Water Provider Information Needs and Innovative Research

Understanding Residential Water Use: New Approaches to Analyzing, Projecting and Managing Demand

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Decision Center for a Desert City and ASU Center for Environmental Economics and Sustainability Policy

Water Provider Information Needs and Innovative Research

- Bruce Flory, Seattle Public Utilities
- Doug Frost, City of Phoenix Water Services
- Tom Arnold, Tucson Water

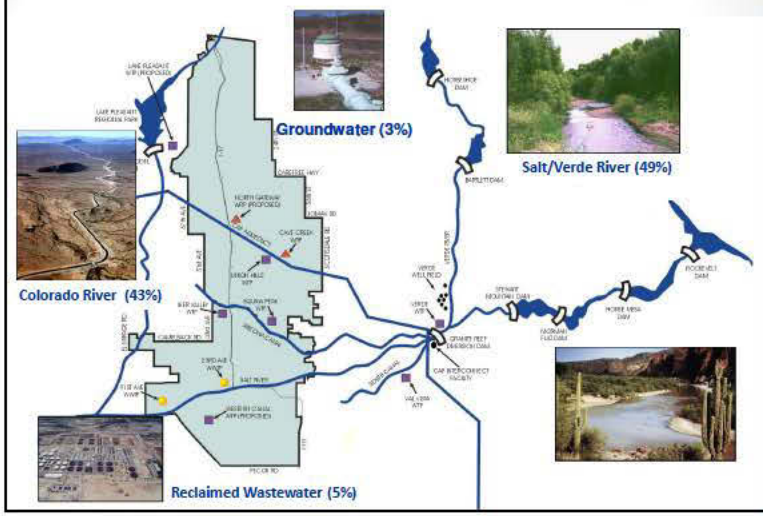
City of Phoenix Water Use And Wastewater Generation Trends

- Context
- What We Used To Think
- What We've Experienced
- What We've Learned
- How We're Applying What We've Learned
- How We Can Learn More In The Future

Phoenix – Context (System)

- Service area: 540 square miles
- Population served: 1,502,287
- Water accounts: 404,647
- Miles of water mains: 6,962
- Treatment plants: 5
- Booster stations:105 (0.03 to 135 MGD)
- Pressure reducing stations: 95 (0.3 to 80 MGD)
- Storage facilities: 47 (0.006 to 90 MG)
- Active wells: 24 (38 MGD Total Capacity)

Phoenix – Context (Water Portfolio)



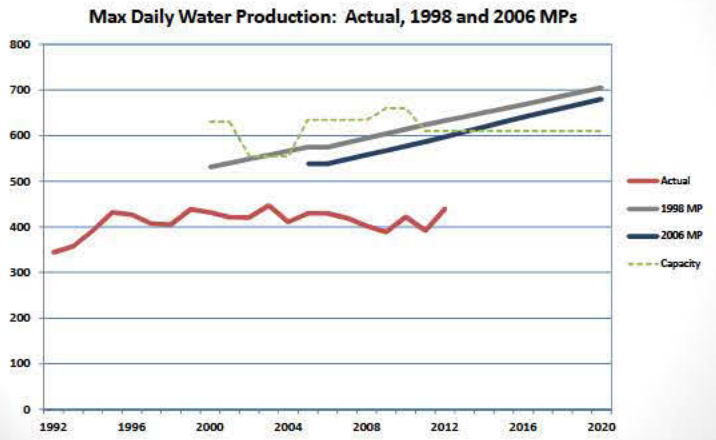
What We Used To Think

- Demand from existing homes and businesses is relatively stable
- Use is affected primarily by price and personal behavior
- Strong population and economic growth would consistently lead to increased water use
- Water demand & wastewater generation would grow steadily, with some response to rate increases

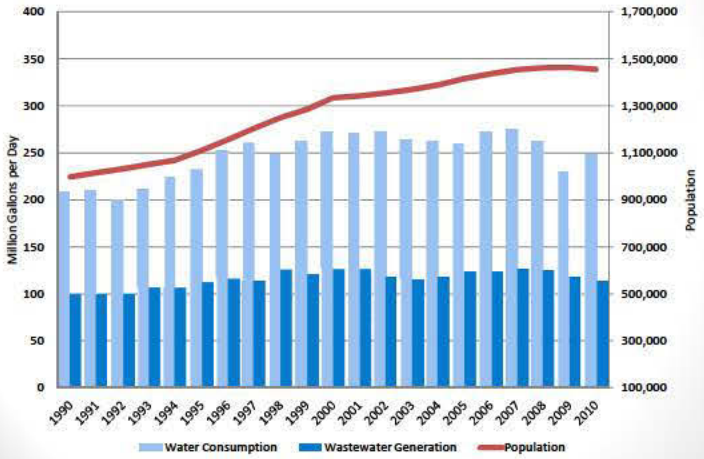
What We've Experienced

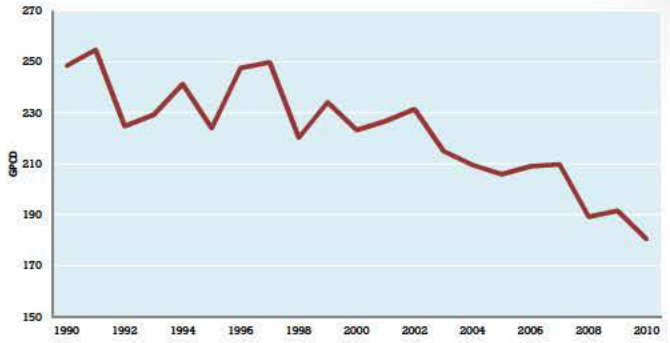
- Total water production remains stable even as growth occurs
- Volume to wastewater treatment plants stays about same even as growth occurs
- Lower water demand on a per capita basis for existing and especially new customers
- Very low flows in sewers and lift stations in new areas
- Increasing concerns about water quality and sewer maintenance because of low flows

