Urban Demand Research Workshop: Landscape and Water Use Project

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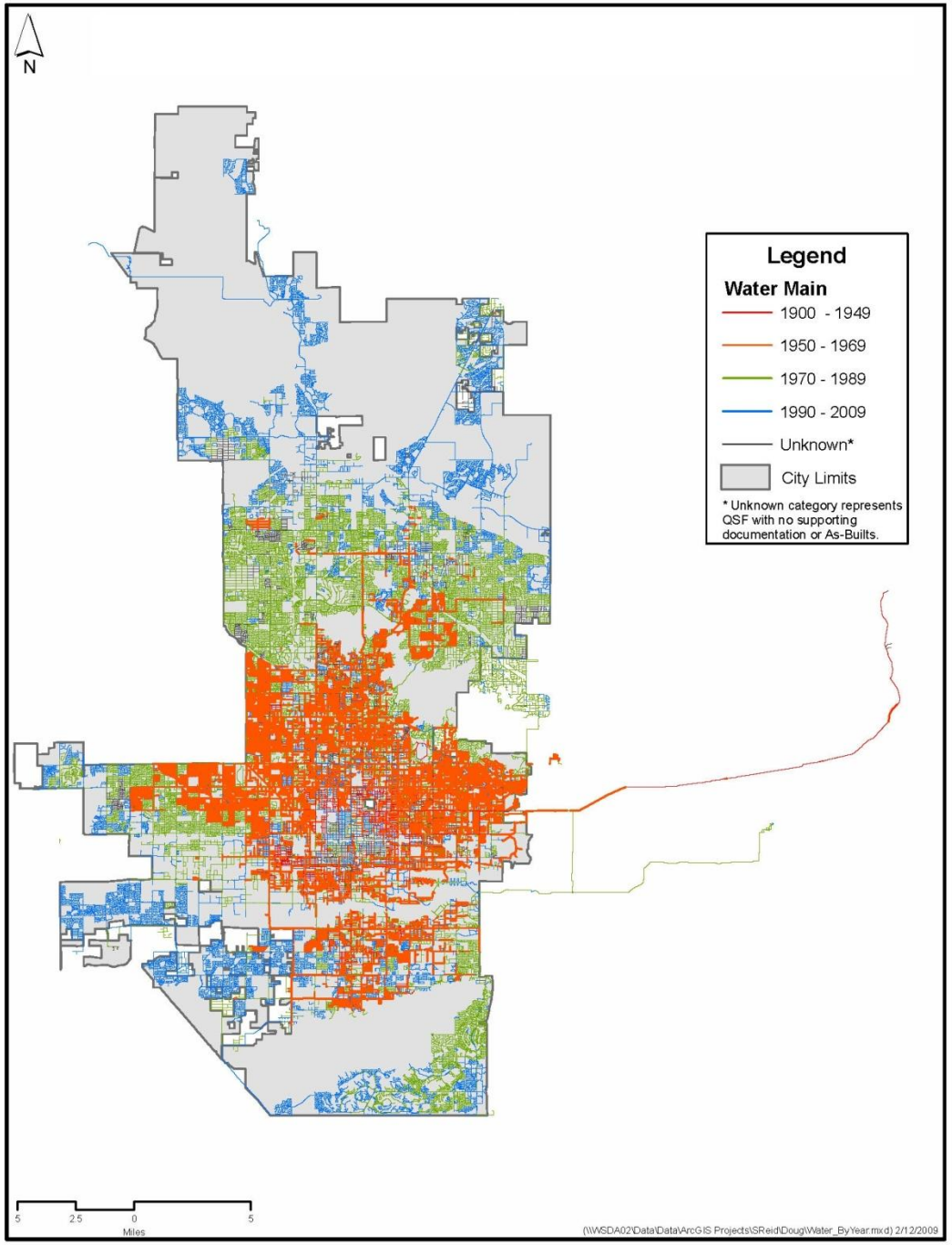
Landscape and Water Use Project

- Phoenix Context
- What We Used To Think
- What We've Experienced
- What We've Learned
- What We're Learning About Landscapes
- Remaining Landscape Research Challenges

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 (System)



Phoenix – Context (Water Portfolio)

Groundwater (3%)

Salt/Verde River (49%)

Colorado River (43%)

Reclaimed Wastewater (5%)

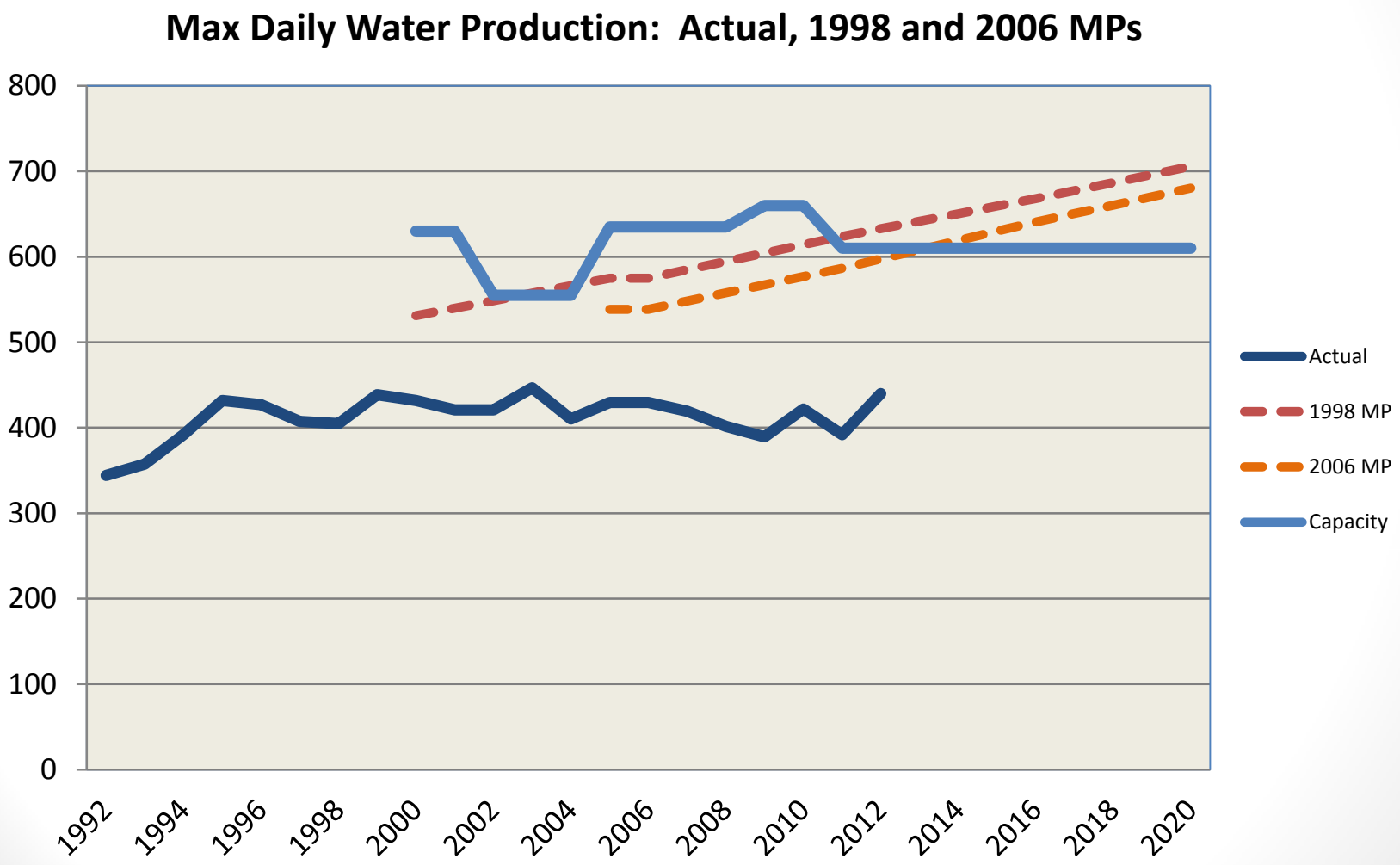
What We Used To Think

- 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

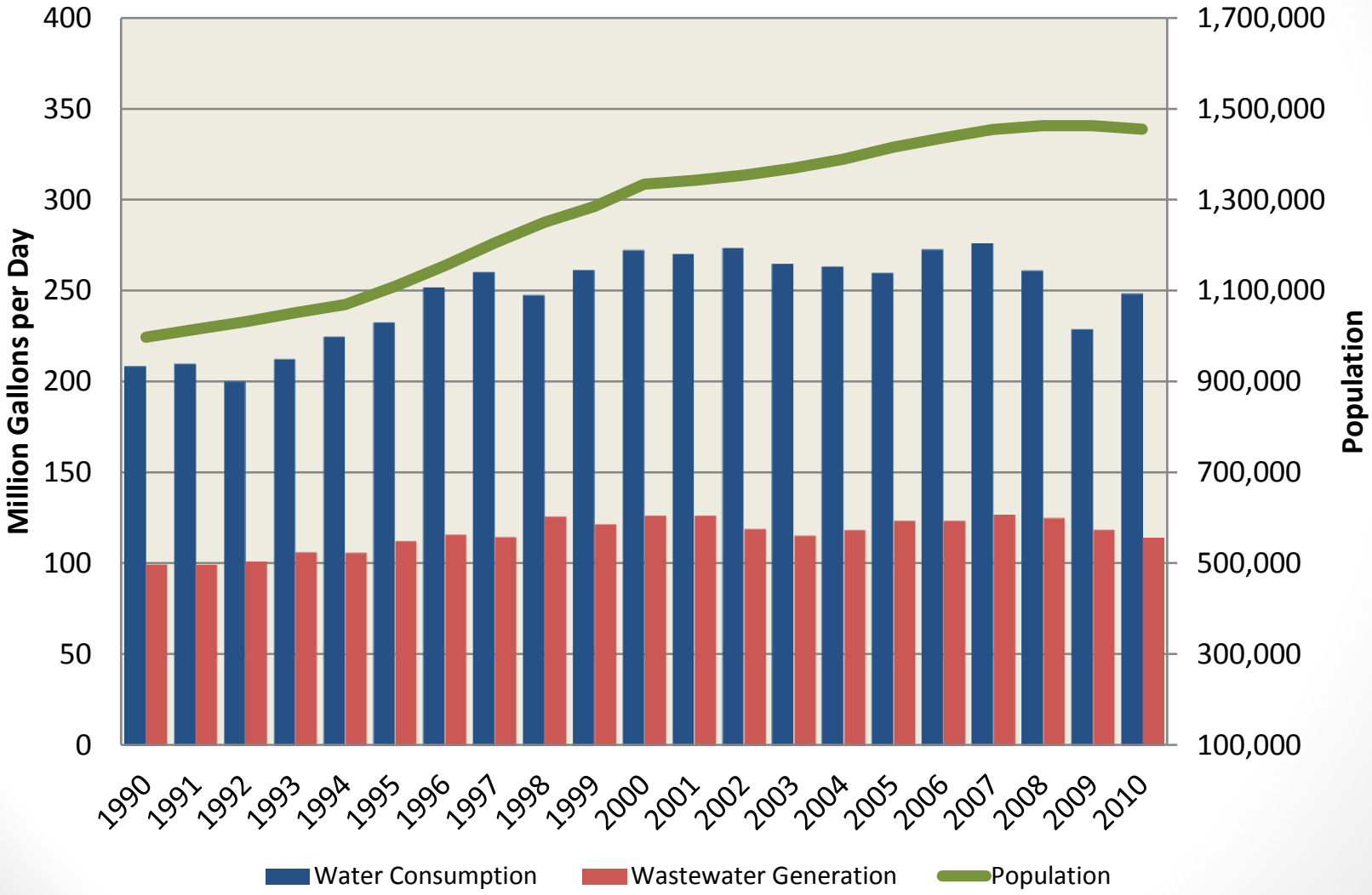
What We've Experienced

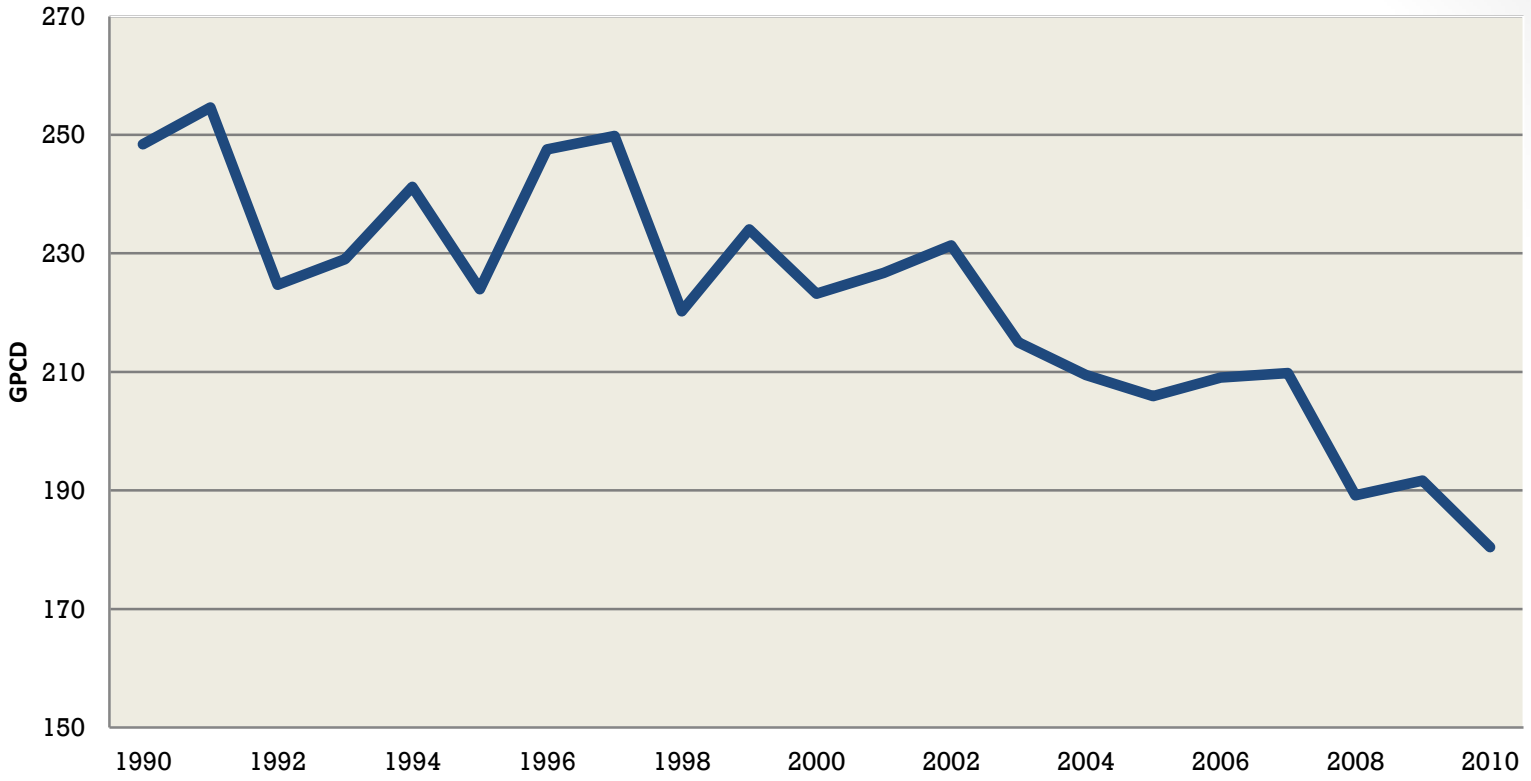
- Total water production remains stable even as growth occurs
- Volume to wastewater treatment plants stays about same even as growth occurs
- Lower water demand on a per capita basis for existing and especially new customers
- Very low flows in sewers and lift stations in new areas
- Increasing concerns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

