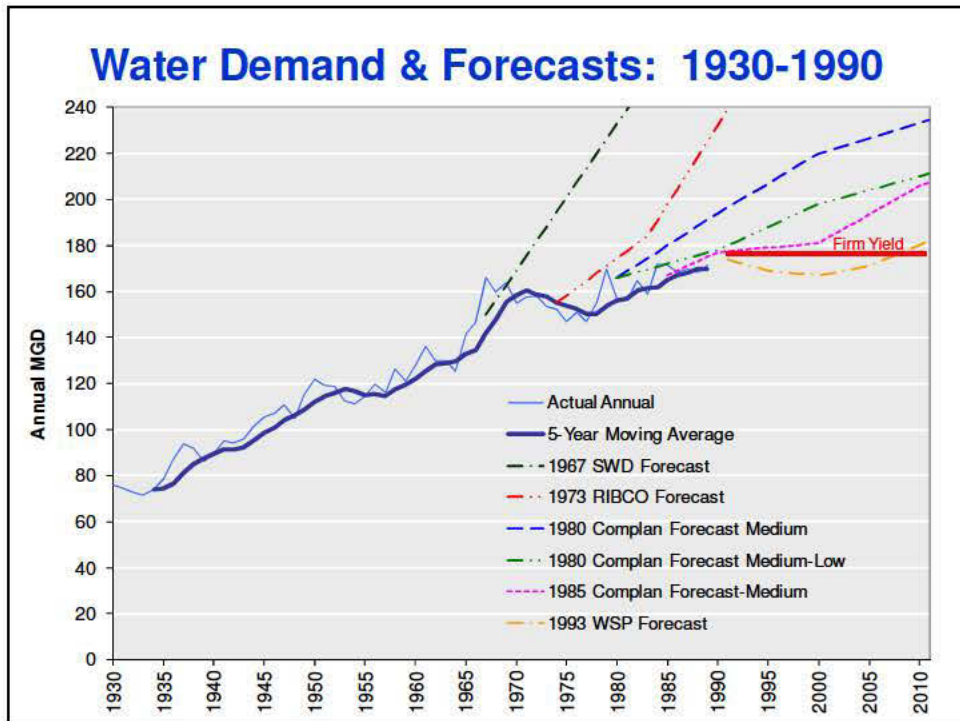
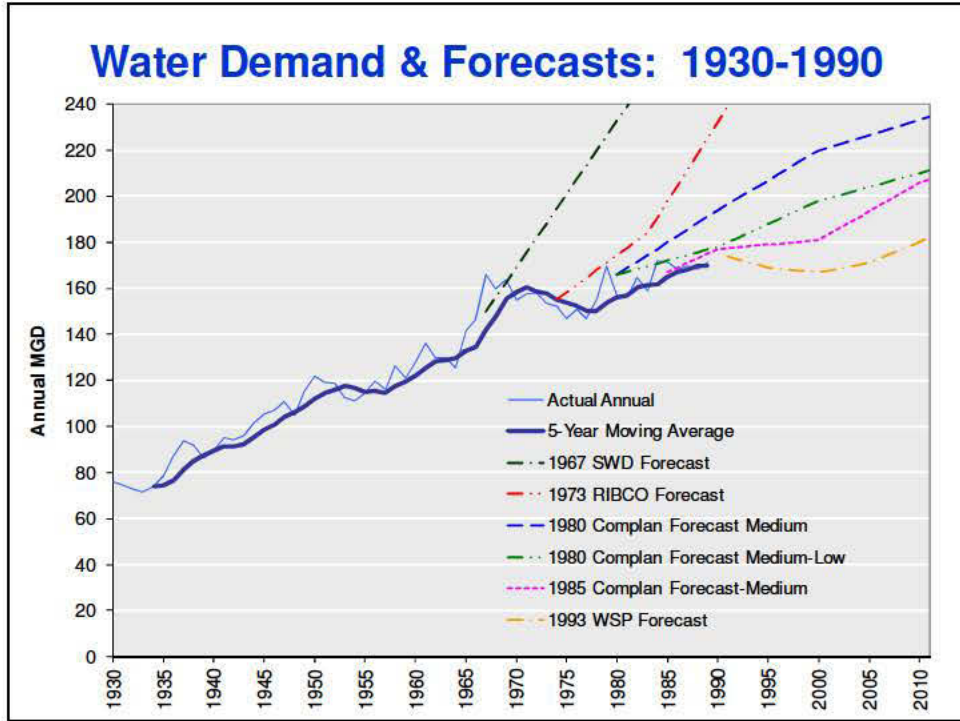


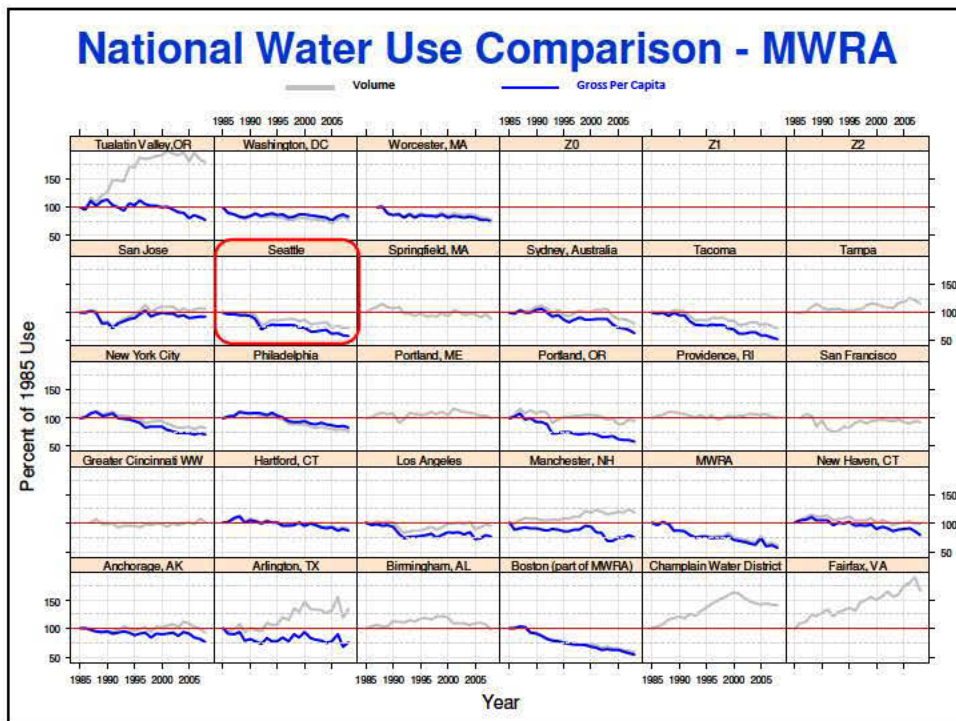
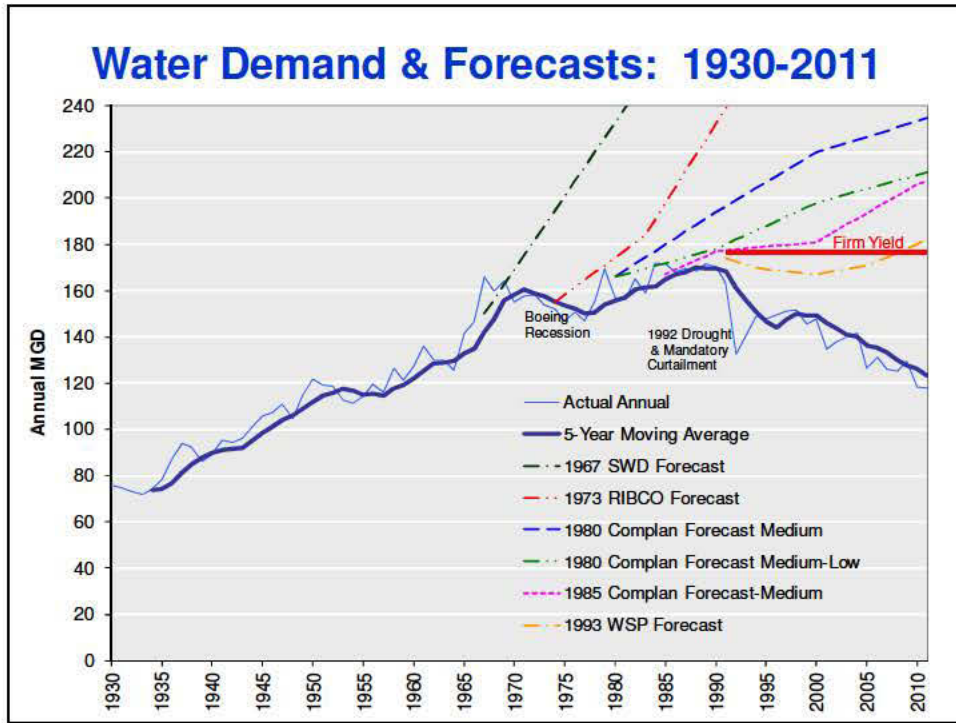
- Serves 1.3 million people
- Retail and wholesale
- 2 main sources:
 - S. Fork Tolt River
 - Cedar River