Anticipated Demand Growth Did Not Occur



Total Water Use and Wastewater Generation Has Been Stable



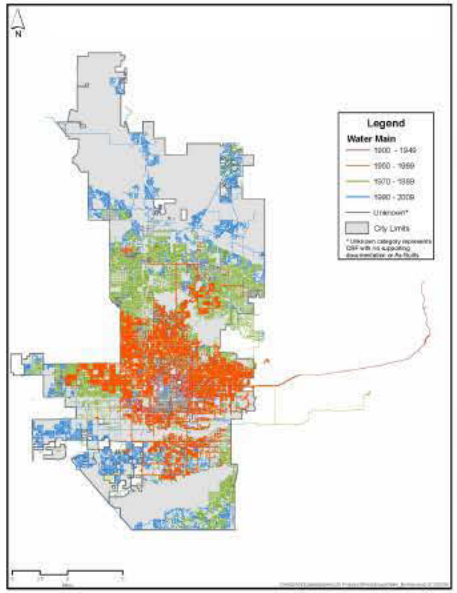


Phoenix Per Capita Water Use: 1996-2010

What We've Learned (1)

- Understanding water demand & wastewater generation like solving puzzle
- Solving puzzle requires research at different levels
- New development is much more efficient
- Existing homes and businesses are gradually becoming more efficient
- Long-term structural change is more important than short-term behavior change

City-Wide Analysis of Data



City-Wide Analysis of Data

- Tracking of metered demand by type of user (single family, multifamily, general commercial, landscape, etc.) category over time
- Analysis of SF and MF demand using additional data from assessment or other records
- Review of aggregate WTP production (daily, monthly, annually, etc.)
- Review of aggregate use of WWTP capacity (daily, monthly, annually, etc.)

Neighborhood or Subdivision Analysis of Data

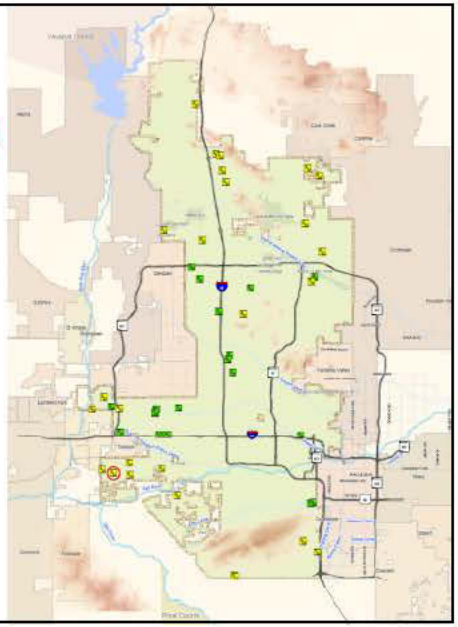
Neighborhood or Subdivision Analysis of Data

- Sewer metering at subdivision or larger level to isolate distinct uses and per unit flows (all single homes, all industrial, etc.)
- Comparison of metered water use data and sewer meter data
- Analysis of landscape type using aerial photography and satellite imagery
- Comparison of metered water use data and landscape coding

Wastewater Metering/Data Collection

Sewer Metering Study Site Selection

- Large sample population
- Homogenous customer base
- One outfall to the collection system
- Post 1994 construction date



Individual Home or Business Analysis of Data

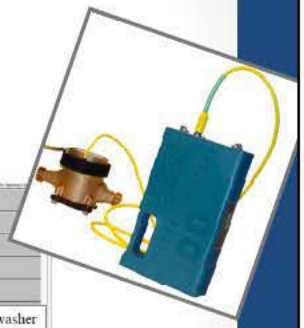
Individual Home or Business Analysis of Data

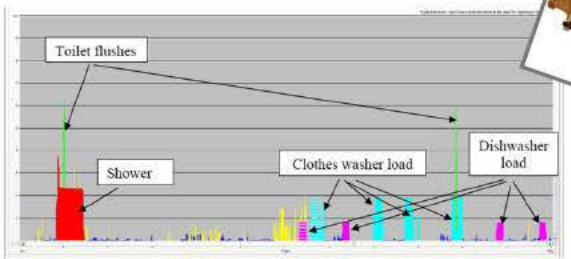
- Site visits to identify number, type and age of fixtures, appliances and irrigation systems
- Creation of inventories of water-using devices and comparison with metered data
- Data-logging to analyze use of appliances, fixtures and irrigation systems in individual homes for limited periods
- In the future, use of advanced water meters that track use over 15 minute increments rather than over 30 day increments