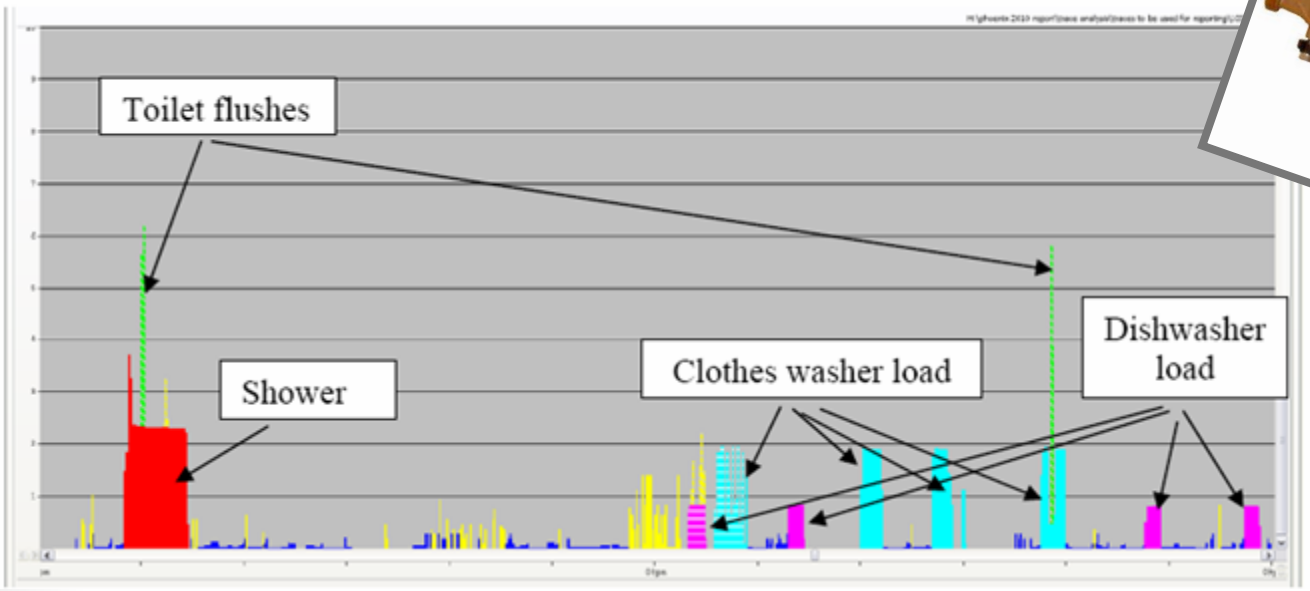
What We've Learned (1)

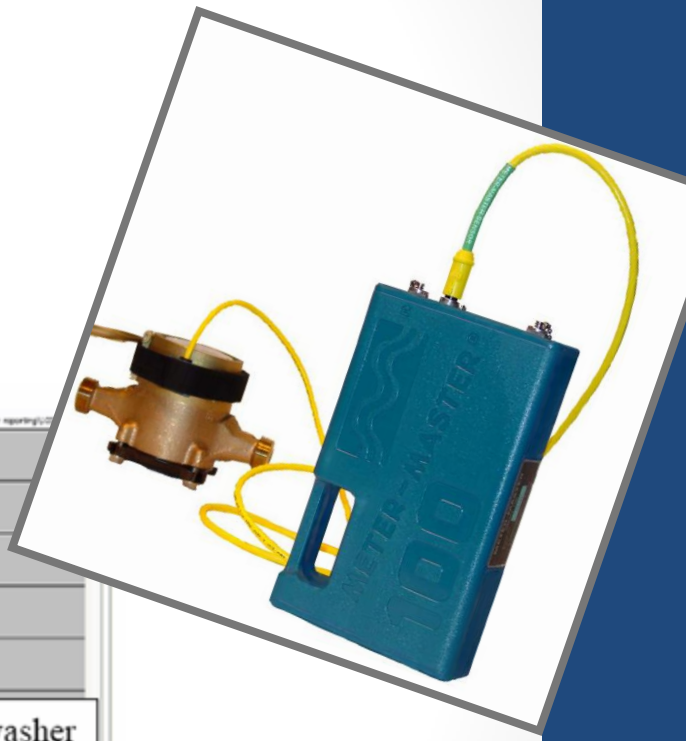
- Understanding water demand & wastewater generation like solving puzzle
- Estimating use requires multiple methods
- Methods have included or will include:
  - Quantitative analysis of City-wide meter data
  - Data-logging of individual homes
  - Site visits to homes & businesses (inventories)
  - Sewer metering
  - Landscaping coding & use of satellite imagery
  - Smart (short interval) meter data analysis

Individual Home Analysis

Data Logging

- Trace Analysis
- Discreet End-Use Information





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

Wastewater Metering/Data Collection

Small Diameter Wastewater Meter Site -Country Place-

Legend

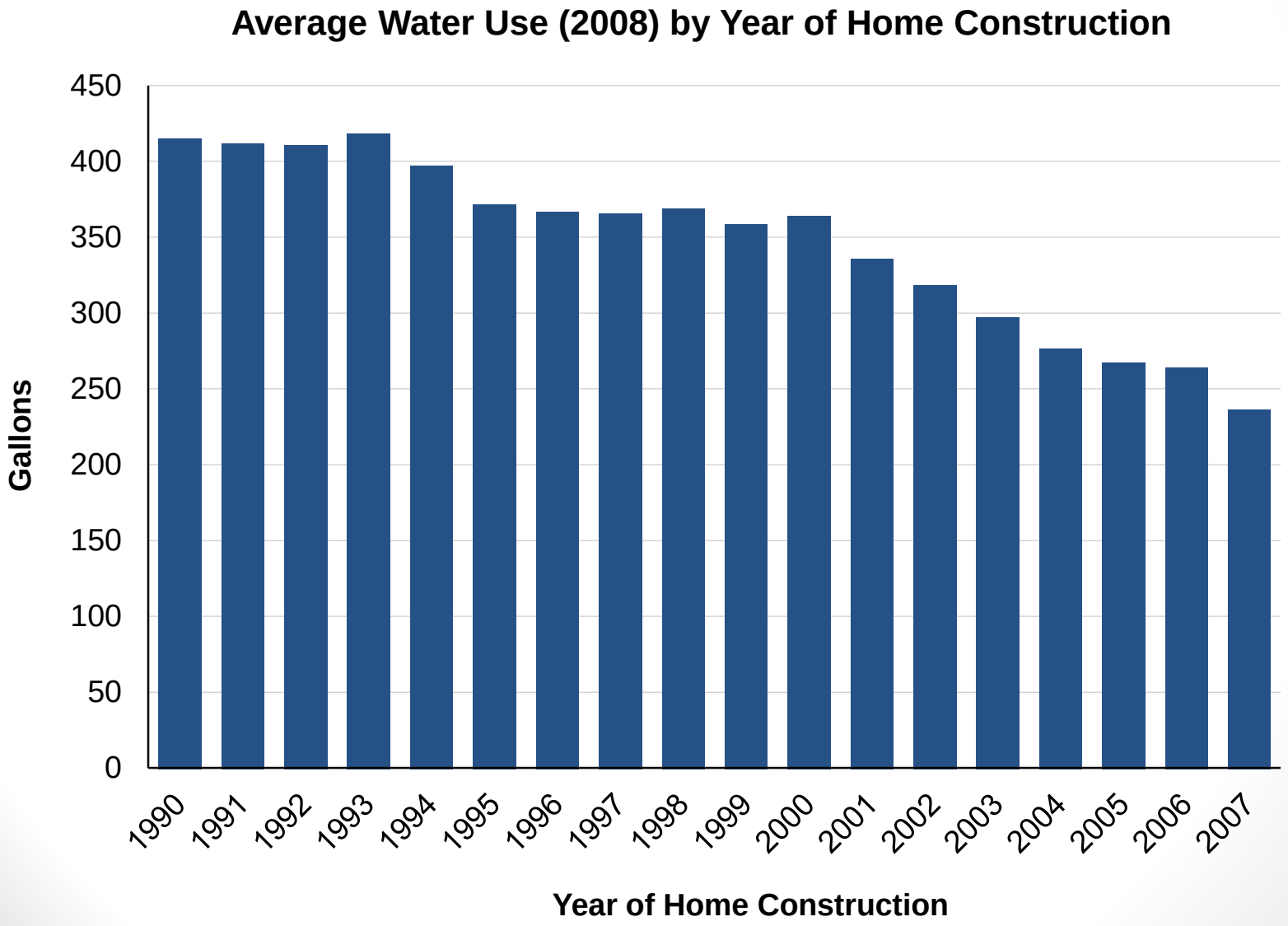
- Sewer Meter
- Drop Manhole
- Standard Manhole
- Sewer Clean Out
- Standard Main
- Sewer Main Outside Project Area
- Streets
- Vacant Parcels < 6 CCF
- QS Index

Country Place Project Area

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
- 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)

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%

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

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

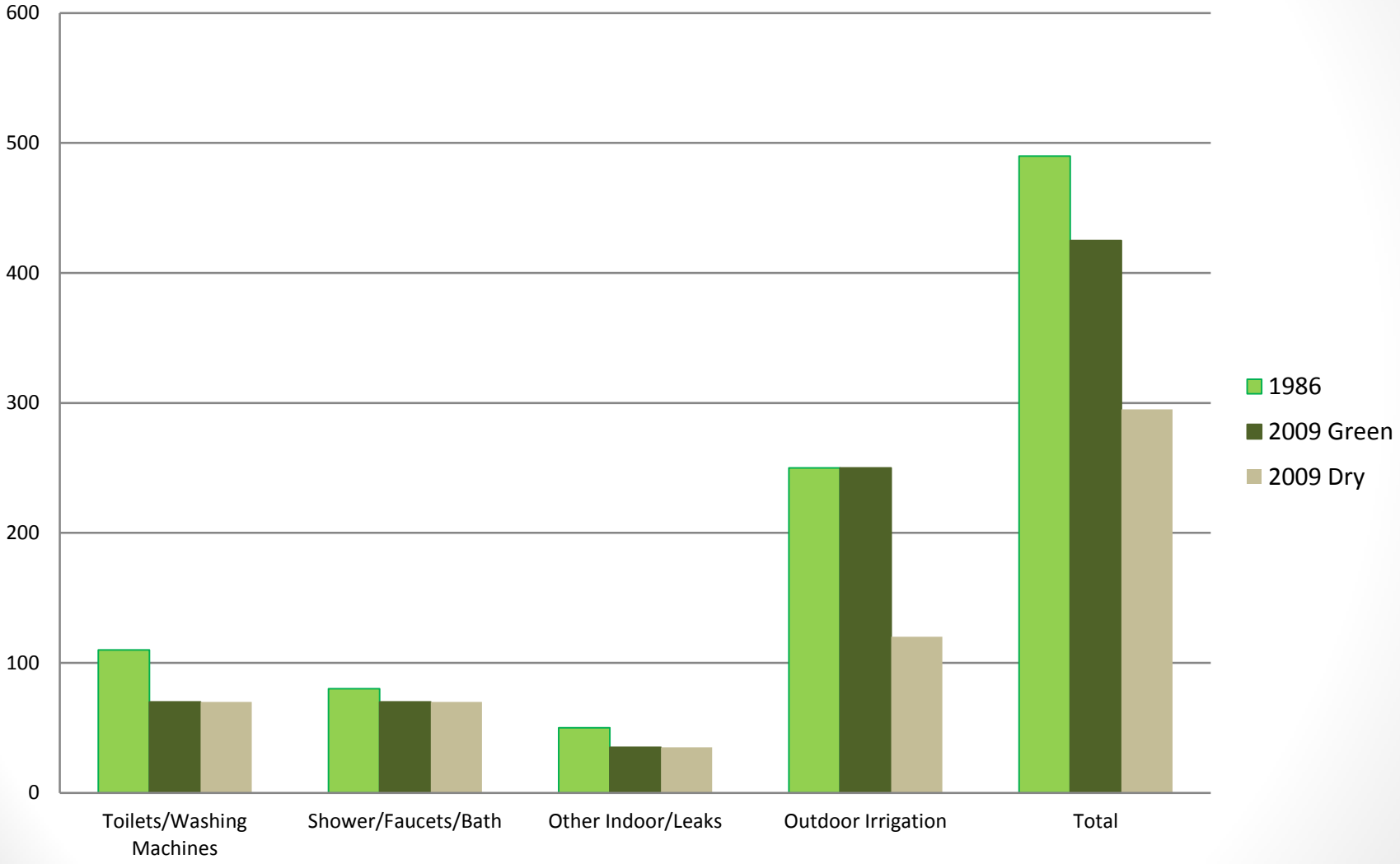
1. Data shown is mean daily use (gallons) except Leak data is median due to right-hand skew.

Revolution In Landscaping Characteristics

Old Model

New Model

Estimated Use by Ahwatukee SF Units Built in Late 70s & Early 80s (Average Annual Gallons Per Day)



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

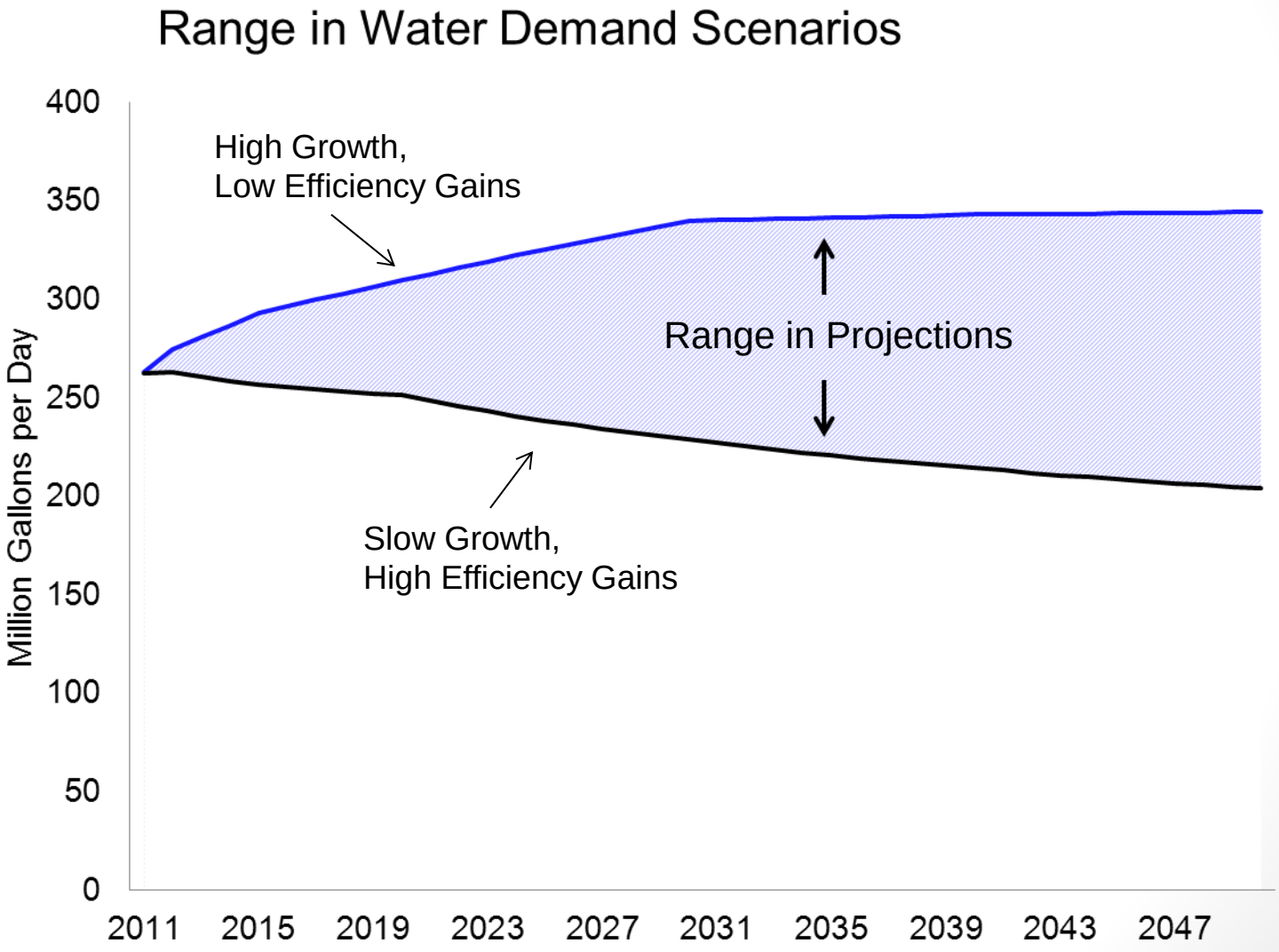
Other Indoor/Leaks = Evaporative Coolers, Water Softeners, Leaks and Unknown