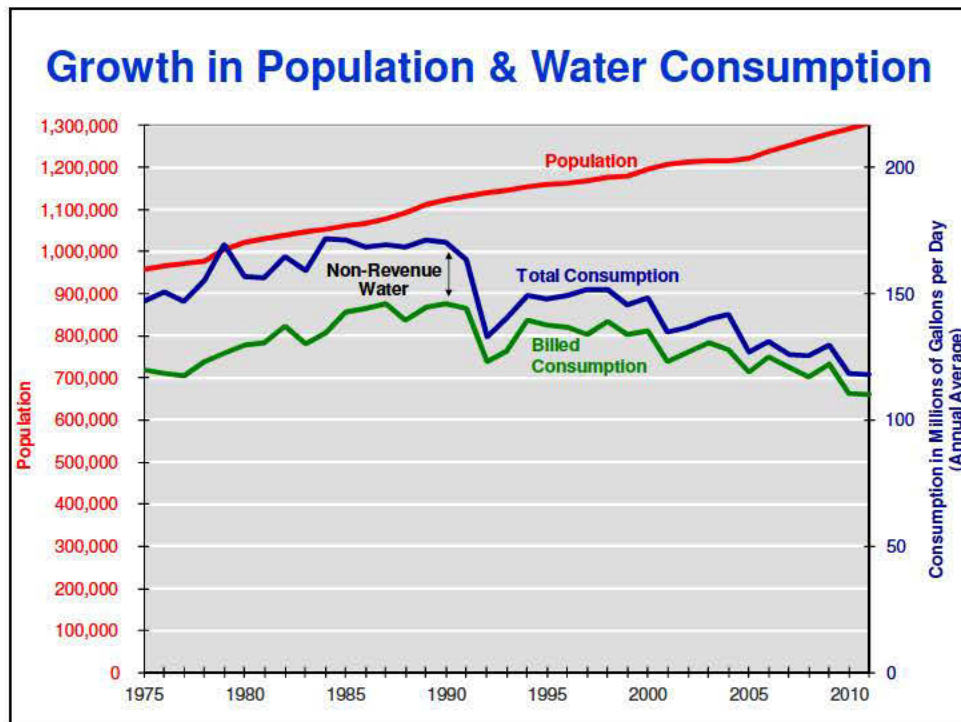


Water Use – Past & Future

- **Past trends: What happened?**
- **What caused it?**
- **What's going to happen?**
- **How do we model it?**
- **Research needs – what are we missing?**