Individual Home Analysis

Data Logging

- Trace Analysis
- Discreet End-Use Information



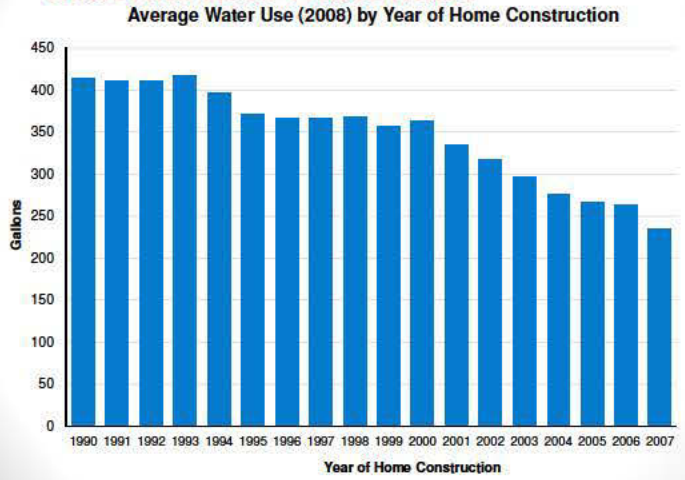


Example of trace analysis from City of Phoenix, Re-Log Study 2009

What We've Learned (2)

- Data indicates that change in water use due to long-term technological and cultural factors, not short-term behavioral/price factors
- Water demand and ww generation falling since 2000 on per capita and per unit basis
- Steadily declining water use and wastewater generation seen in all sectors, in all areas, and in existing and new customers
- Trends seen across U.S. regardless of rates
- Change most pronounced in new customers

New Homes Use Less Water and Generate Less Wastewater



All Homes are Using Less Water and Generating Less Wastewater

- Water use by single family homes decreased 12 – 15% during the first decade of the 21st Century

TREND IN SINGLE FAMILY AVERAGE DAILY WATER USE FOR VARIOUS PERIODS OF HOME CONSTRUCTION

HOME BUILD YEAR	Consumption Period 1997 - 1999	2007 - 2009
pre - 1960	437	367
1960 - 1975	478	409
1975 - 1990	473	412
1990 - pres	436	368

Results displayed in average gallons per account per day (GPAD)

What We've Learned (3)

- Indoor residential reductions due mostly to gradual transition to more efficient devices
- Majority of residential reductions due to more efficient toilets and washing machines
- Indoor business reductions more complex
- Outdoor residential reductions due to conscious shift to desert landscaping
- Individual homes use same amount of water while green, then use falls dramatically with transition to drier landscape

Indoor Use Is Very Low For New Units

SUBDIVISION NAME	UNITS	TOT FLOW	WW / UNIT	W / UNIT	% WW
Anthem West	631	84,854	134	222	61%
Carefree Crossing	370	61,693	167	254	66%
Colina Del Norte #2	294	65,626	223	285	78%
Country Place	1143	180,120	158	288	55%
Desert Ridge Lot #24	475	38,744	82	252	32%
Foothills Clubwest MH #407	320	39,533	124	296	42%
Foothills Clubwest MH #105	536	84,081	157	272	58%
Larissa	324	33,028	102	237	43%
Moon Valley	1000	120,802	121	323	37%
North Canyon	585	64,919	111	261	43%
Ocotillo	312	33,874	109	227	48%
Silver Creek	226	30,768	136	235	58%
Sonoran Foothills	701	68,178	97	286	34%
Tarracita	534	86,132	161	235	69%
Tatum Highlands	1248	240,248	193	254	76%
Trailwood East	479	79,291	166	240	69%
Trailwood West	707	62,965	89	211	42%
Tramonto Parcel #4	268	58,578	219	332	66%
Volterra	490	55,124	112	228	49%
AVERAGE	560	78,345	140	260	54%

More Efficient Devices Have Driven Falling Indoor Use

- Major efficiency improvements have been achieved for toilets and clothes washers

TREND IN USAGE RATES FOR RESIDENTIAL DEVICES
Pre-1996 Homes

Fixture / Appliance	1999 Use Rate (gal/day)	2009 Use Rate (gal/day)
Toilet	48.3	35.2
Clothes Washer	43.5	27.9
Shower	33.3	31.3
Faucet	24.7	28.0
Leak[1]	14.1	15.1
Other	10.1	11.7
Dish Washer	2.2	1.0
Bathtub	3.0	1.8
Total	179.2	152.0

Data from the 1999 REUWS and the 2009 city of Phoenix ReLog Study
1. Data shown is mean daily use (gallons) except Leak data is median due to right-hand skew.

Still Plenty of Capacity For Increased Efficiency Indoors

- More than 74% of single family households have installed low-flow toilets, but 77% have yet to install high efficiency clothes washers.