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

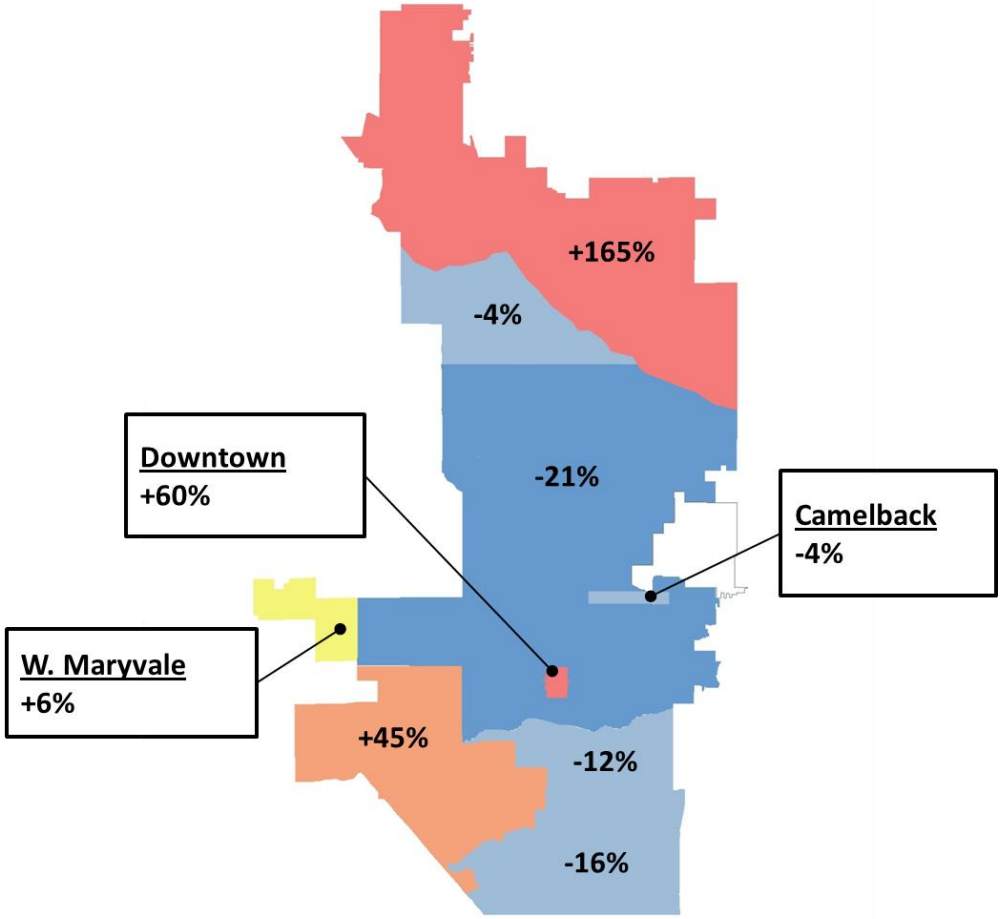
What We've Learned (4)

- Even with new population and economic growth, new customers may not be enough to offset demand reductions due to efficiency
- Regardless of growth rates increased efficiency will have big impacts on water demands
- Changing demands will have big impact on local & regional infrastructure sizing and on O&M, not just on water resource planning & finances
- Changing demand has important geographic element – overall demand likely to stay stable while some areas see fall and others see rise

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



Projected Change in Water Demand by Phoenix Area
Water Master Plan Medium Scenario - 2030



What We're Learning About Landscapes (1)

- Investigations began as effort to validate landscape assumptions in models – question was 'how prevalent is desert landscaping?'
- Initial work involved review of aerial images and simple spreadsheet tallies
- Early work began to reveal numerous opportunities for further analysis
- Project now underway involves interns using new GIS program and guide to code thousands of SF residential landscapes

Example of ‘turf’ in front and back.

Example of ‘extensive plant coverage’ front and back, 45’ angle and aerial.

Example of front and back ‘moderate plant coverage’.

Example of front and back ‘sparse plant coverage’ aerial.

Example of ‘arid’ front and back.

Examples of homes with pools.

Landscape Classification Project - Code Definitions

Lot Configuration Classification

Code	Description
1	Standard
2	Pie Slice
3	Corner
4	Irregullar
5	Extended Backyard
6	Extended Frontyard
7	Ranch/Farm

Landscape Classification

Code	Description
1	Turf
2	Extensive Plant Coverage
3	Moderate Plant Coverage
4	Sparse Plant Coverage
5	Arid
6	Transition

Landscape Class Supplement

Code	Description
1	Well Defined
2	Could be Wetter
3	Could be Dryer
4	Compromise
5	Could be 2 or 4
6	Could be 1 or 6
7	Difficult to Code

Pool Classification

Code	Description
0	None
1	Full
2	Empty
3	Filled In
4	Small Pool Or Large Water Feature
5	Above Ground

Questionable Classification

Code	Description
0	No
1	Yes

Turf Coverage Classification

Code	Description
0	No Turf
1	10% Turf
2	20% Turf
3	30% Turf
4	40% Turf
5	50% Turf
6	60% Turf
7	70% Turf
8	80% Turf
9	90% Turf
10	Transition

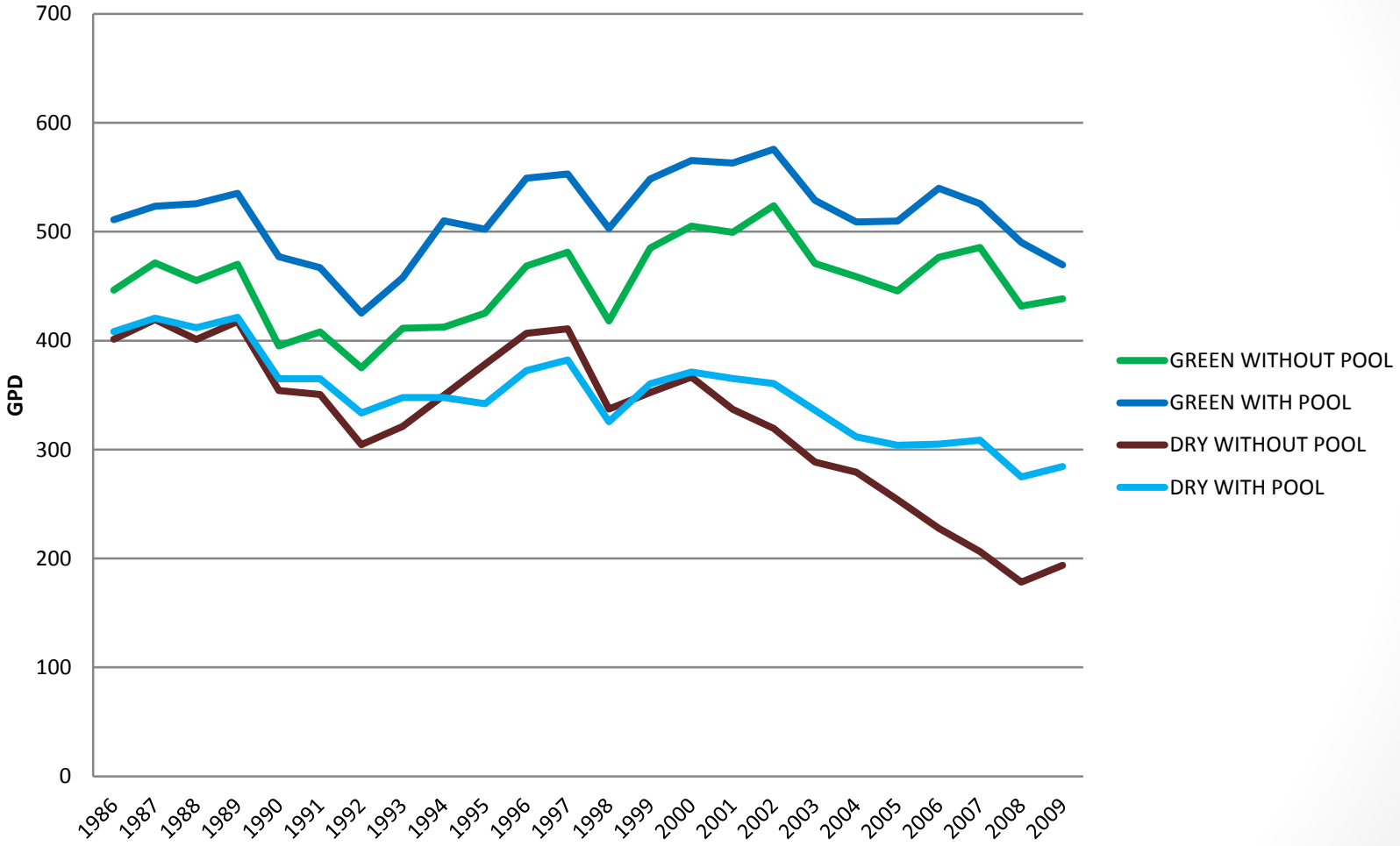
Turf Classification Supplement

Code	Description
1	High Quality Turf
2	Medium Quality Turf
3	Low Quality or Dying Turf
4	Dormant Turf

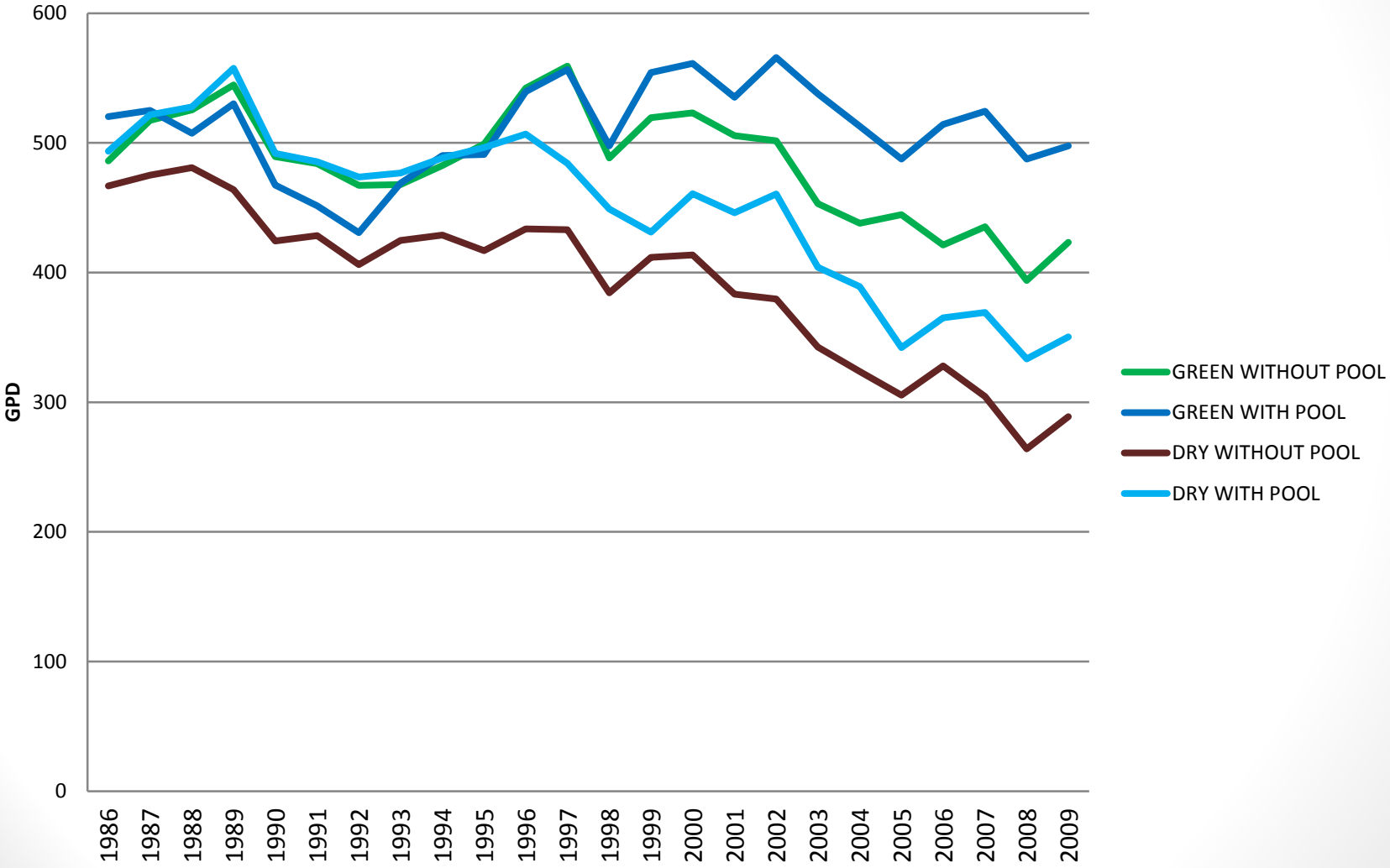
Analyst

CODE	NAME
1	Adam Miller
2	Alec Mostov
3	Cory Deleon
4	Dale McKendrick
5	Darius Zolnierczyk
6	Doug Frost
7	Tianna Saucedo
8	Amanda Lam
9	Kenneth Wannemacher
10	Marek Lubomirski
11	Andrew Deemer
12	Brad Bohail
13	Chris Floyd
14	Daniel Tilley
15	Madison Pike
16	Navid Tavalaei
17	Heidi Wang
18	Elly Wang
19	Joe Hennessy