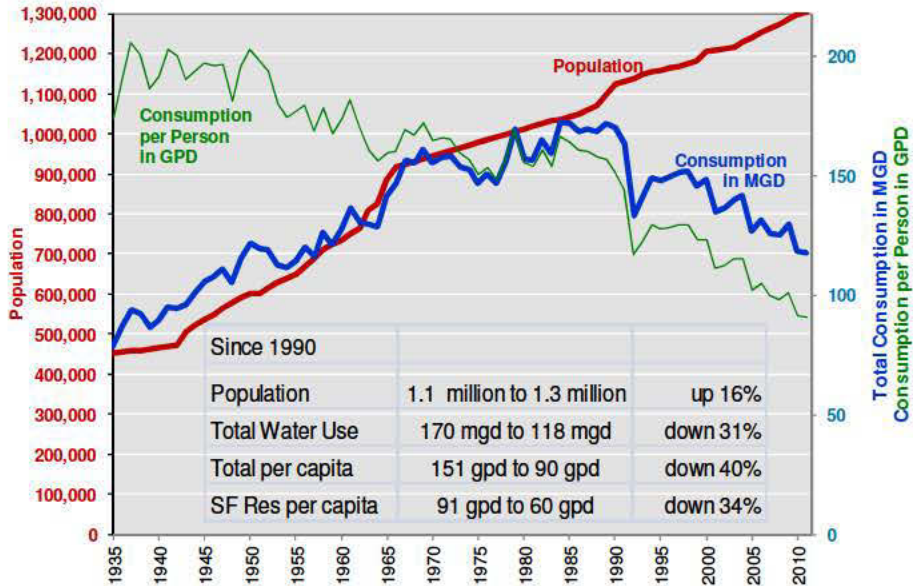




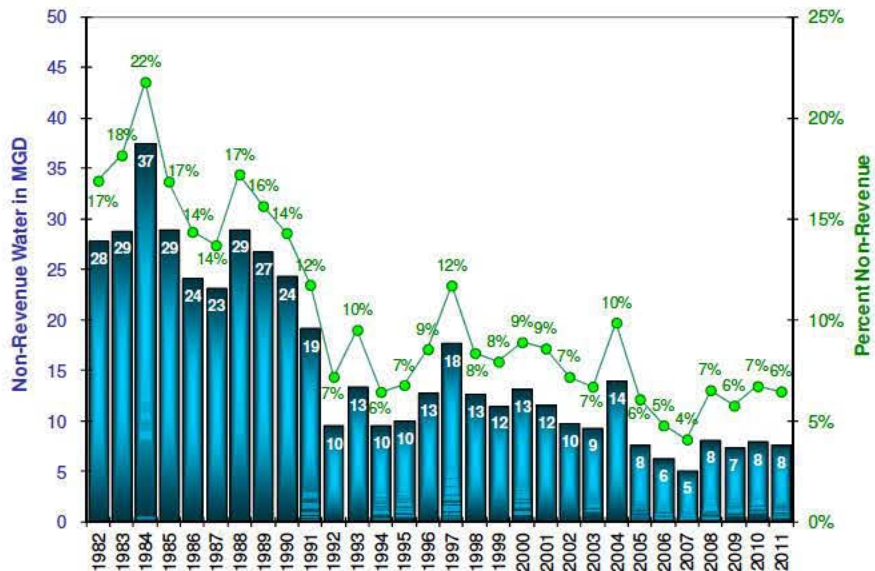
The Great Decoupling

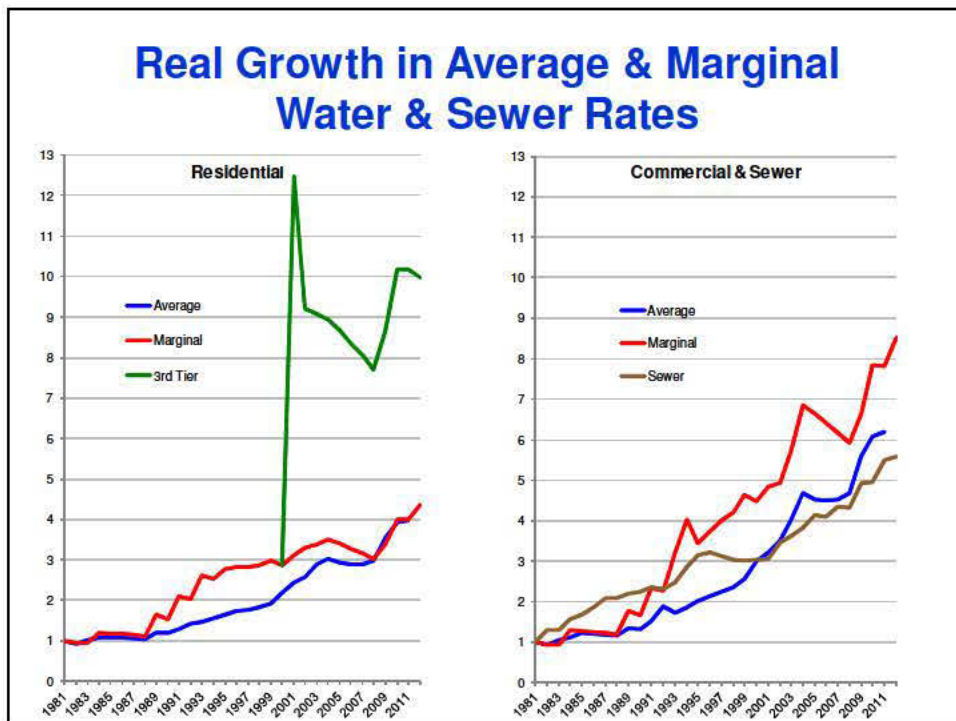
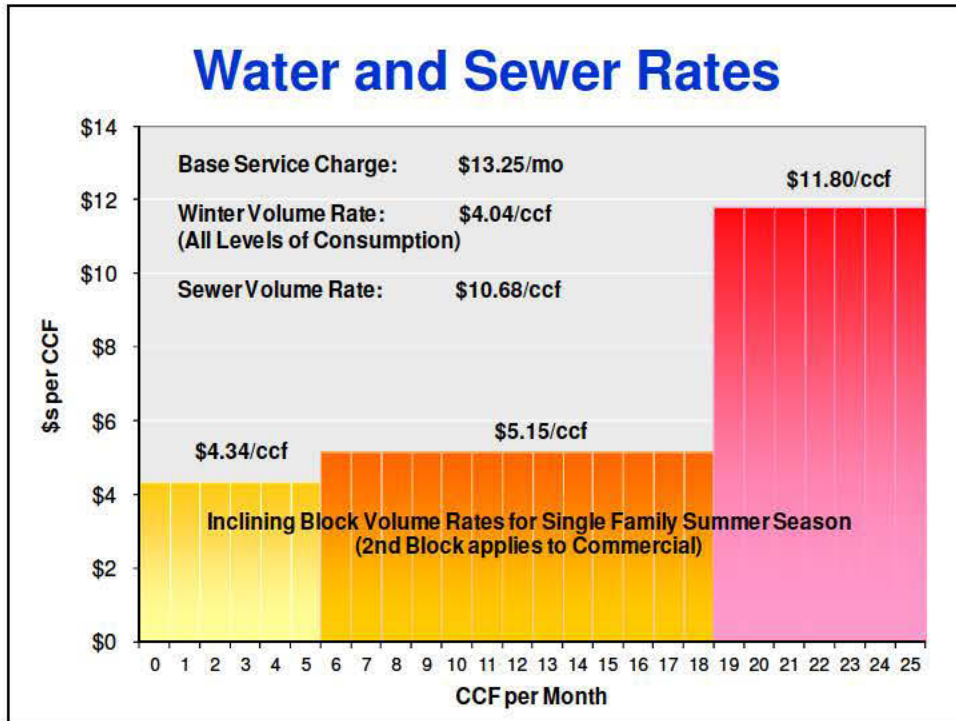
- 1992 Drought and Curtailment
- Non-Revenue Water
- Pricing – Water and Sewer Rates
- Conservation Programs
- Plumbing Fixture Codes

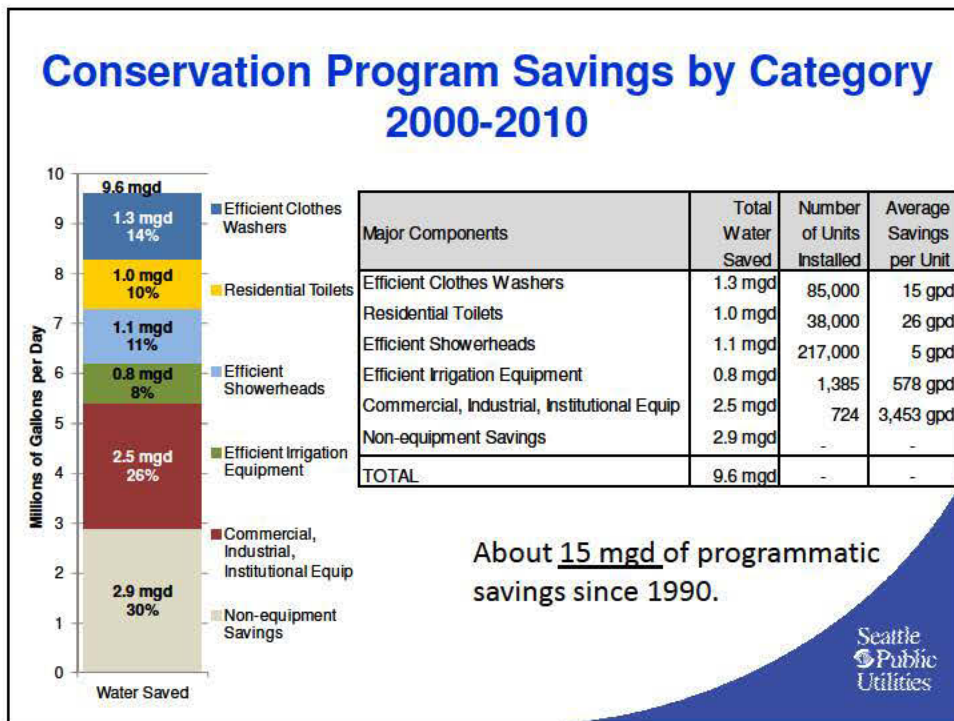
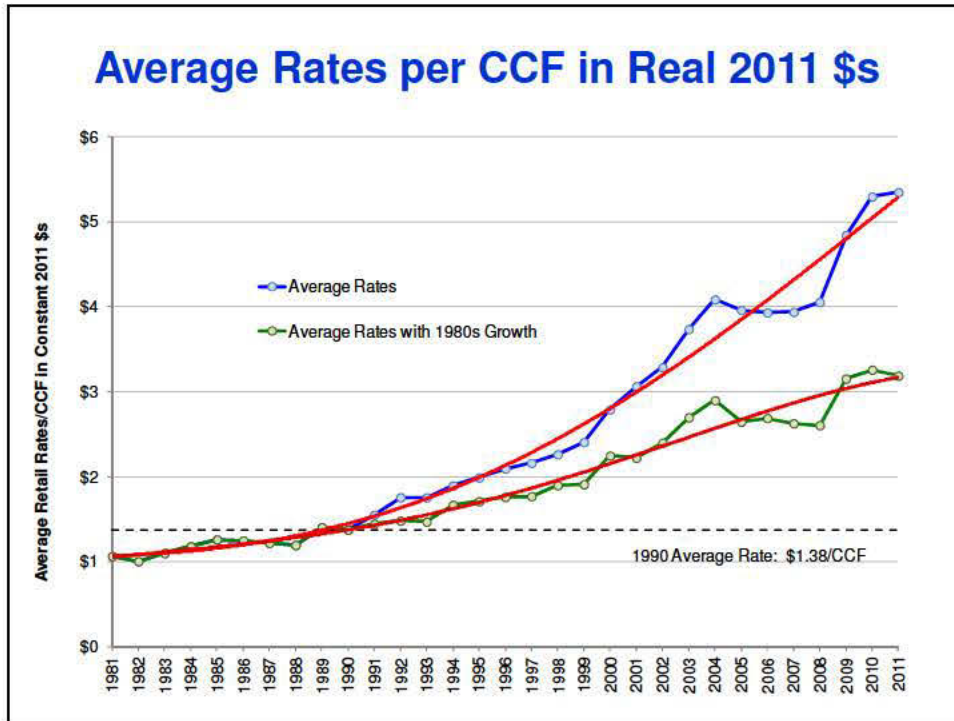
Population & Water Consumption: 1935-2011



Total System Non-Revenue Water: 1982-2011 (in MGD and as a Percent of Total System Water Use)





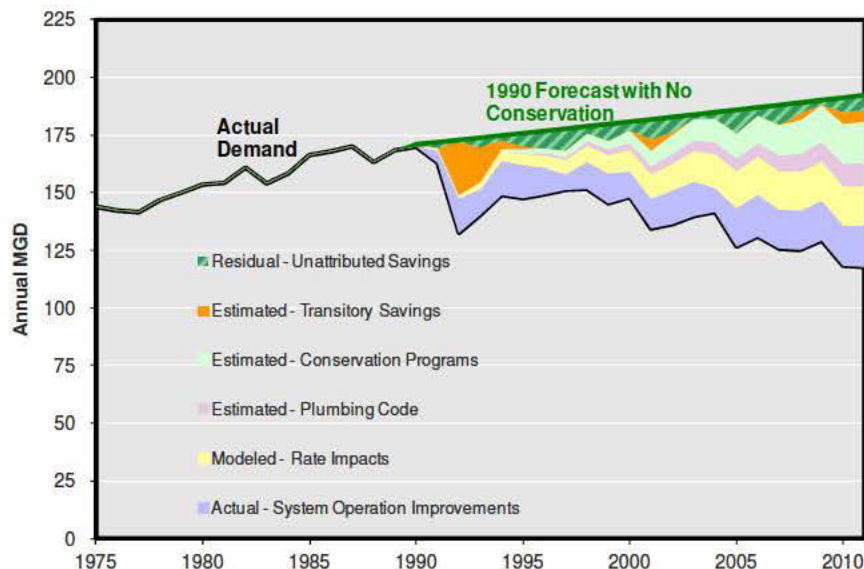


Code Savings

- 1992 Federal Energy & Policy Act
 - ✓ Toilets: 3.5 to 5 gpf \Rightarrow 1.6 gpf
 - ✓ Showerheads: 3 to 5 gpm \Rightarrow 2.5 gpm
 - ✓ Faucet aerators: 3 to 5 gpm \Rightarrow 2.5 gpm
- Savings estimates based on replacement rates + new construction
 - ✓ Fixture lives of 30, 10 and 5 years assumed for toilets, showerheads, and aerators, respectively
- Estimated 20 year savings: 9 mgd