PENETRATION RATES FOR *EFFICIENT* RESIDENTIAL DEVICES

Low-Flow Toilets (ULFT)	74.31%
Shower Heads (ULFS)	88.74%
Bathroom Faucets (ULFF)	58.58%
High Efficiency Clothes Washers	22.86%
High Efficiency Dish Washers	22.51%

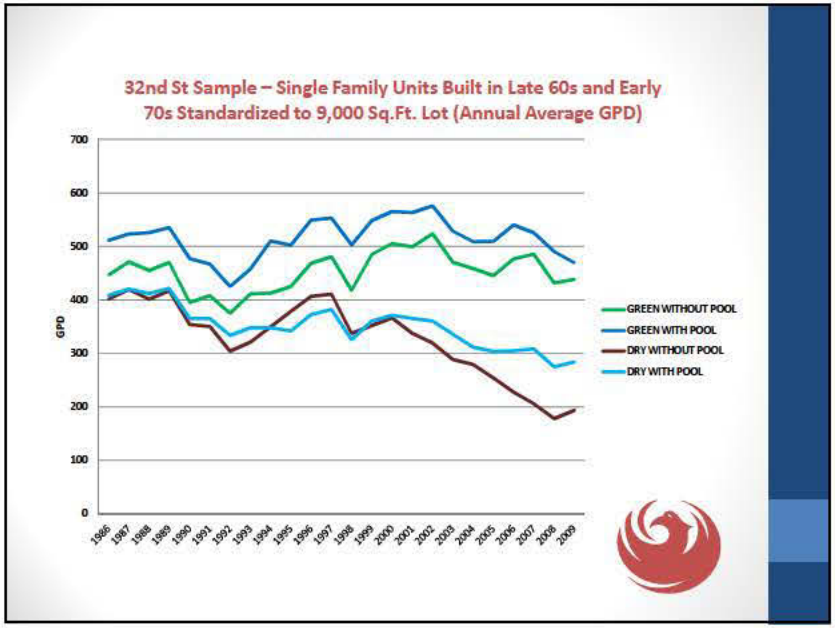
Major Transition Underway From Green to Drier Landscapes

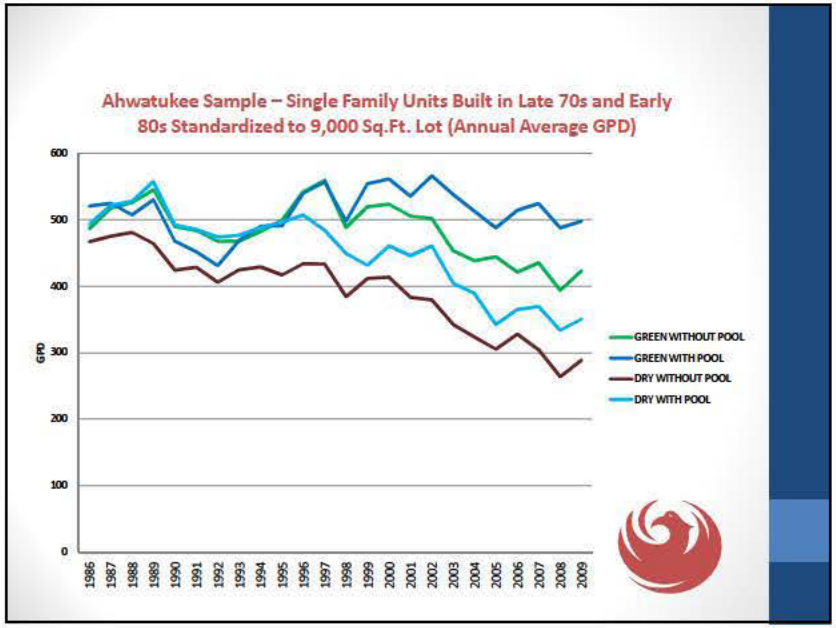
- Most residential and business landscapes 30 years ago were 'green' (turf, non-native, etc.)
- Transition to alternative landscapes appears to have begun in large way in 1990s
- Some switch to totally desert landscapes
- Most switch to mixed with native species
- Switching to mixed with native species dramatically reduces use, even with pool
- Culture plays big role – whole neighborhoods seem to convert quickly

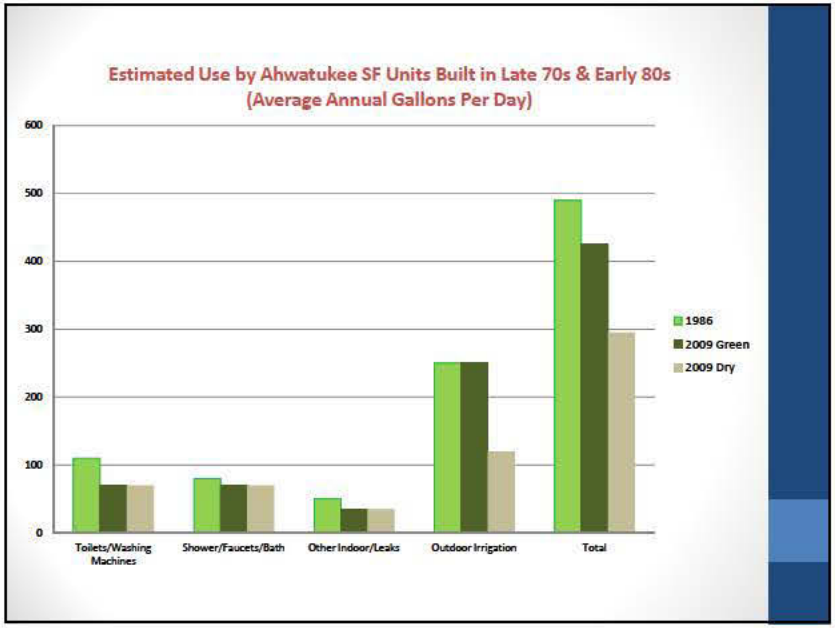
Revolution In Landscaping Characteristics