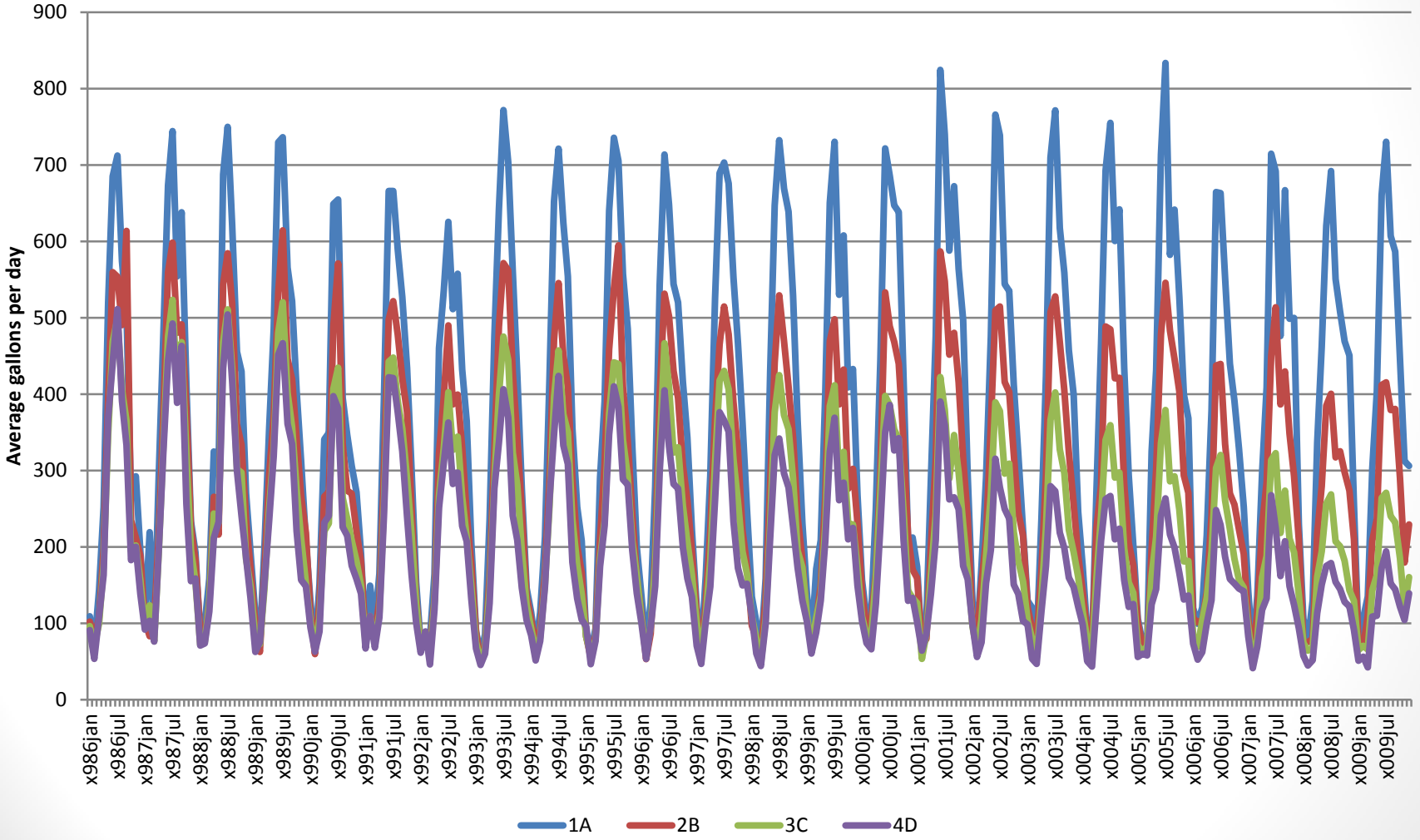
Early Sample – Late 60s and Early 70s SF Units in 32nd St Sample Standardized to 9,000 Sq.Ft. Lot (Annual Average GPD)



Early Sample – Late 70s and Early 80s Ahwatukee Sample SF Units Standardized to 9,000 Sq.Ft. Lot (Annual Average GPD)



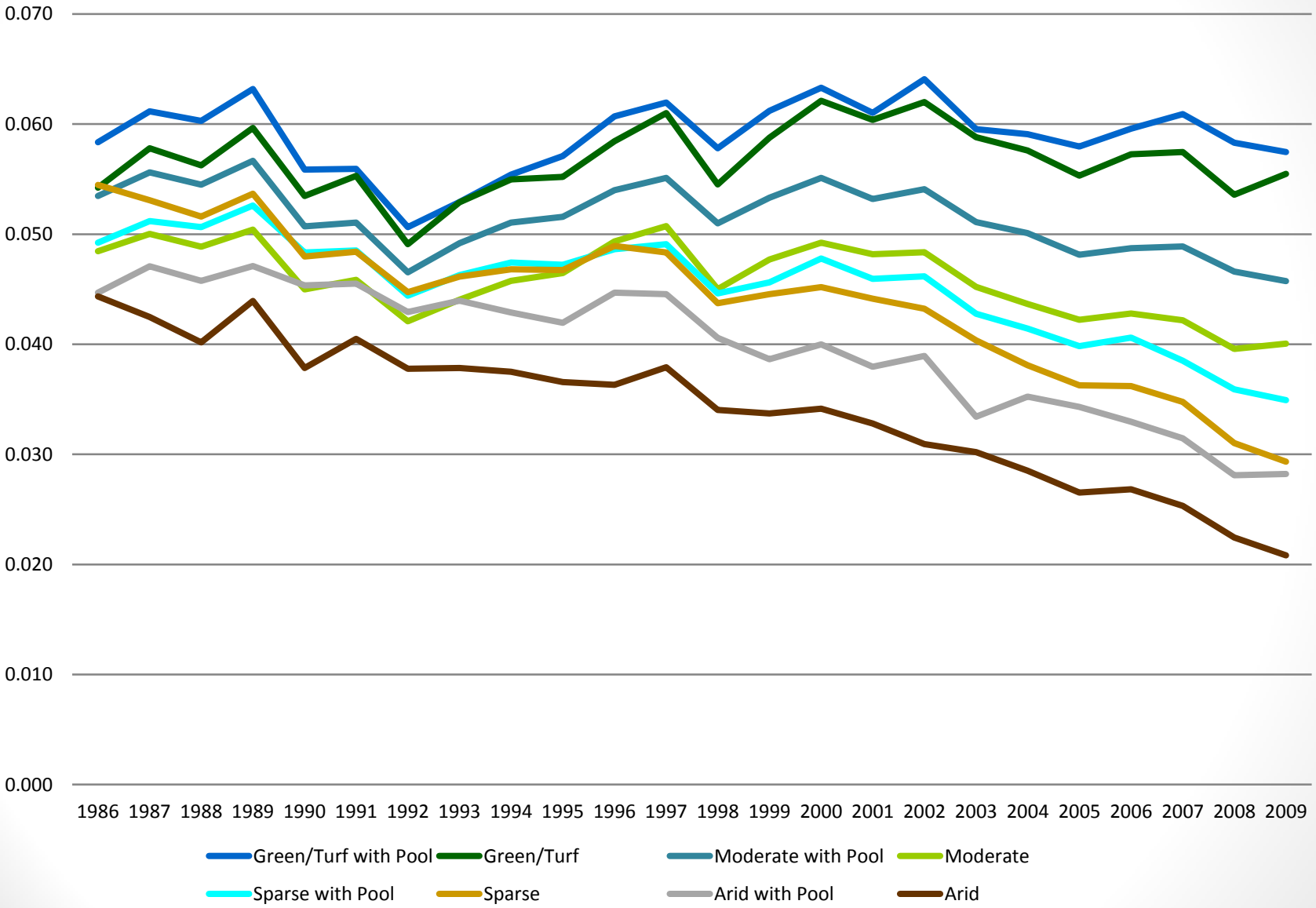
Early Sample - Outdoor Water Use By Yard Type Over Time By Category of Landscape (1A = Turf in Front & Back, 4D = Desert Front & Back)



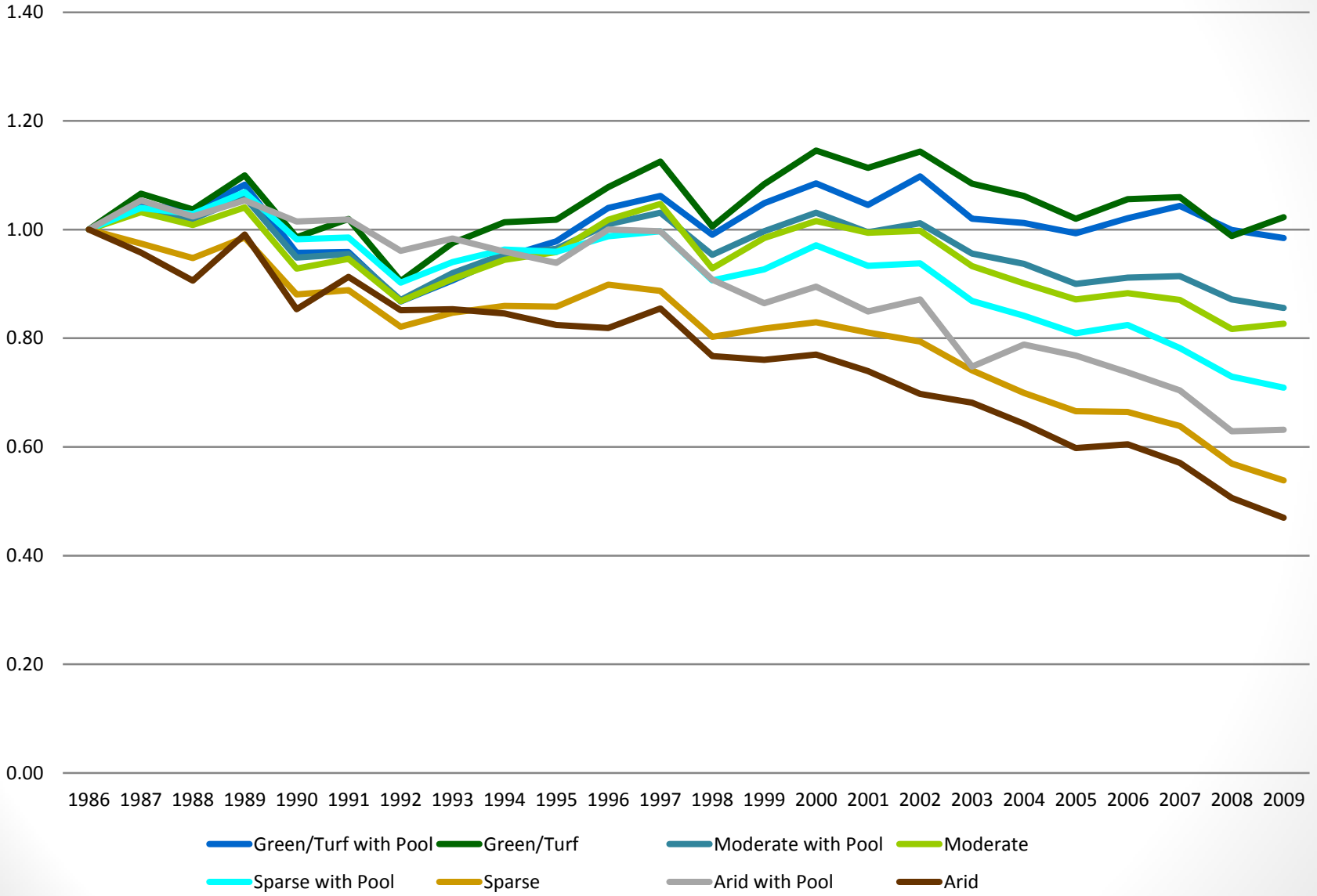
What We're Learning About Landscapes (2)

- Green/turf homes use about as much water as they did in 1986 (some indoor reductions)
- Insofar as rates affect outdoor use, impact appears to be one time/one way
- Reductions in outdoor use have come from other groups
- Summer peaking for dry parcels much lower
- Sample shows transition to desert landscapes well under way – less than one in five are 'turf' or 'extensive plant coverage'

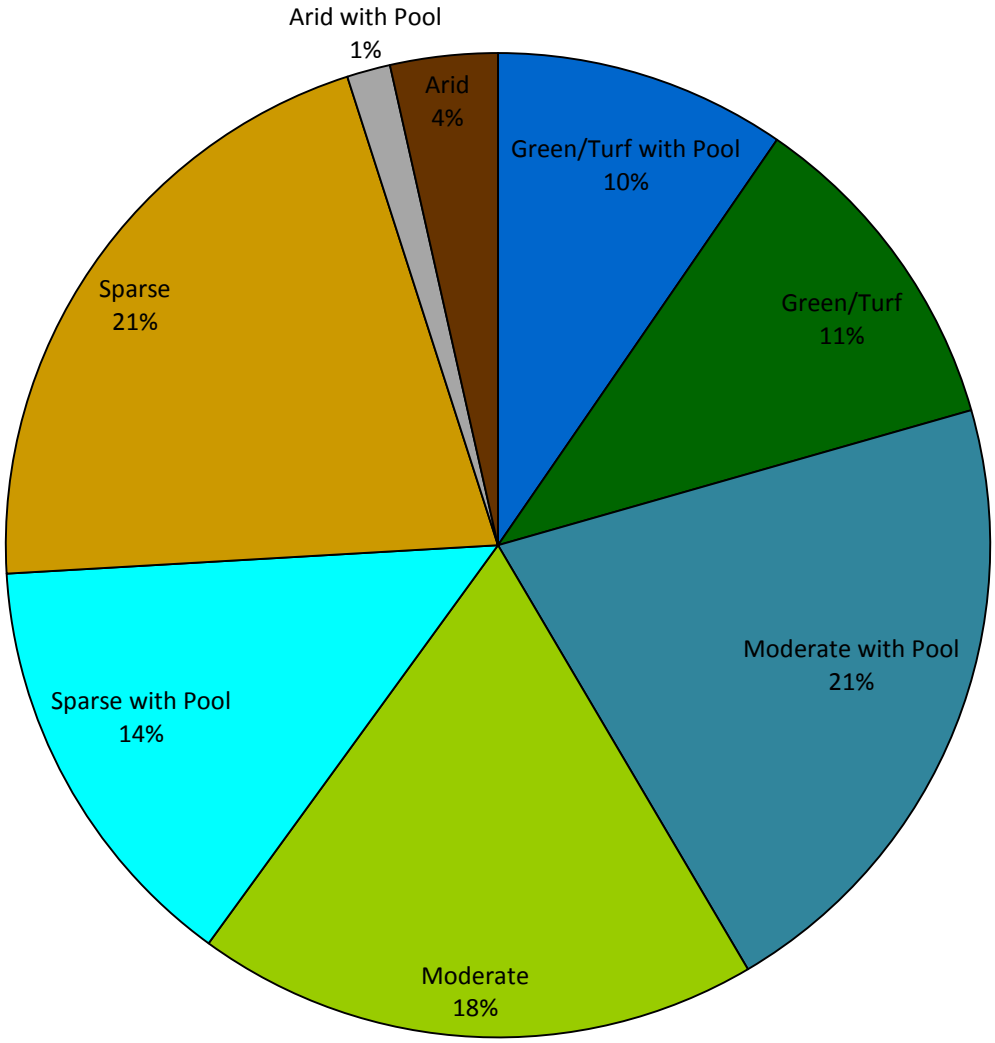
Summer 2012 Sample - SF Unit Avg Annual Use Per Sq. Ft. By Current Landscape Type (Less Than 16, 000 Sq. Ft.)