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Impact of Conservation on Historical Water Demand

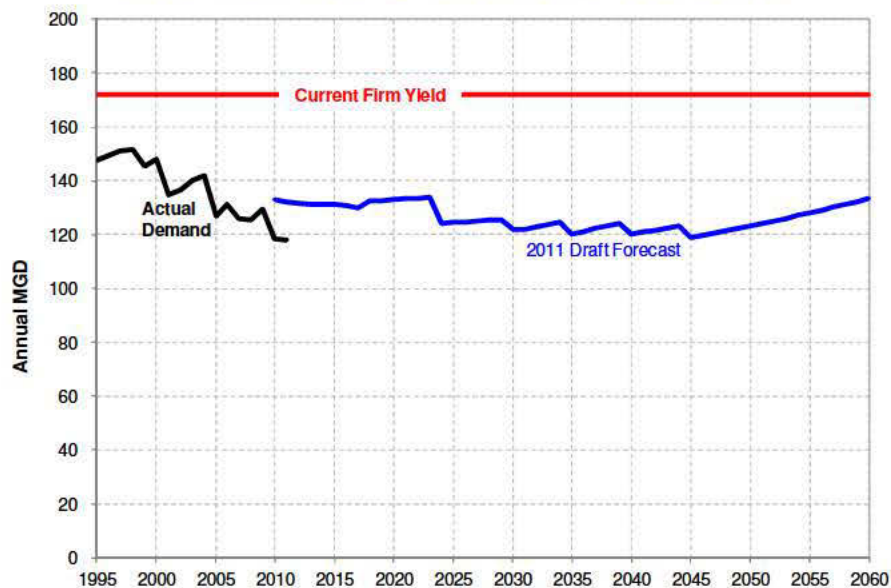


Forecasting Demand

- Main Purpose
 - ✓ Supply Planning (Long Term)
 - ✓ Rate Design (Short Term)
- Approach: Variable Flow Factor Model
 - ✓ Takes advantage of econometric analysis done by others (and ourselves)
 - ✓ Assumptions can easily be made and varied (for sensitivity analysis)
 - ✓ Simple yet takes account of many explanatory variables
 - ✓ Modest data requirements