Old Model

New Model


32nd St Sample – Single Family Units Built in Late 60s and Early 70s Standardized to 9,000 Sq.Ft. Lot (Annual Average GPD)
GPD
700
600
500
400
300
200
100
0
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
GREEN WITHOUT POOL
GREEN WITH POOL
DRY WITHOUT POOL
DRY WITH POOL


Ahwatukee Sample – Single Family Units Built in Late 70s and Early 80s Standardized to 9,000 Sq.Ft. Lot (Annual Average GPD)
GPD
600
500
400
300
200
100
0
1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
GREEN WITHOUT POOL
GREEN WITH POOL
DRY WITHOUT POOL
DRY WITH POOL



Estimates of Water Use by Sample of Ahwatukee Single Family Units Built During Late 70s and Early 80s

	1986	2009 Green	2009 Dry
Toilets/Washers	110	70	70
Shower/Faucets/Bath	80	70	70
Other Indoor/Leaks	50	35	35
TOTAL INDOOR	240	175	175
Outdoor Irrigation	250	250	120
Net Pool	40	40	55
TOTAL OUTDOOR	290	290	175
TOTAL	530	465	350

Assumes Lot Size of Approximately 9,000 Sq.Ft.

Toilets/Washers = Toilets, Clothes Washers and Dish Washers

Other Indoor/Leaks = Evaporative Coolers, Water Softeners, Leaks and Unknown

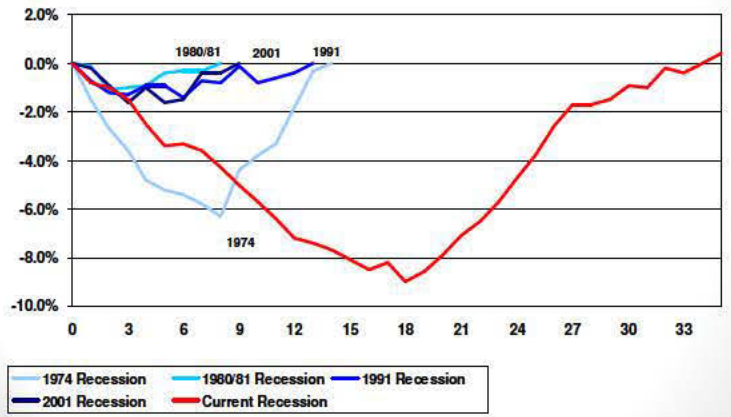
Net Pool = Difference Between Pool and No Pool (Less Grass for Green Lots)

What We've Learned (4)

- Even with new population and economic growth, new customers may not be enough to offset demand reductions due to efficiency
- Strong population and economic growth experienced during 1960-2000 not inevitable
- Unclear what drivers of new economic expansion will be
- Unlikely that new industries or businesses would be major water users or wastewater generators

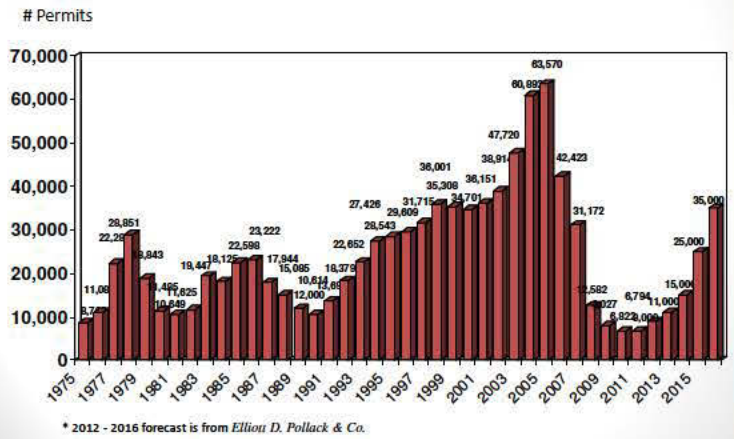
Greater Phoenix Y/Y Job Losses - Recent Recessions