Summer 2012 Sample - SF (Less Than 16,000 Sq. Ft. Parcels) Average Annual Daily Use By Landscape Type, 1986 = 1

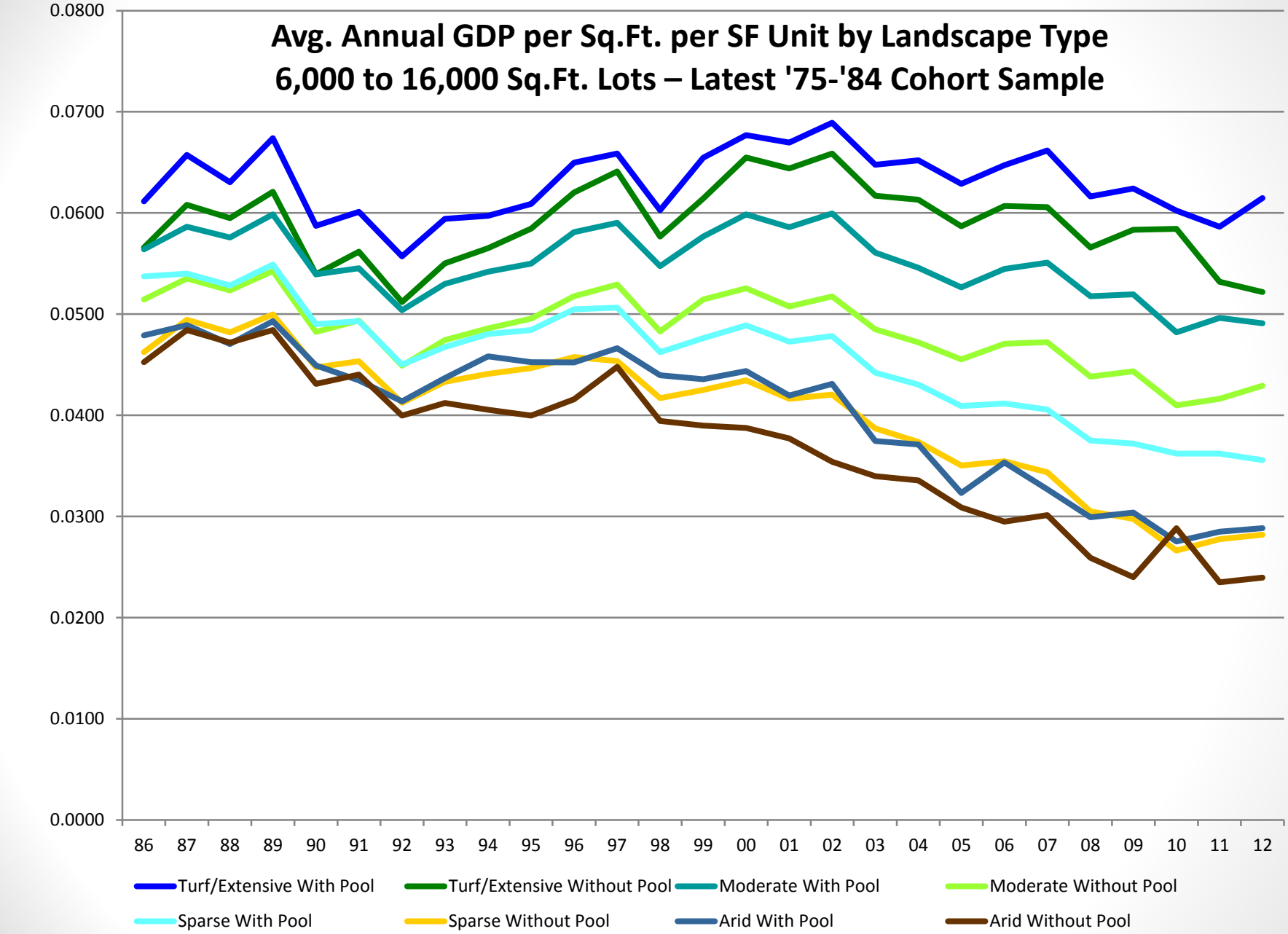


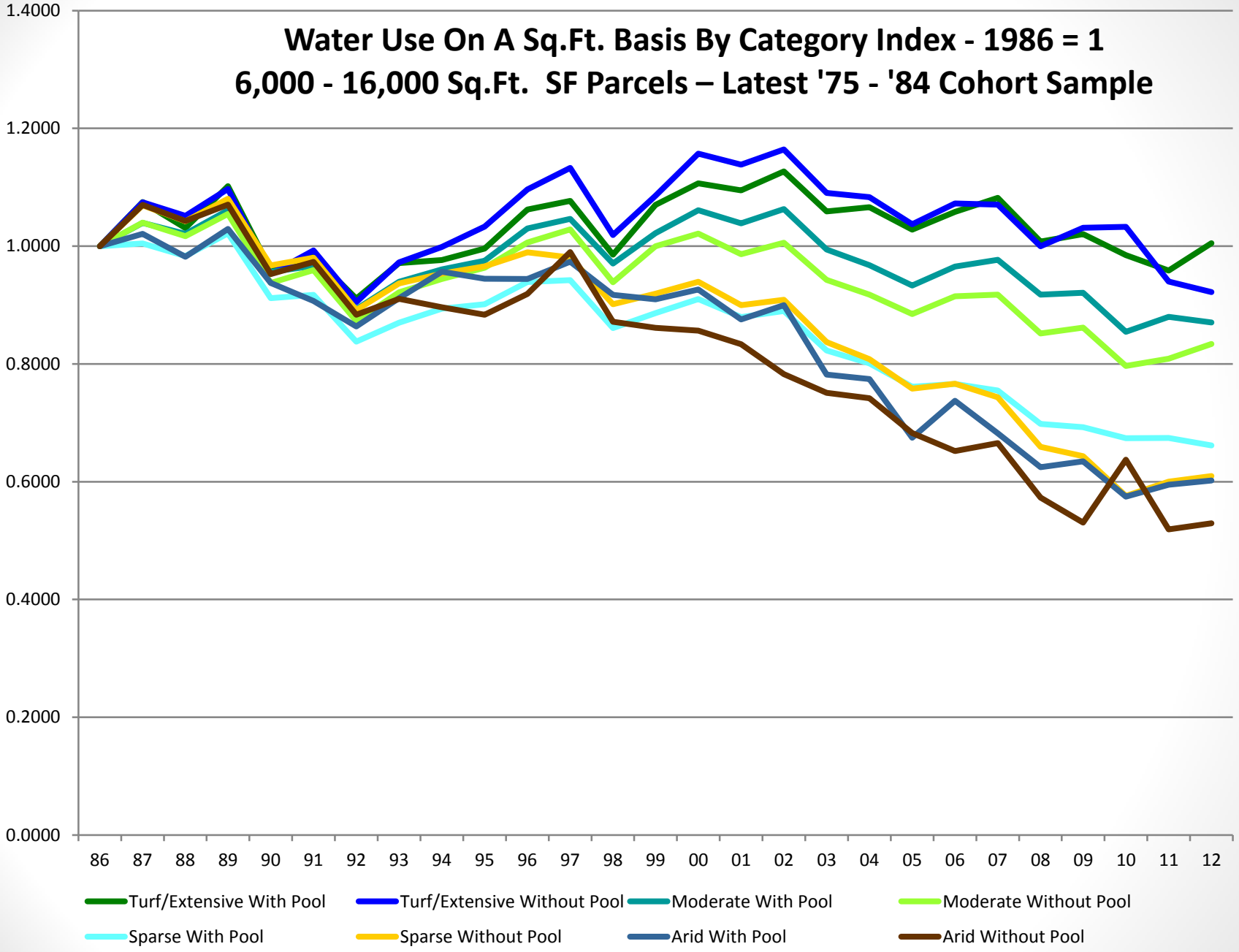
Summer 2012 Sample - SF Units Less Than 16,000 Sq. Ft. Parcel Size By Landscape Type (86-09 Use Records)



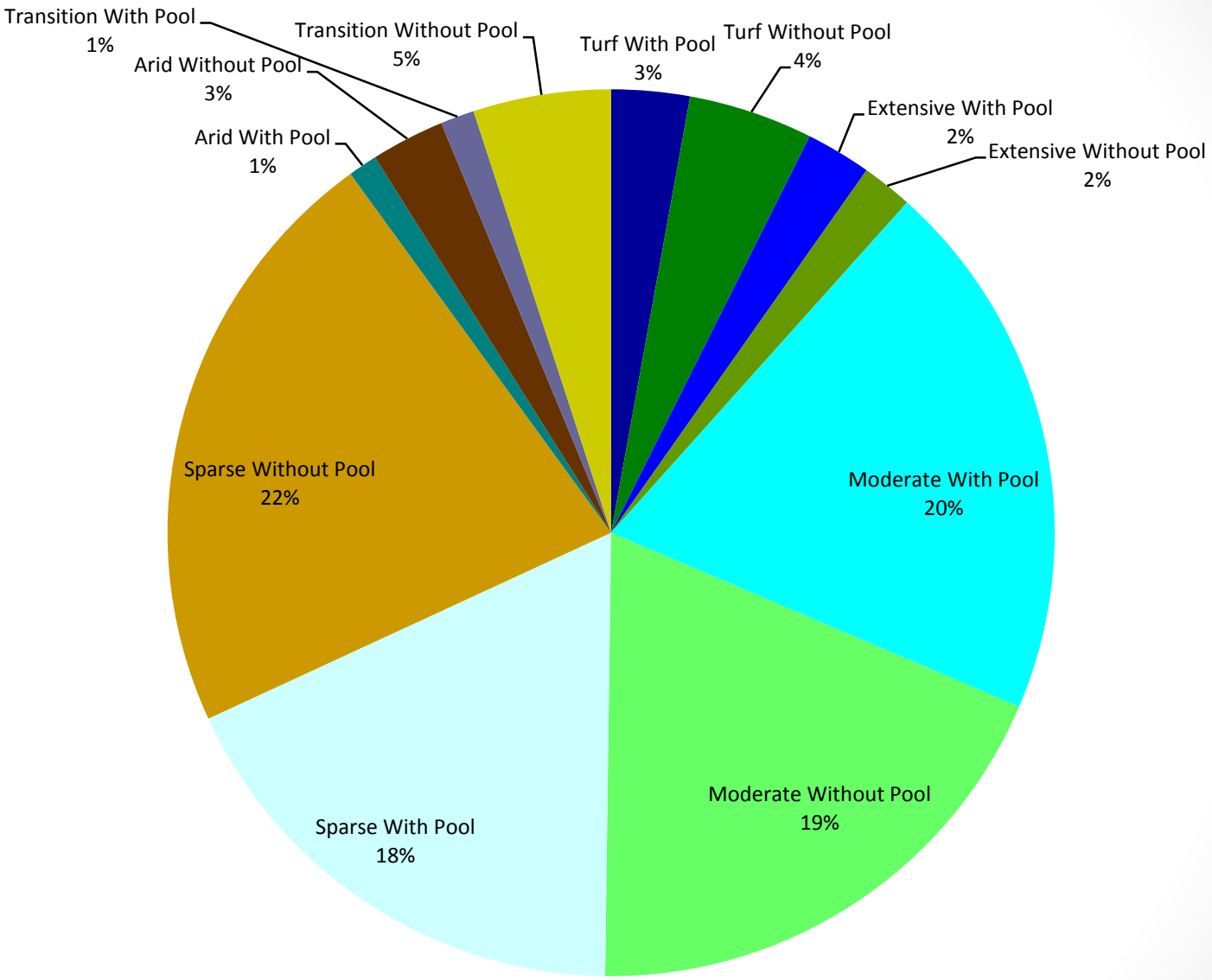
What We're Learning About Landscapes (3)

- Water use by moderate landscape homes has declined significantly since '86
- Water use by sparse and arid landscape homes has dropped dramatically since '86
- As expected homes with pools use considerably more water on average
- Almost equal breakdown between those with or without pools in green/turf, moderate and sparse categories


Avg. Annual GDP per Sq.Ft. per SF Unit by Landscape Type
6,000 to 16,000 Sq.Ft. Lots – Latest '75-'84 Cohort Sample
0.0800
0.0700
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12
Turf/Extensive With Pool
Turf/Extensive Without Pool
Moderate With Pool
Moderate Without Pool
Sparse With Pool
Sparse Without Pool
Arid With Pool
Arid Without Pool

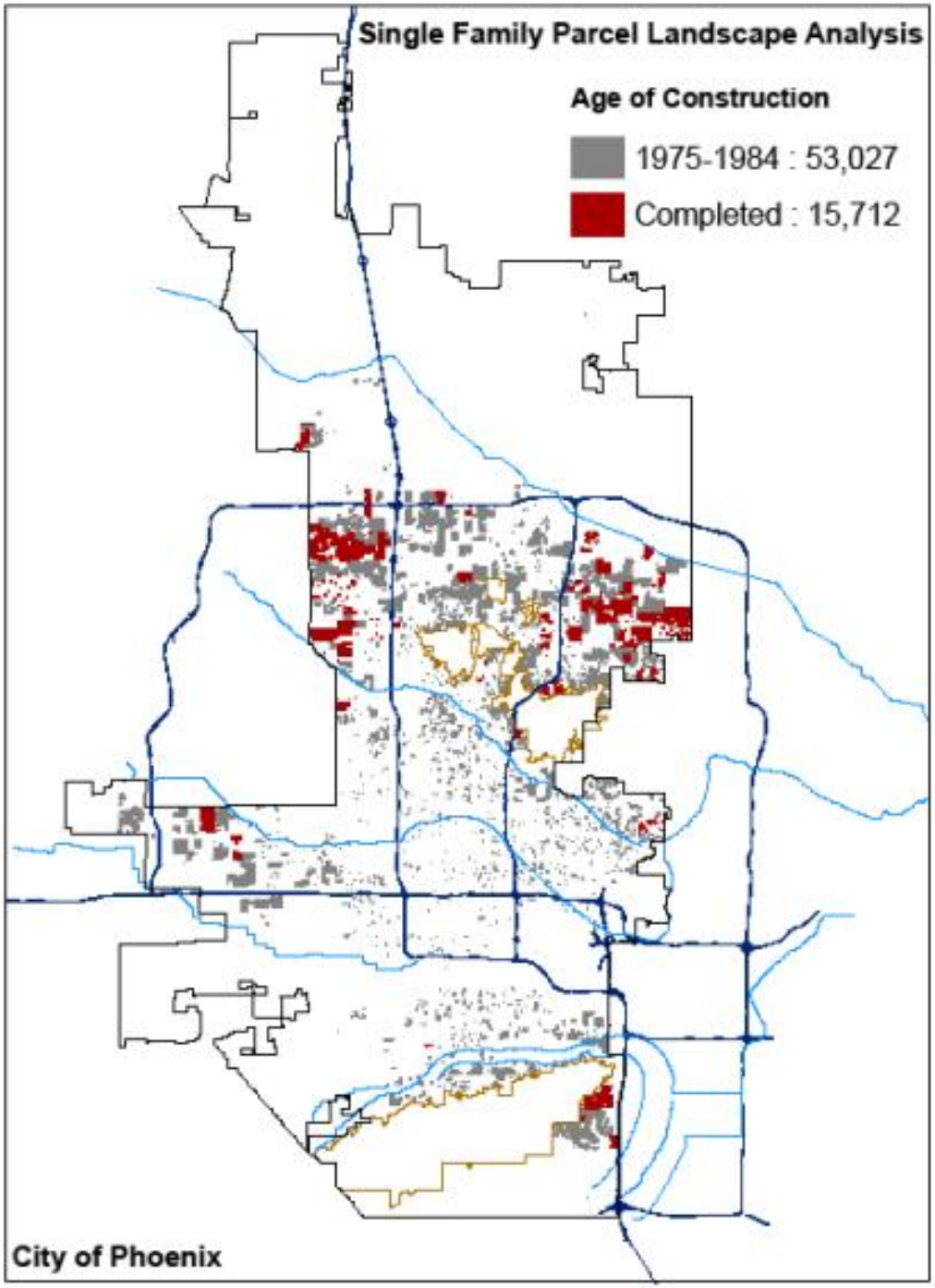

Water Use On A Sq.Ft. Basis By Category Index - 1986 = 1
6,000 - 16,000 Sq.Ft. SF Parcels – Latest '75 - '84 Cohort Sample
1.4000
1.2000
1.0000
0.8000
0.6000
0.4000
0.2000
0.0000
86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12
Turf/Extensive With Pool
Turf/Extensive Without Pool
Moderate With Pool
Moderate Without Pool
Sparse With Pool
Sparse Without Pool
Arid With Pool
Arid Without Pool