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2011 Water Demand Forecast

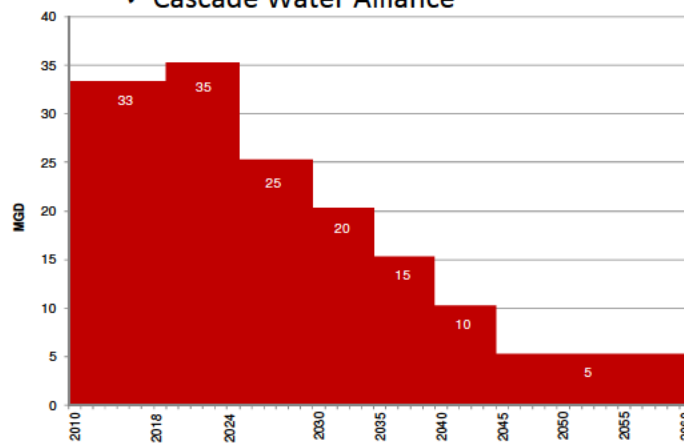


Factors Affecting Wholesale Demand

Block Contracts

✓ Northshore: 8.6 mgd

✓ Cascade Water Alliance

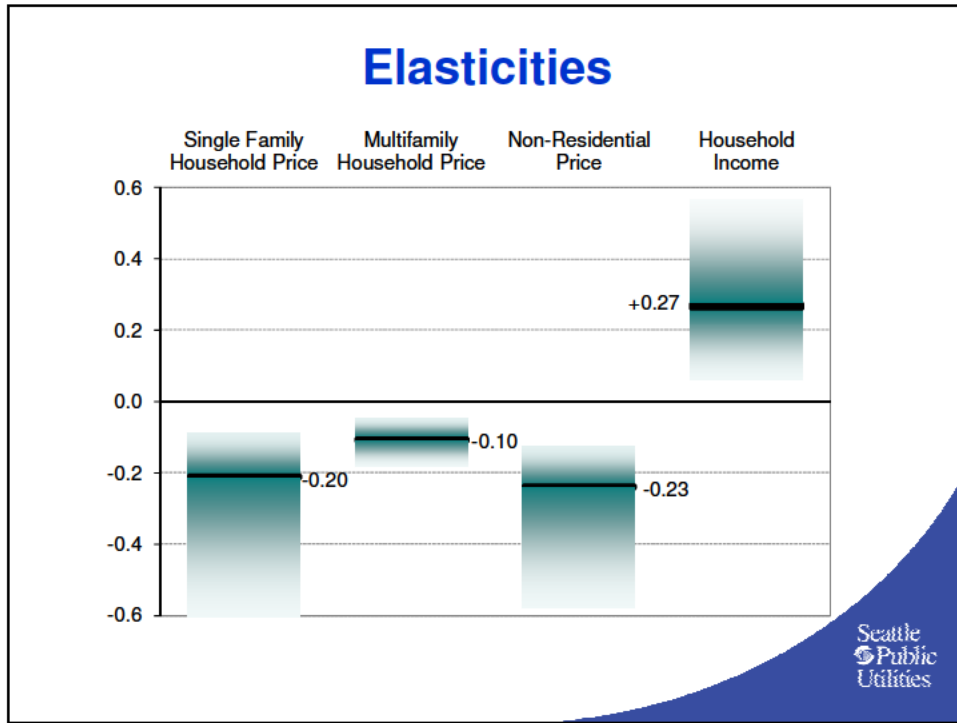


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Model Overview

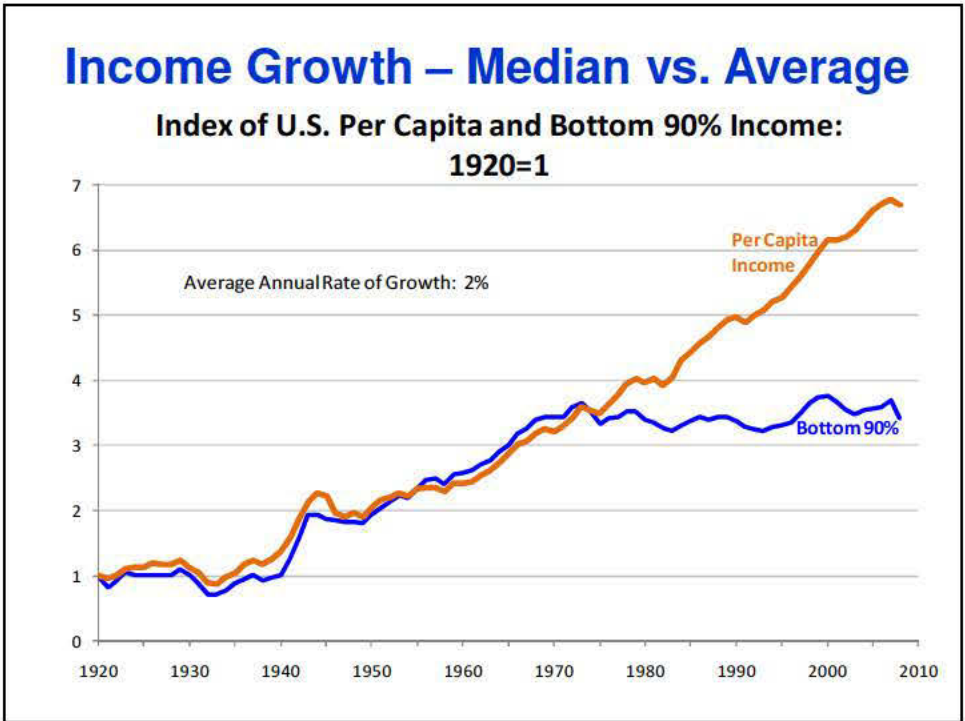
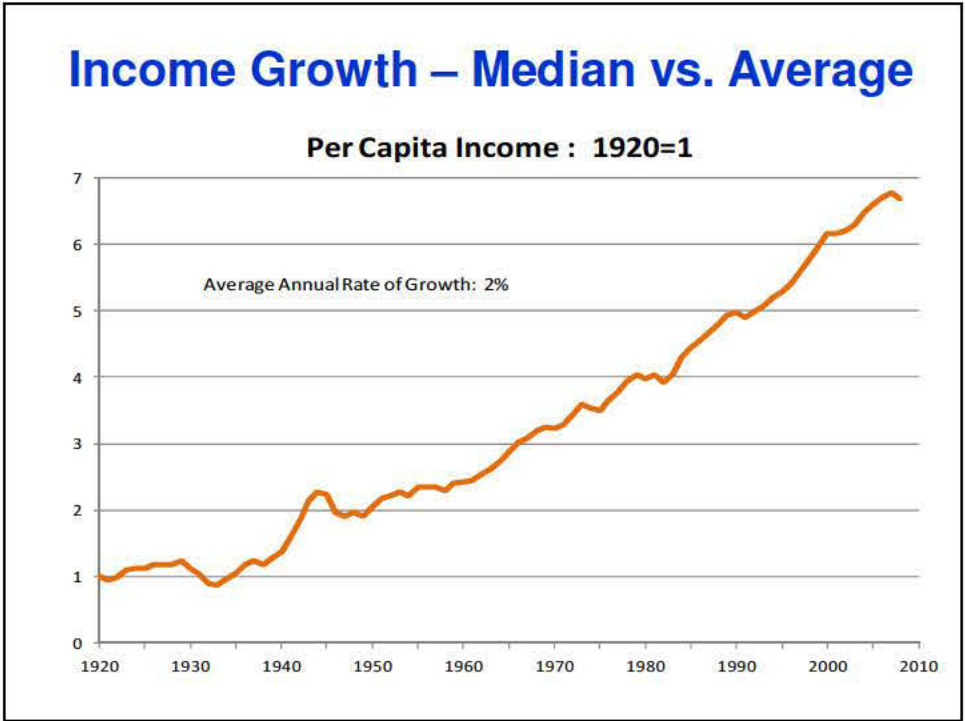
- Base Year Flow Factors by Sector
- Future Flow Factors affected by:
 - ✓ Projected growth in water and sewer rates
 - ✓ Projected growth in household income
 - ✓ Planned conservation program savings
 - ✓ Passive savings
- Forecasts of households and employment
- Other Adjustments
 - ✓ Non-Revenue Water
 - ✓ Other Sources of Supply
 - ✓ Blocks

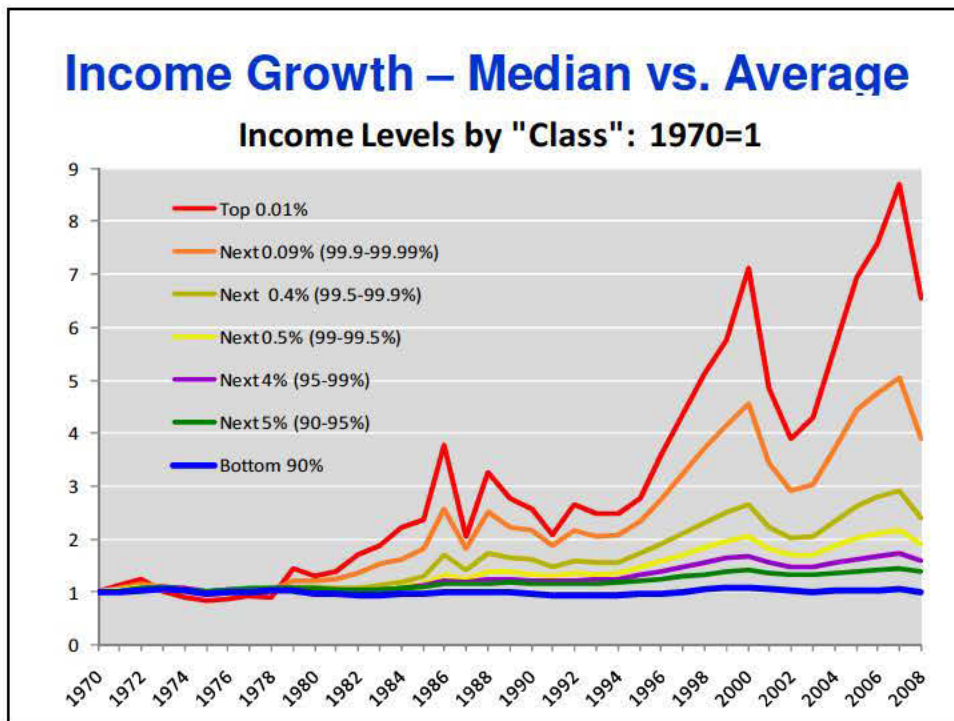
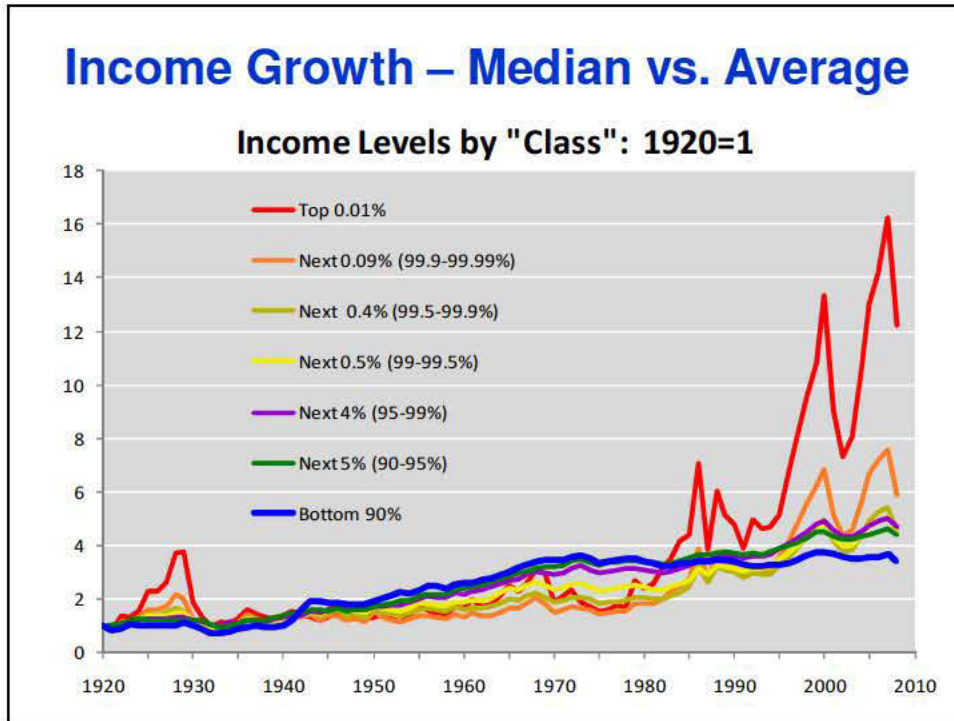
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Household Income

The Seattle Public Utilities logo is in the bottom right corner.





Income Growth – Median vs. Average

Implications for forecast of income growth

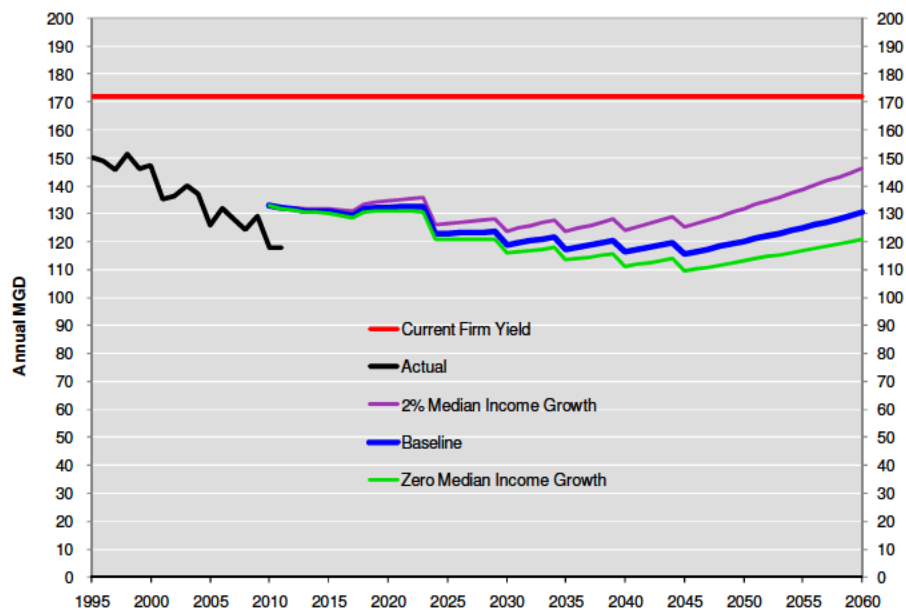
(Assuming per capita income growth rate of about 2% continues)

Class Warfare Scenarios	Income Distribution	Annual Median Income Growth
Wealthy-Take-All Continues	Gets worse	0%
Wealthy Take Most	Gets worse more slowly	0% - 2%
Rising Tide Lifts All Boats	Holds constant	2%
Wealthy Get Smaller Share of New Growth	Improves	> 2%

- Model assumption: 0.9%

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Forecast with High and Low Income Growth Scenarios



Water & Sewer Rates

- Water and sewer rates have increased by more than 2% annually, inflation-adjusted.
- Rate models project almost flat real rates after several years of large increases.