Duration in Months – BLS - January



Single-Family Permits
Greater Phoenix 1975–2016

Source: PMHS / RL Brown



* 2012 - 2016 forecast is from *Elliott D. Pollack & Co.*

How We Are Applying What We Learned

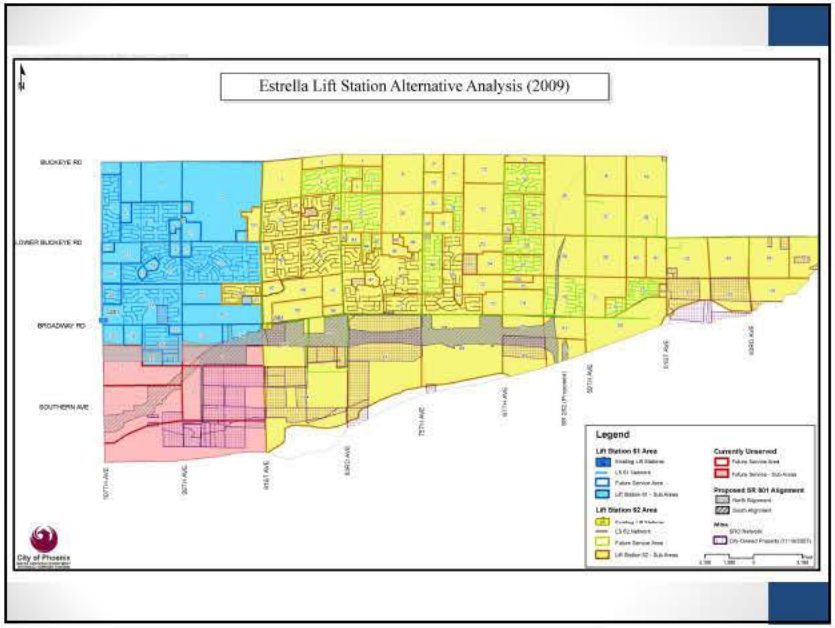
- Improved planning – specific development level
- Improved planning – drainage basin level
- Improved planning – City-wide infrastructure and water resource plans
  - Use of scenarios

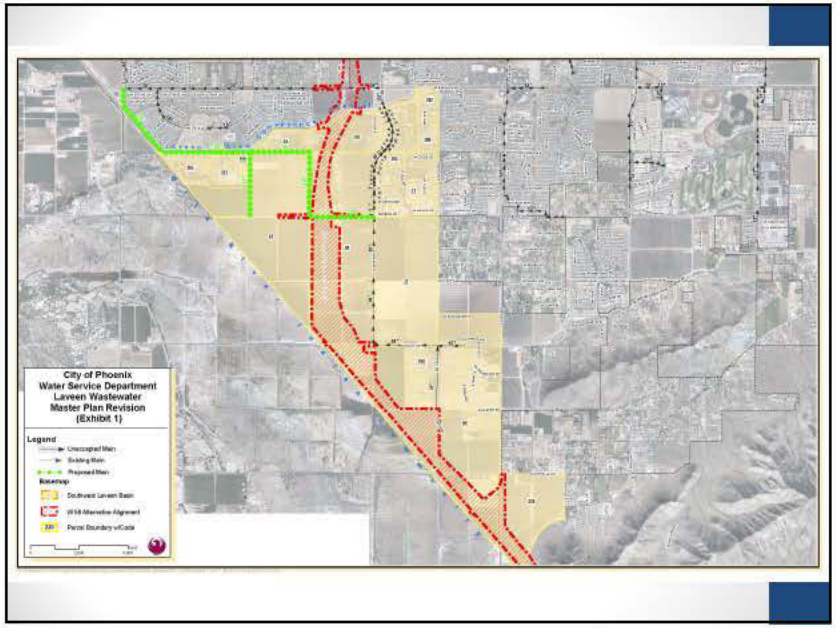
Improved Planning – Specific Development Level: Revised (Proposed) Wastewater Design Standards

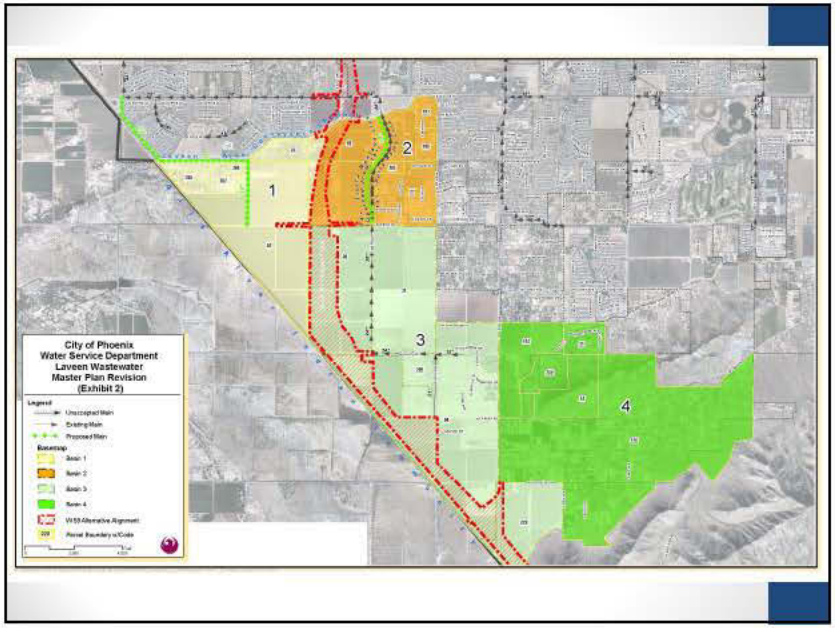
Land Use	Wastewater 2004 Design Standards		Wastewater Proposed Design Standards	
	Unit	Daily Flow / Unit (gal)	Unit	Daily Flow / Unit (gal)
Single Family	Dwelling	320	Dwelling	240
Multifamily	Dwelling	250	Dwelling	180
Commercial (retail / mall)	Sq-ft	.5	1000 sq-ft	75
Commercial (office)	1000 sq-ft	100	1000 sq-ft	90
Warehousing / Big Box Retail	N/A	N/A	1000 sq-ft	25
Industrial	Person	50	1000 sq-ft	50
Schools	Student	75	Student	20
Hotel / Motel (w/o restaurant)	Room	130	Room	100
Hotel (w/ restaurant)			Room	150
Resort			Room	210
Hospital	N/A	N/A	Bed	300