Breakdown of '75 to '84 Single Family Sample By Landscape Type

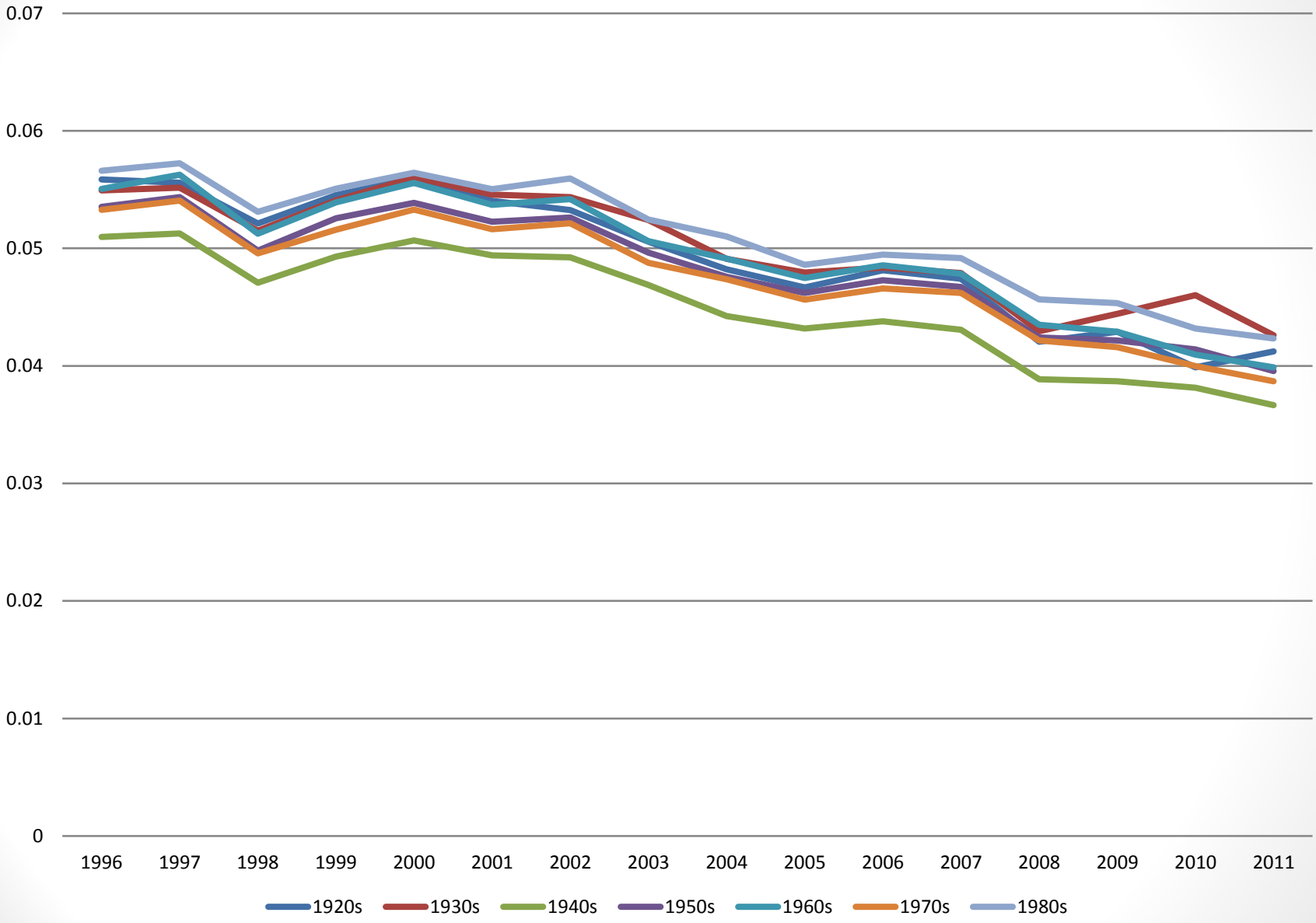


What We're Learning About Landscapes (4)

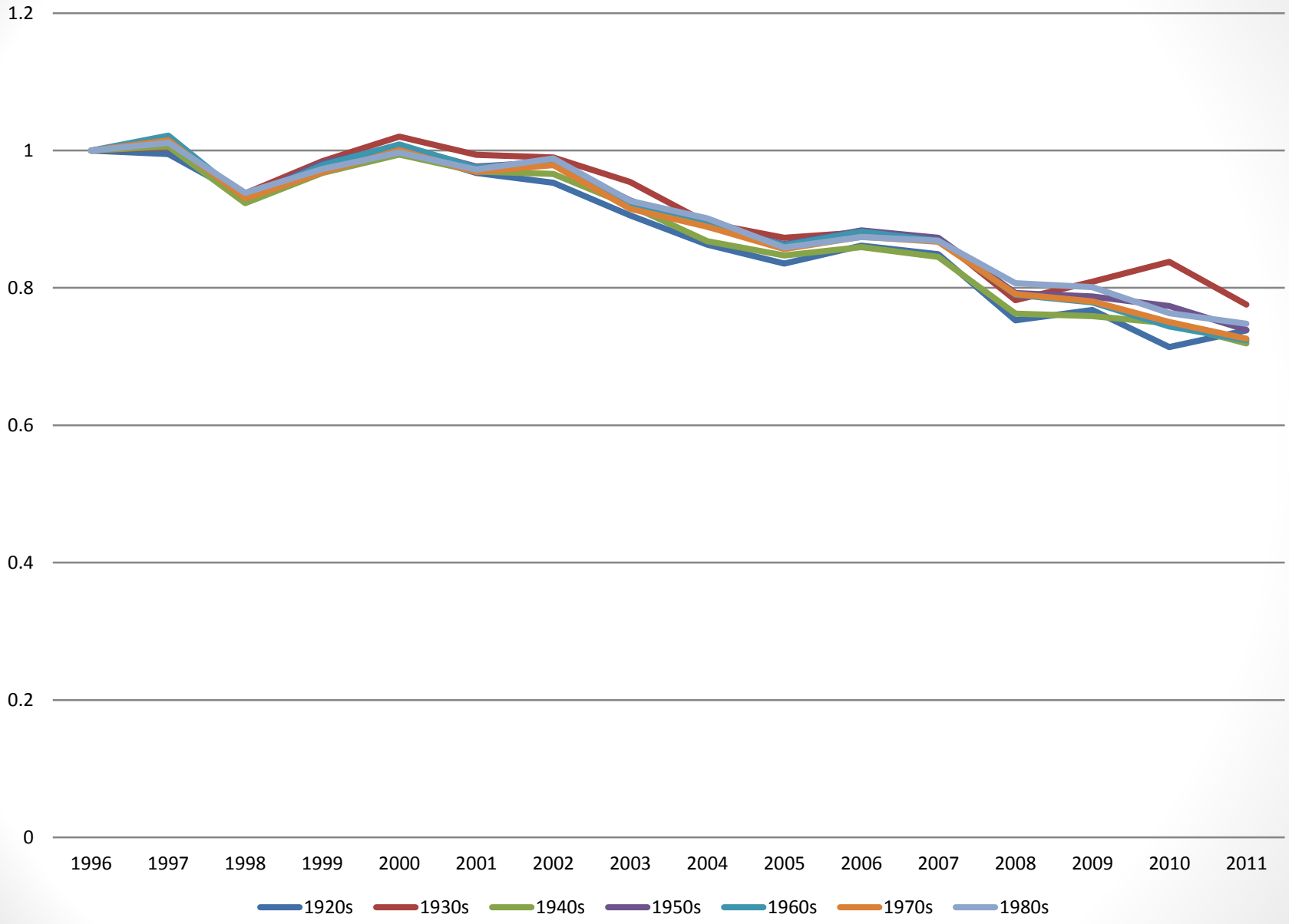
- Key issue is how representative is this sample of '75 to '84 age cohort?
- Key issue is how representative is '75 to '84 of all pre-1995 age cohorts?
- How well do these numbers compare with model numbers used in the master plan exercise?
- What happens when water use numbers are used to estimate what landscapes used to be?


Single Family Parcel Landscape Analysis
Age of Construction
1975-1984 : 53,027
Completed : 15,712
City of Phoenix

Water Use Per Sq. Ft. Parcel By Decade of Construction



GPD Annual Per Sq. Ft. By Age Cohort



Per Square Foot Water Use By SF Units In 1986 And 2009 (GPD Annual Average)

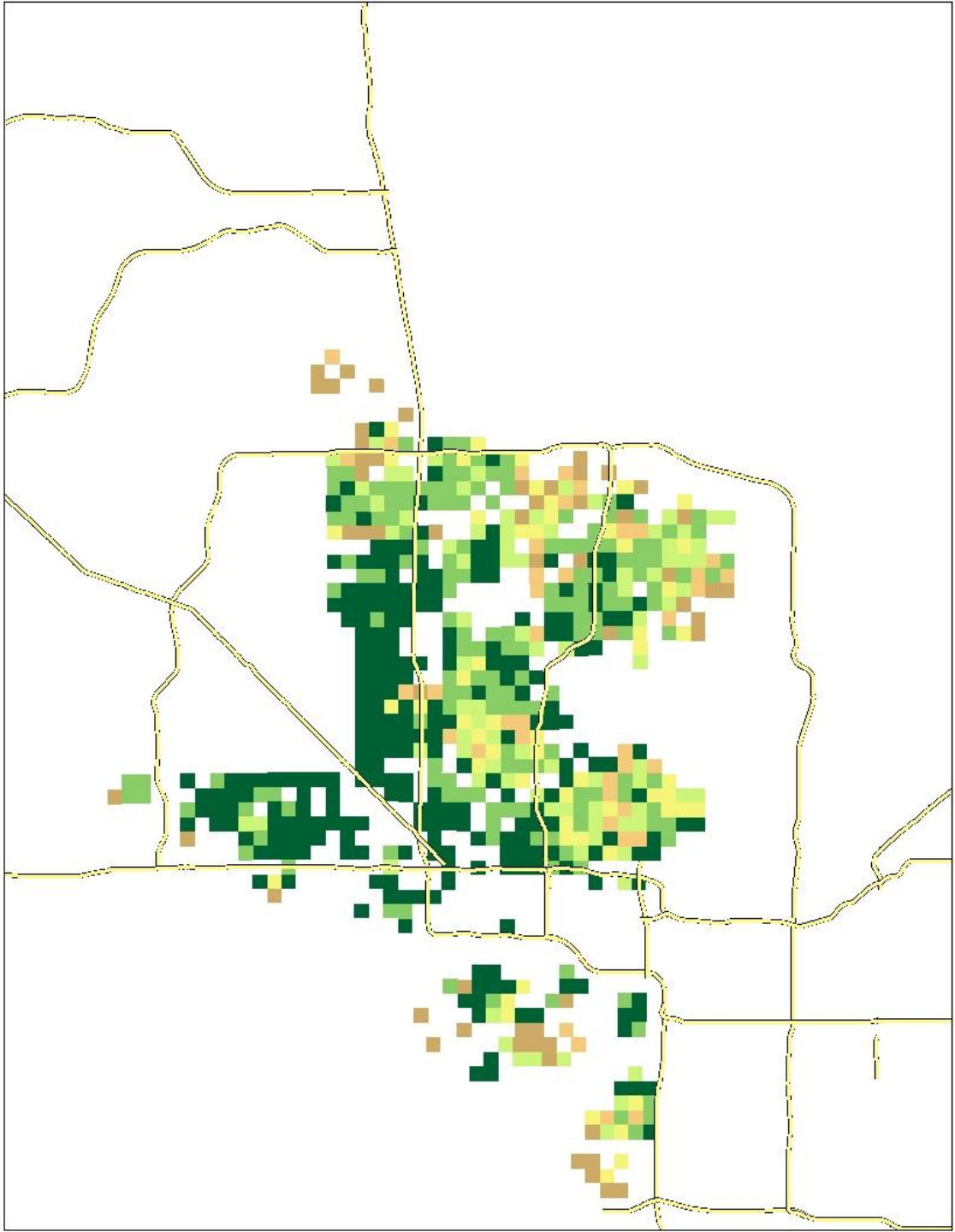
75-84 cohort in 1986	75-84 cohort in 2009
Intern sample: 0.0512	Intern sample: 0.0394
Actual cohort: 0.0517	Actual cohort: 0.0415
WSD model: 0.0498	WSD model: 0.0383

What We're Learning About Landscapes (5)

- The summer intern sample appears to closely resemble overall '75 to '84 cohort
- '75 to '84 cohort appears to be following almost identical trends to other cohorts
- The WSD model numbers are very close to sample numbers both for '86 and '09
- Using water use to estimate landscape (reverse engineering) appears to work well for green/turf and arid, not so well for sparse