Annual Growth Rates

	Seattle Retail*	Wholesale Customers
2010-2015	6.5%	2.5%
2015-2020	1.0%	0.9%
2020-2060	0.4%	0.4%



Forecasting Programmatic Conservation

- Conservation Potential Assessment
- Alliance for Water Efficiency Conservation Tracking Tool
 - Diminishing returns
 - Code enhancement
- By policy



Programmatic Conservation Savings

Estimate based on policy: Seattle Regional Water System Operating Board, January 2006

- ✓ 15 mgd of combined price-induced and programmatic conservation savings between 2011 and 2030
- ✓ No programmatic conservation thereafter

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Passive Savings

Code savings

- ✓ 1992 code for showerheads, toilets and aerators
- ✓ 2001 code for clothes washers
- ✓ 2002 code for aerators
- ✓ Anticipated 2012 (effective 2016)

Beyond Code – Market Transformation

- ✓ Energy Star/CEE standards for washing machines
- ✓ Toilets 1.6 gpf ⇒ 1.28 gpf
- ✓ Showerheads 2.5 gpm ⇒ 2.0 gpm
- ✓ Aerators 2.2 gpm ⇒ 2.0 gpm

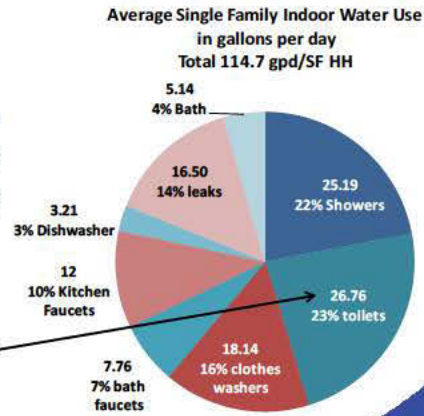
Replacement, New Construction, PSE

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Passive Savings Model

Example: Toilets

Existing share by gpf	
10%	5 gpf
40%	3.5 gpf
50%	1.6 gpf
Current gpf	2.7 gpf
Flushes/person/day	4
Persons/hhld	2.5
Flushes/hhld/day	10
Gal/Hhld/Day	27.0
Ratio (ghd/gpf)	10
Fixture Life	30 yrs

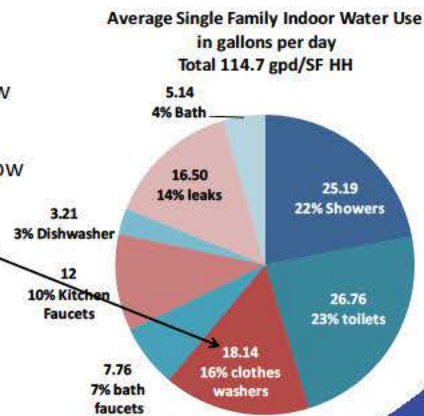


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Passive Savings Model

Example: Clothes Washers

Current water factor	8.5 gpw
Average volume	4 cf
Current use per wash	34.0 gpw
Washes/machine/day	0.55
Gal/Hhld/Day	18.7
Ratio (ghd/wf)	2.2
Appliance Life	12 yrs



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Passive Savings Assumptions

Washing Machine Water Factors

	Code		Energy		Most Eff.		Single Family Calculations				Average SF WF
	Top	Horizntl	Star	CEE	Energy Star	Code	ES	CEE	ME		
1996	11	11	9.5	6		90%	8%	2%	0%	100%	10.8
1997	11	11	9.5	6		87%	10%	4%	0%	100%	10.7
1998	11	11	9.5	6		83%	11%	5%	0%	100%	10.6
1999	11	11	9.5	6		80%	13%	7%	0%	100%	10.5
2000	11	11	9.5	6		77%	15%	9%	0%	100%	10.4
2001	9.5	9.5	7.5	6		73%	16%	10%	0%	100%	8.8
2002	9.5	9.5	7.5	6		70%	18%	12%	0%	100%	8.7
2003	9.5	9.5	7.5	6		67%	20%	14%	0%	100%	8.6
2004	9.5	9.5	7.5	6		63%	22%	15%	0%	100%	8.5
2005	9.5	9.5	7.5	6		60%	23%	17%	0%	100%	8.4
2006	9.5	9.5	7.5	6		57%	25%	18%	0%	100%	8.4
2007	9.5	9.5	7.5	6		53%	27%	20%	0%	100%	8.3
2008	9.5	9.5	7.5	4.5		50%	28%	22%	0%	100%	7.8
2009	9.5	9.5	7.5	4.5		47%	30%	23%	0%	100%	7.7
2010	9.5	9.5	6	4.5		50%	25%	25%	0%	100%	7.4
2011	9.5	9.5	6	4	3.3	49%	30%	20%	1%	100%	7.3
2012	9.5	9.5	6	4	3.3	46%	32%	21%	1%	100%	7.2
2013	9.5	9.5	6	4	3.3	43%	34%	22%	1%	100%	7.0
2014	9.5	9.5	6	4	3.3	40%	36%	23%	1%	100%	6.9
2015	8.5	6	4.5	3.3	3.3	19%	38%	24%	1%	100%	5.2
2016	8.5	6	4.5	3.3	3.3	17%	40%	25%	1%	100%	5.1
2017	8.5	6	4.5	3.3	3.3	16%	42%	26%	1%	100%	5.0
2018	8.5	6	4.5	3.3	3.3	14%	44%	27%	1%	100%	4.9
2019	8.5	6	4.5	3.3	3.3	13%	46%	28%	1%	100%	4.8
2020	8.5	6	4.5	3.3	3.3	11%	48%	29%	1%	100%	4.7
2030	8.5	4.5	4	3.3	3.3		60%	39%	1%	100%	3.7
2040	8.5	4.5	4	3.3	3.3		50%	49%	1%	100%	3.7

Forecast of Passive Savings

	Shower-heads	Toilets	Aerators	Clothes Washers	Total
2020	-0.1	2.7	0.2	1.9	4.7
2030	0.8	4.9	0.4	4.4	10.5
2040	1.4	6.8	0.6	5.8	14.5
2050	1.8	8.0	0.7	6.6	17.1
2060	2.0	8.8	0.7	7.2	18.7

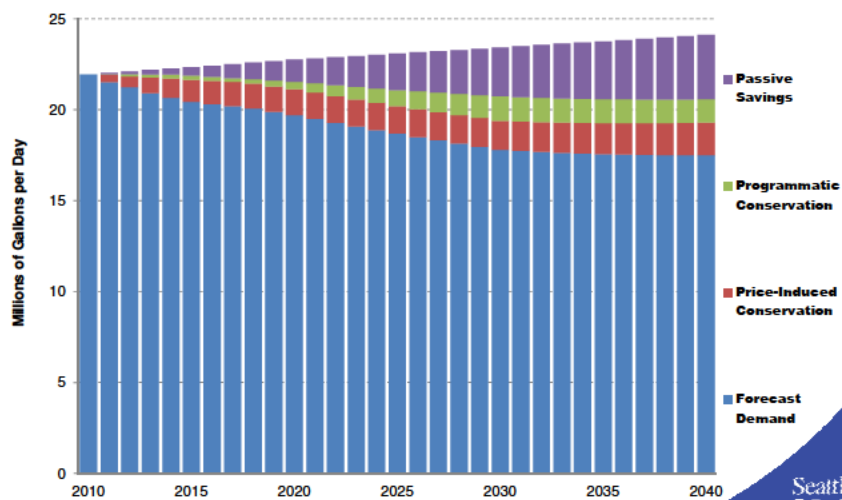
	Single Family	Multi-family	Non-Residential	Total
2020	2.3	1.7	0.6	4.7
2030	5.2	4.0	1.2	10.5
2040	7.1	5.8	1.7	14.5
2050	8.0	7.0	2.1	17.2
2060	8.5	7.8	2.4	18.7