Improved Planning – Drainage Basin Level

- Opportunities for reducing scale and cost of new facilities
  - Estrella lift station example:
    - 15 MGD expansion of existing station vs construction of proposed 40 MGD regional station and deep sewers
  - Laveen sewer main example:
    - One 12" and one 15" increased to a 24"will replace a 36"

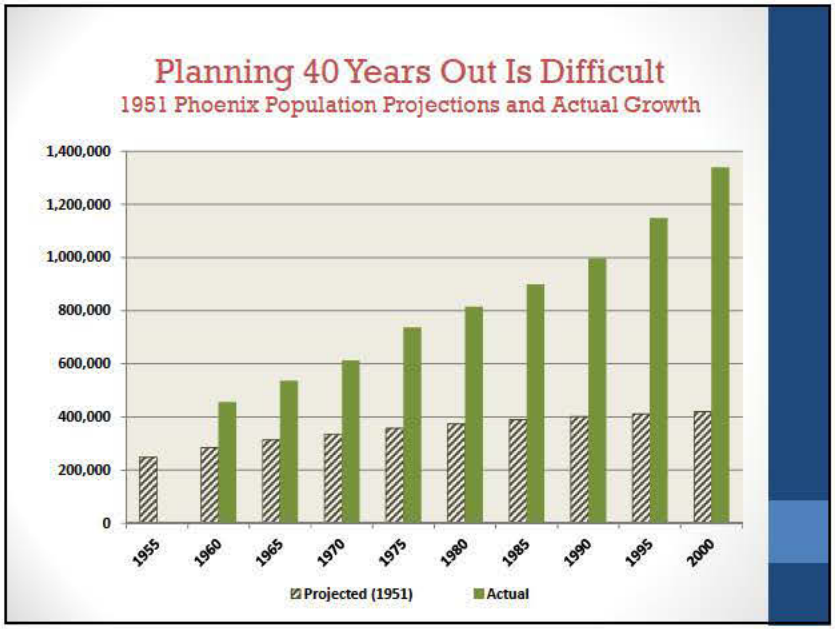

Estrella Lift Station Alternative Analysis (2009)
BUCKEYE RD
LOWER BUCKEYE RD
BROADWAY RD
SOUTHERN AVE
Legend
Lift Station 01 Area
Lift Station 02 Area
Currently Unserved
Proposed SR 801 Alignment
City of Phoenix

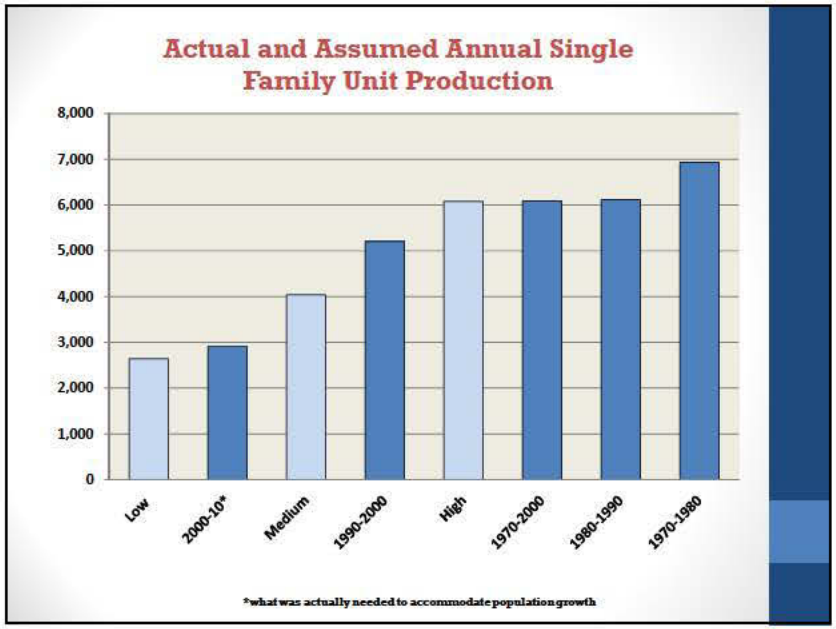

City of Phoenix
Water Service Department
Laveen Wastewater
Master Plan Revision
(Exhibit 1)
Legend
Basemap



Improved Planning – Use of Scenarios in City-Wide Infrastructure & Resource Plans

- Difficult to predict long-term technological, demographic and economic trends
- Possible to provide range of realistic possibilities for 5-20 year period to assist with planning
- Scenario planning is good way to provide realistic range of possibilities to manage risk
- Phoenix is using three scenarios to estimate likely range of possible outcomes
- Scenarios combine assumptions about water use and future development


Planning 40 Years Out Is Difficult
1951 Phoenix Population Projections and Actual Growth
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
Projected (1951)
Actual


Actual and Assumed Annual Single Family Unit Production
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Low
2000-10*
Medium
1990-2000
High
1970-2000
1980-1990
1970-1980
*what was actually needed to accommodate population growth