Average Single Family Water Use per FT^2 By Quarter Section

1986

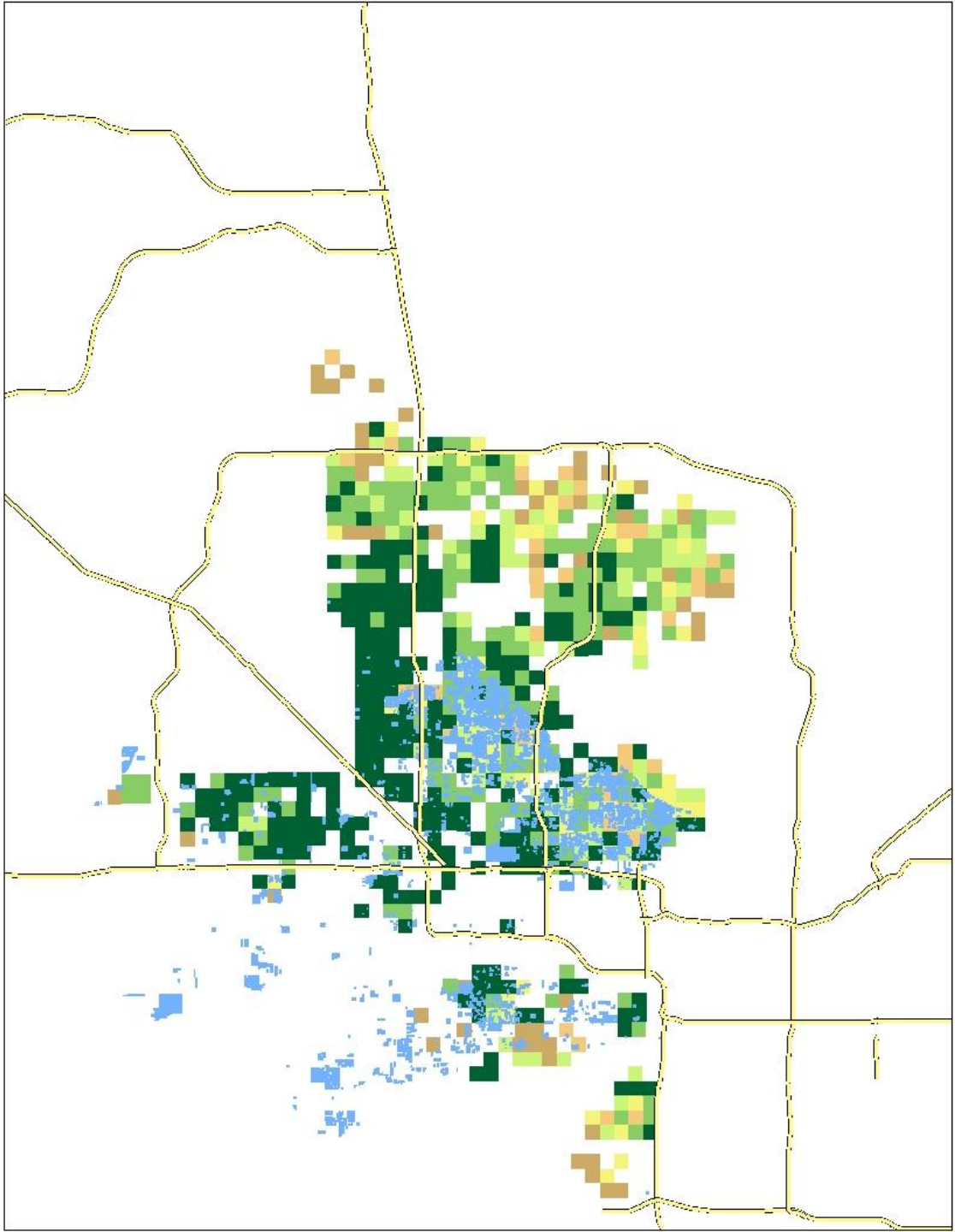


Low Use

High Use

Average Single Family Water Use per FT^2 By Quarter Section

1986

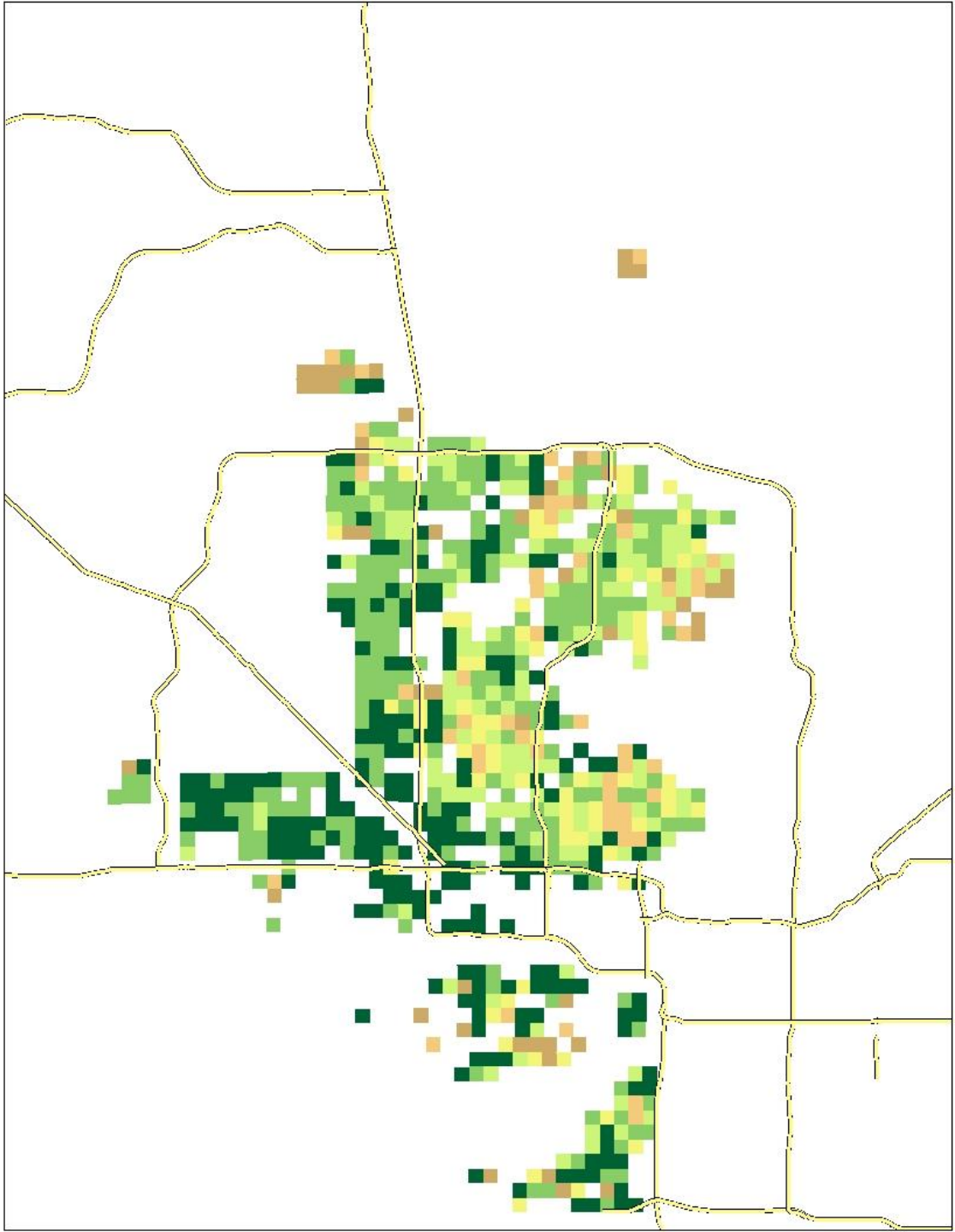


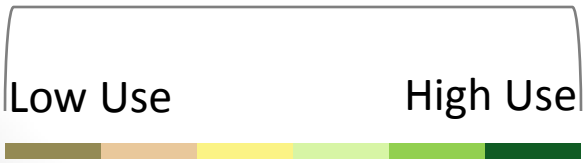
Parcels w/ Flood Irrigation

Low Use — High Use

Average Single Family Water Use per FT^2 By Quarter Section

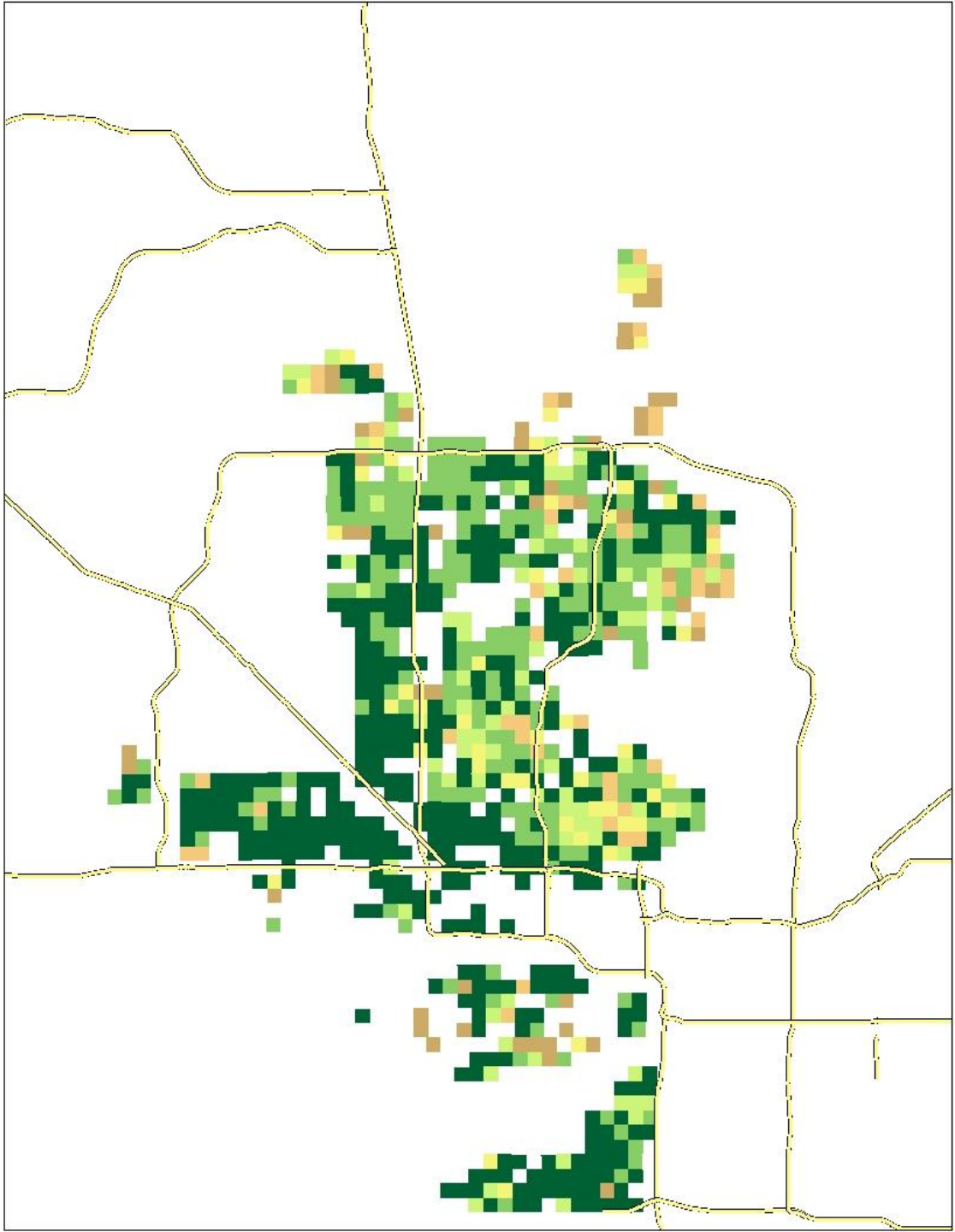
1990

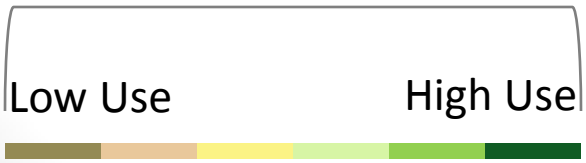




Average Single Family Water Use per FT^2 By Quarter Section

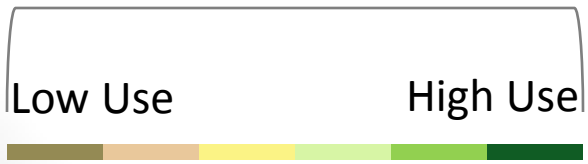
1996

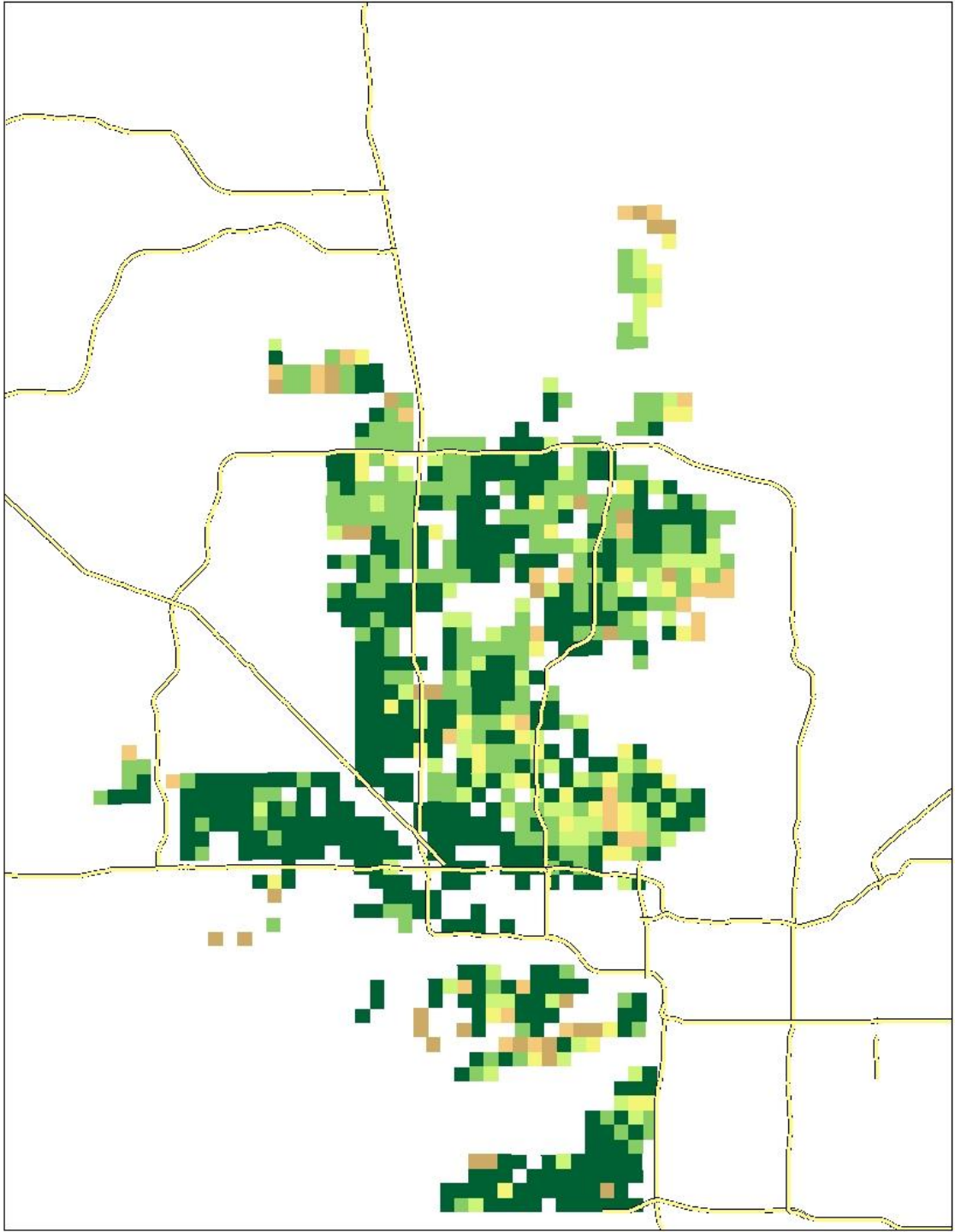




Average Single Family Water Use per FT^2 By Quarter Section

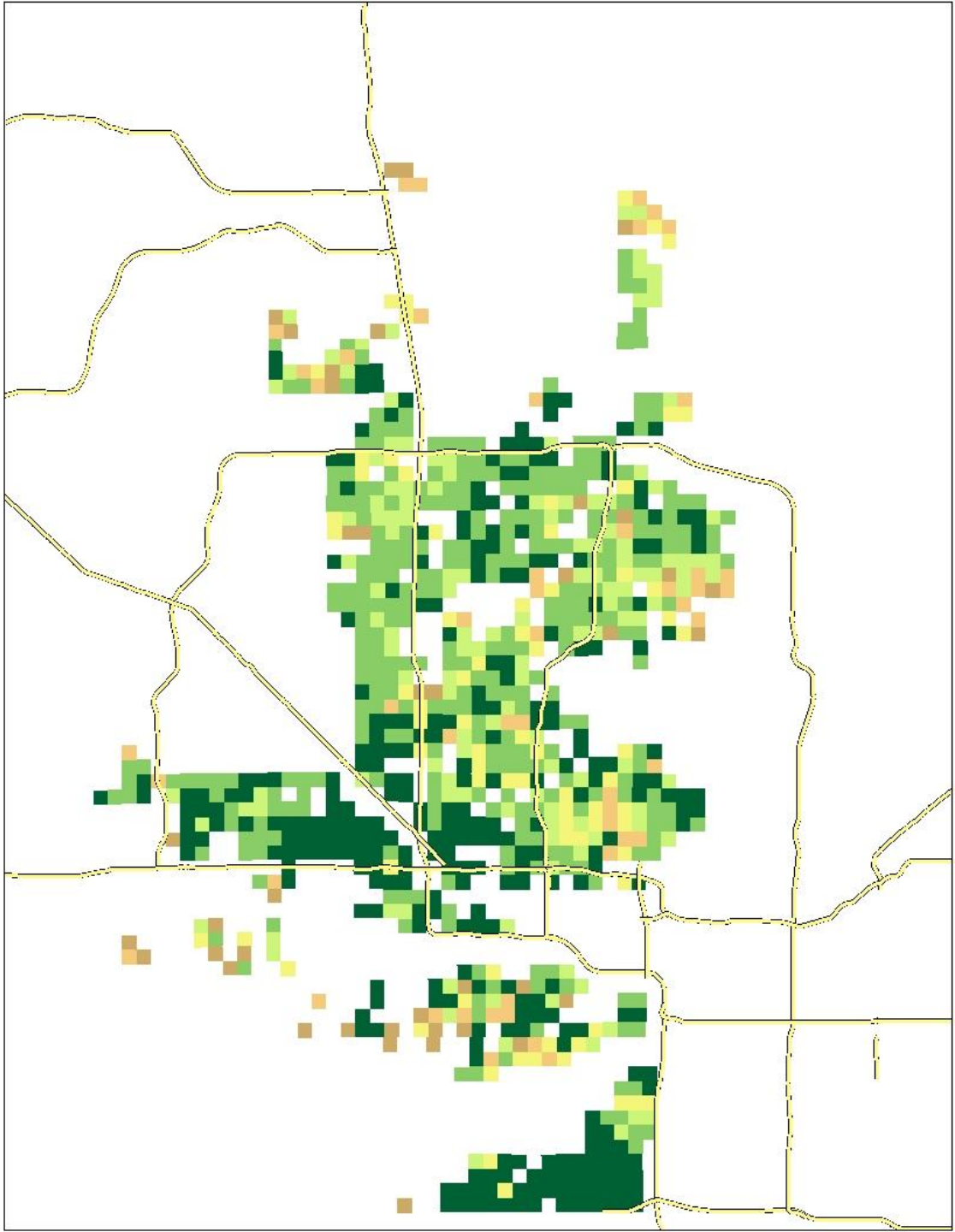
2000

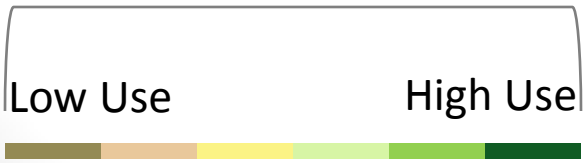