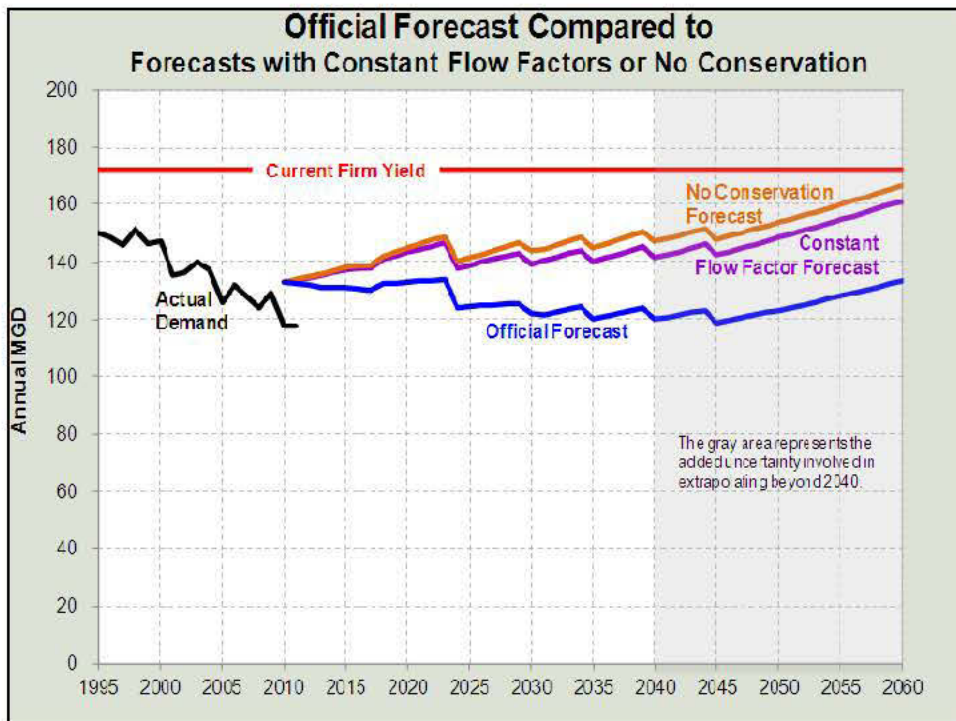
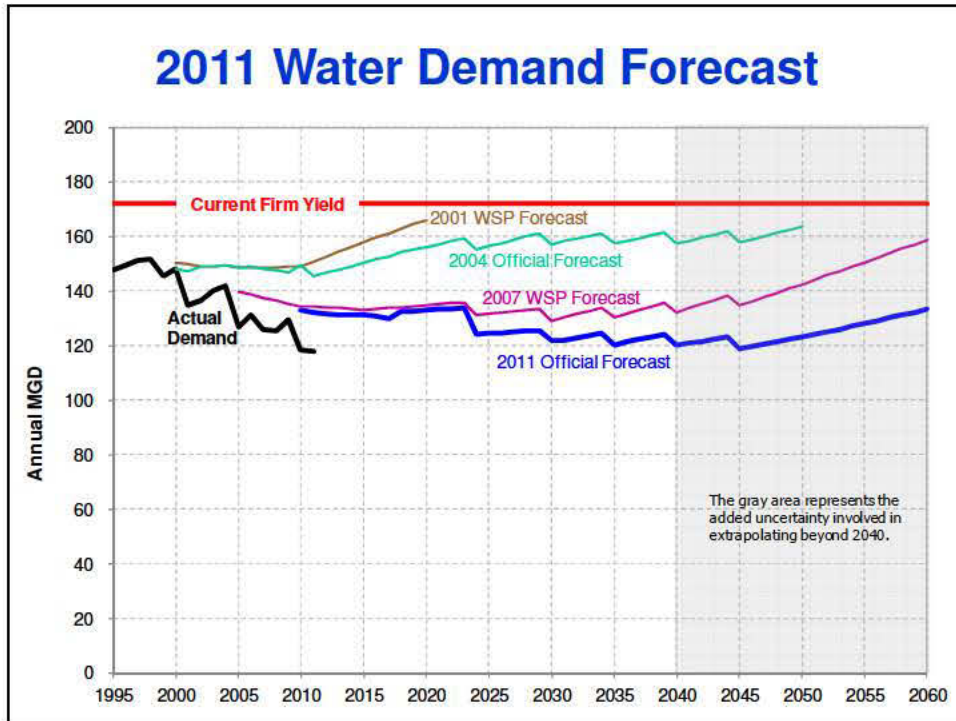
Conservation Overlap Function (Free Riders)

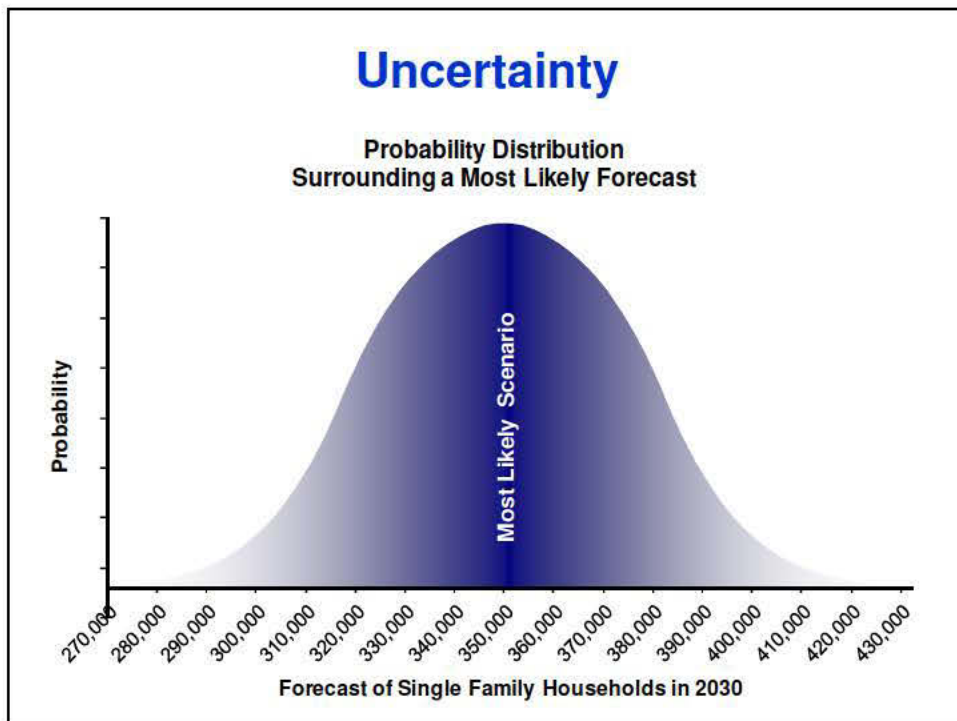
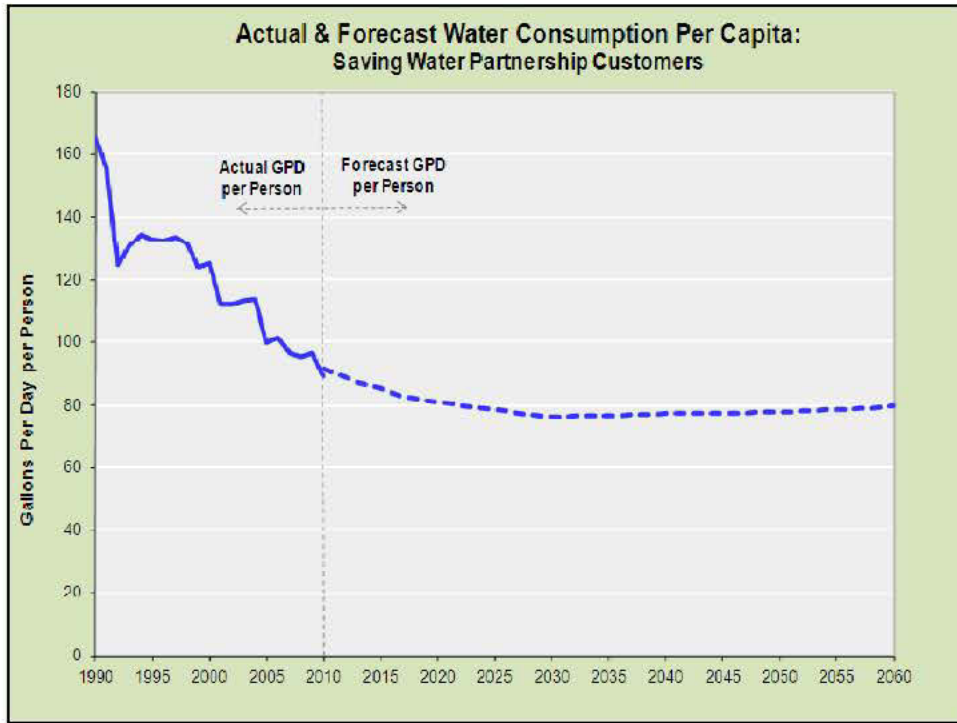
Price/Programmatic/Passive