Existing SF Residential Customers
Efficiency Assumptions - Toilets

- LOW SCENARIO
  - All inefficient units replaced within 20 years
- MEDIUM SCENARIO
  - All inefficient units replaced within 30 years
- HIGH SCENARIO
  - All inefficient units replaced within 40 years

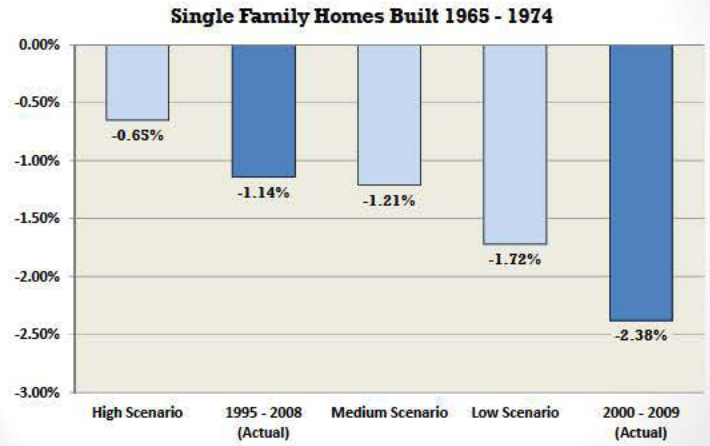
Existing SF Residential Customers
Efficiency Assumptions – Washing Machines

- LOW SCENARIO
  - All inefficient units replaced within 15 years
- MEDIUM SCENARIO
  - All inefficient units replaced within 20 years
- HIGH SCENARIO
  - All inefficient units replaced within 25 years

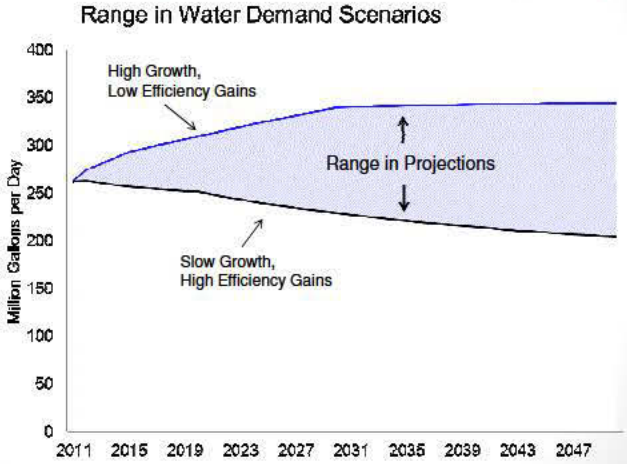
Existing SF Residential Customers
Efficiency Assumptions – Landscapes

- LOW SCENARIO
  - All landscapes are mixed or desert within 20 years
- MEDIUM SCENARIO
  - All landscapes are mixed or desert within 30 years
- HIGH SCENARIO
  - All landscapes are mixed or desert within 75 years

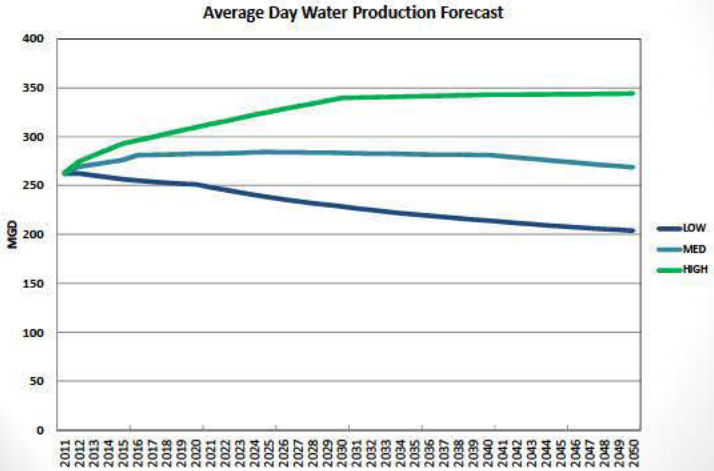
Existing Single Family Customers
Comparing Rates of Change in Demand



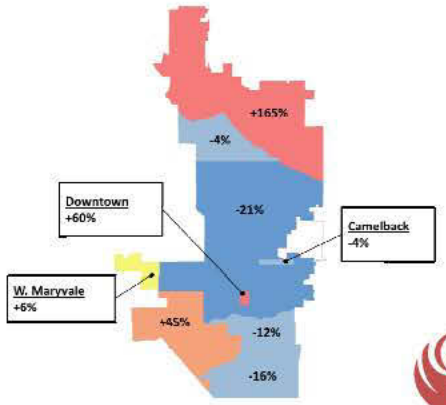
Scenario Planning: Using Differing Rates of Decline to Project Alternative Futures (Draft)



Water Master Plan Scenarios (Draft)



Projected Change in Water Demand by City of Phoenix Area
Medium Scenario - 2030



How We Can Learn More In The Future
Better Information On:

- How people actually use appliances, fixtures & irrigation systems
- Adoption of more efficient appliances, fixtures & irrigation systems
- Actual (not theoretical) water use for various vegetation types
- Economic & cultural trigger points for major changes
- Trigger points and trends for commercial, industrial and MF