- ✓ Assumed that half the price effect overlaps with passive and programmatic savings
- ✓ Overall effect – reduces total gross conservation savings by 14%

Impact of Conservation on Forecast of Seattle's S.F. Residential Water Demand



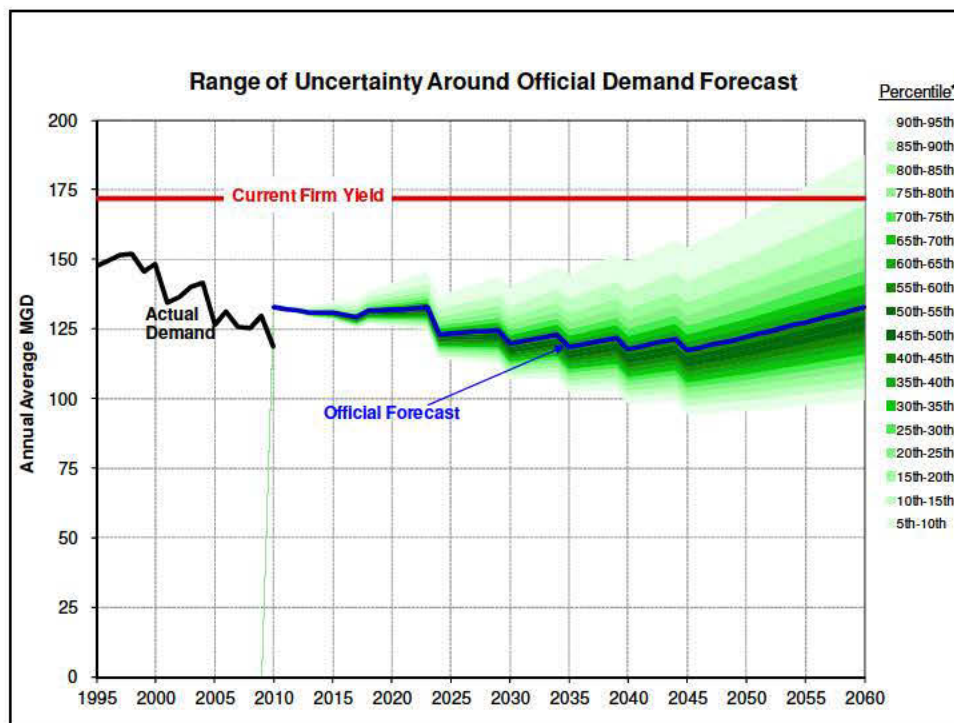


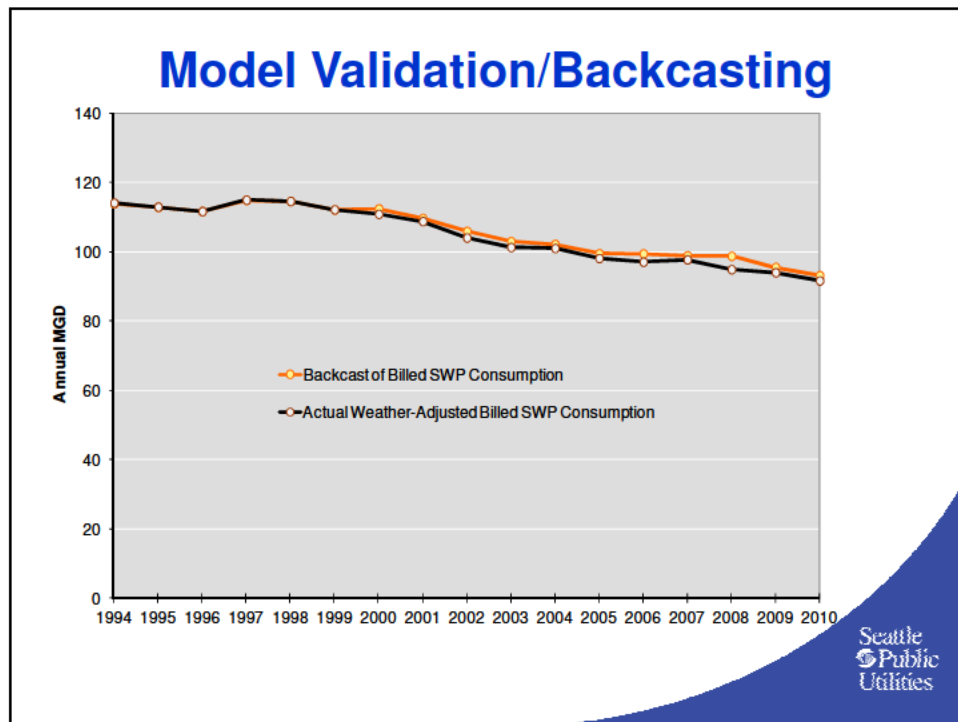


Modeling Demand Uncertainty

- Estimate range of uncertainty around model inputs
- Assign probability distributions
- Run Monte Carlo simulations
 - ✓ 10,000 iterations

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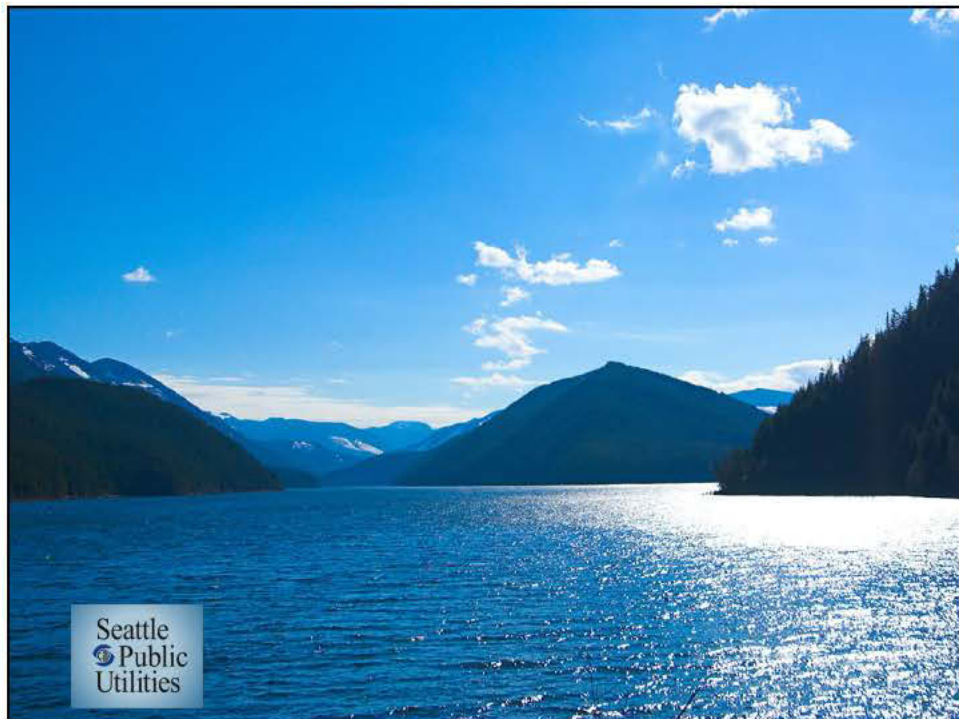
Research Needs & Questions

- Household Income and Water Use
- End Use Studies – especially MF and CII
- Separating sources of conservation and accounting for overlap
- Modeling passive savings
- Future shock – what new technologies and trends can we foresee now?
- Technology tipping points

One Last Question

- Rate Structures Revenue Stability
 - Unstable rate structures adopted to provide strong price signals.
 - Is it time for utilities to reevaluate?

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