Average Single Family Water Use per FT^2 By Quarter Section

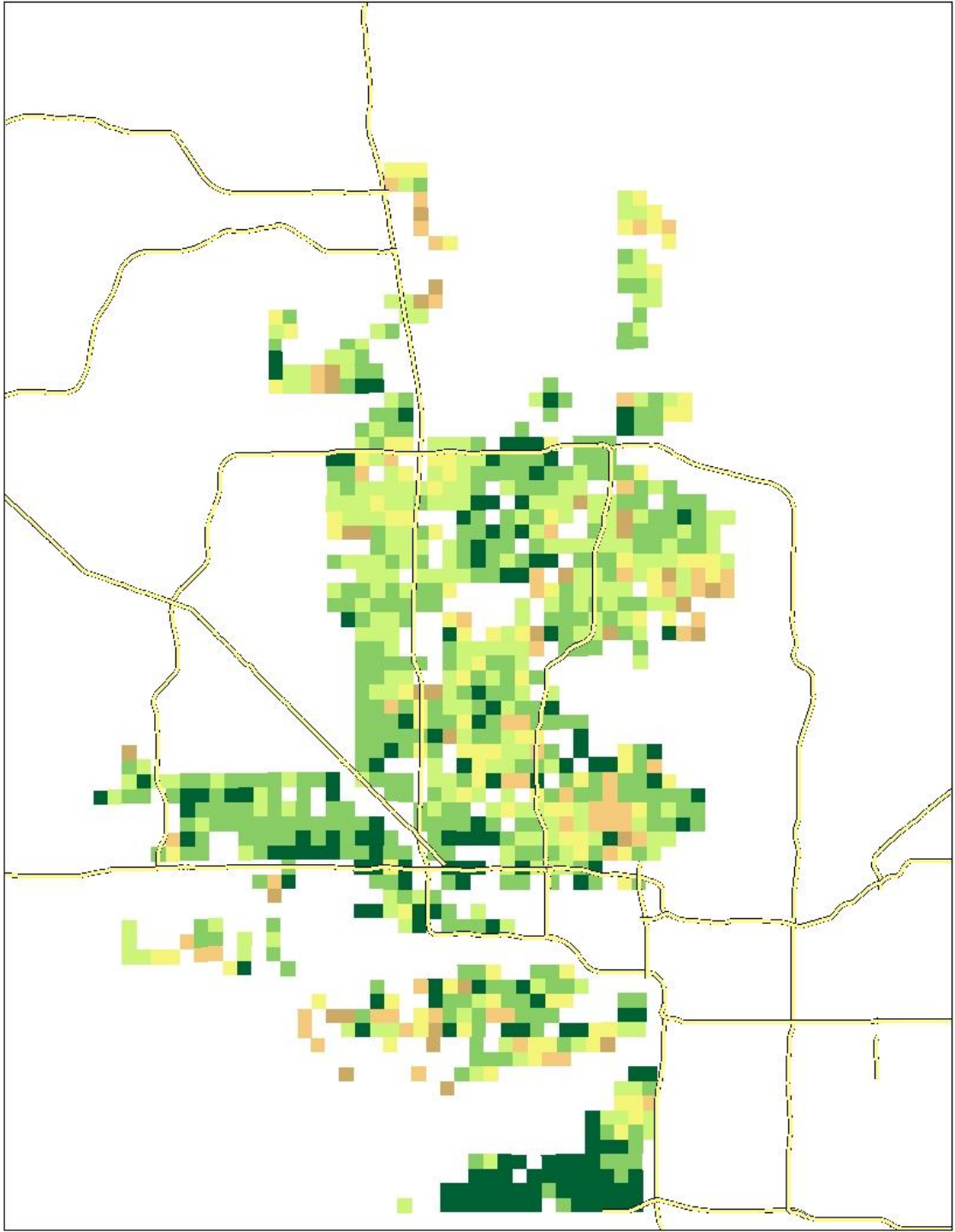
2003





Average Single Family Water Use per FT^2 By Quarter Section

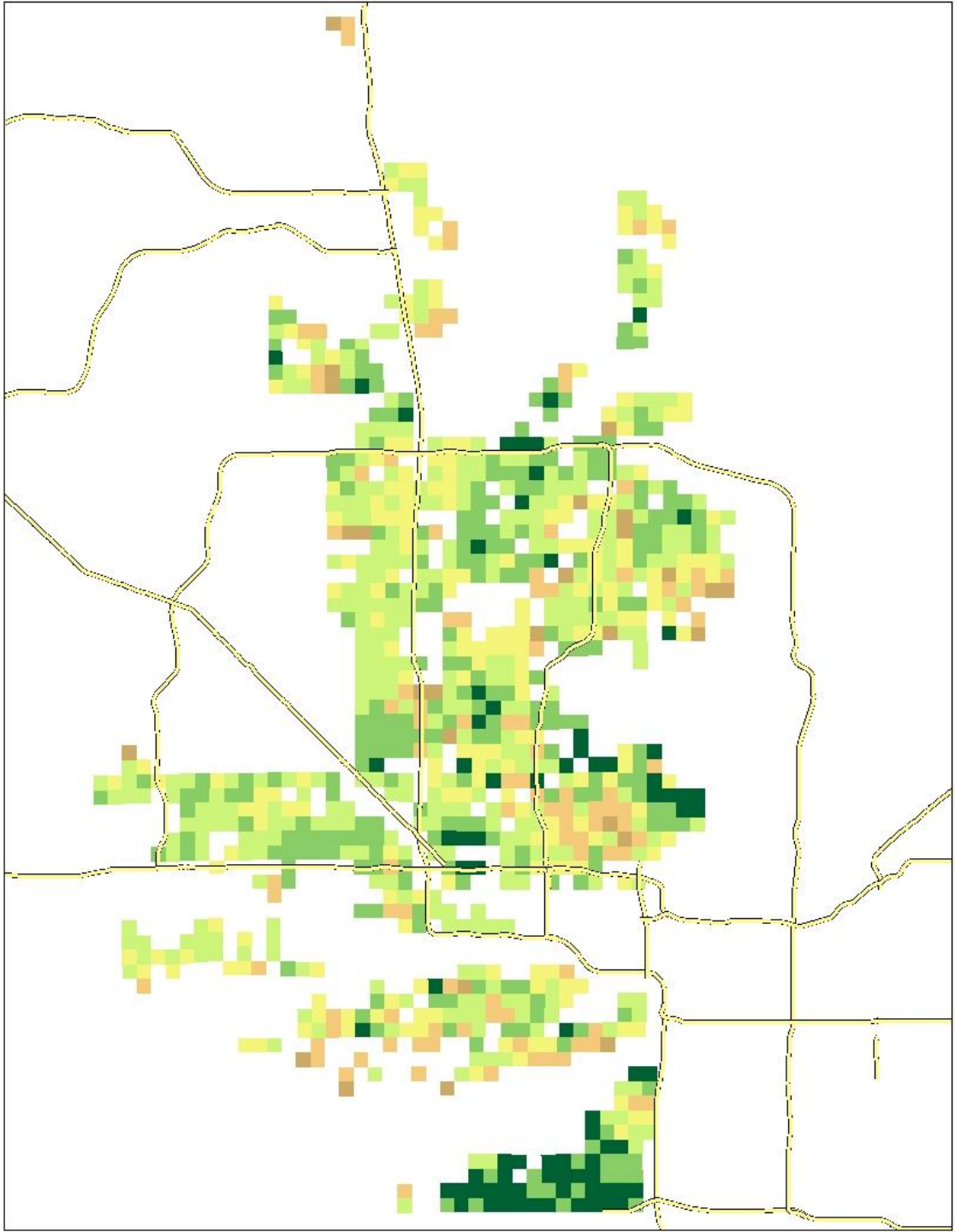
2005



Low Use — High Use

Average Single Family Water Use per FT^2 By Quarter Section

2008

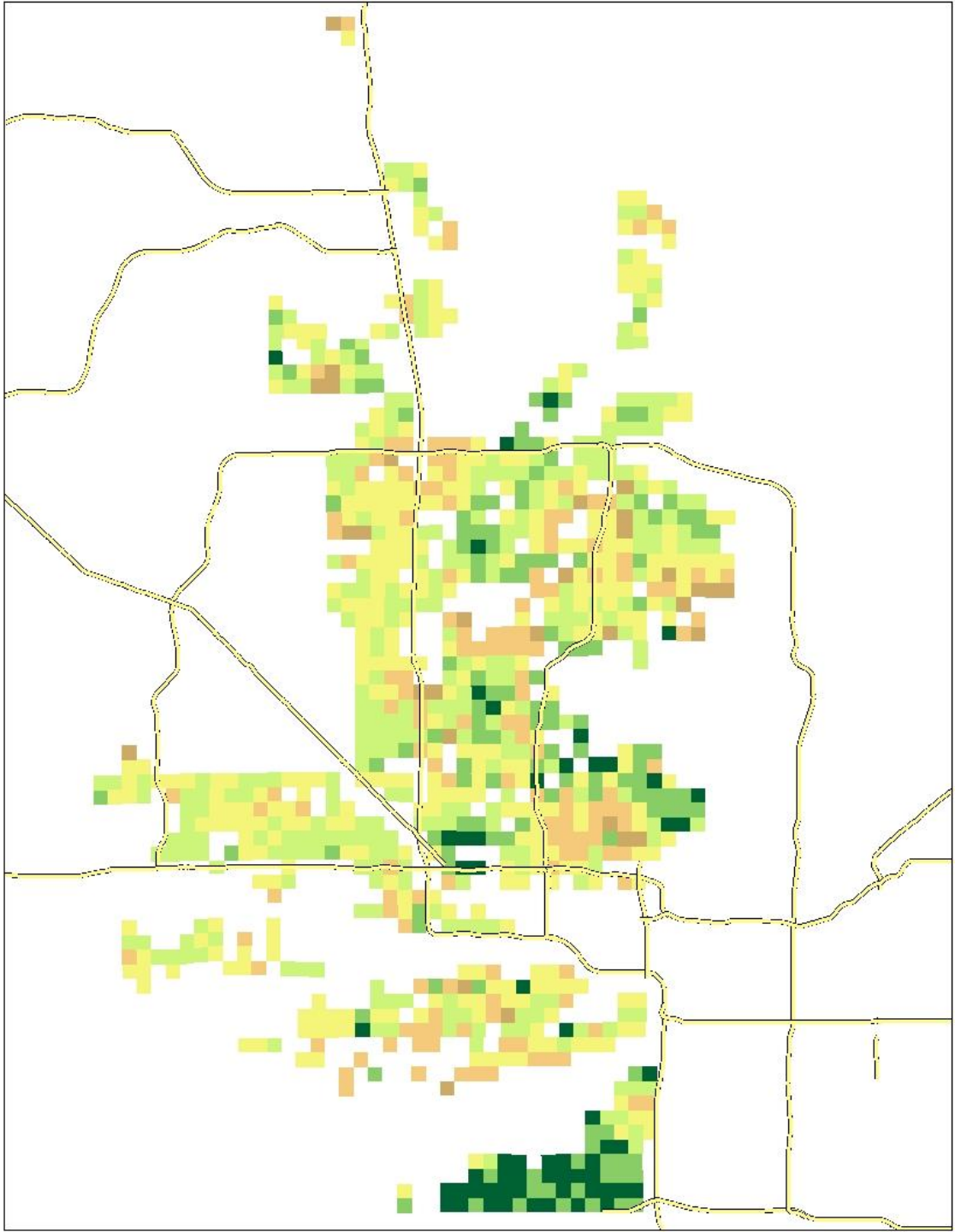


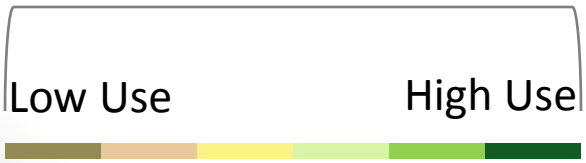
Low Use

High Use

Average Single Family Water Use per FT^2 By Quarter Section

2011





What We're Learning About Landscapes (5)

- Sample appears to be fairly representative of the whole city, at least as far as 6,000 to 16,000 square foot parcel single family units built before '96 are concerned
- Sample is slightly drier than 75' to 84' group as a whole (less than 16,000 sq.ft.) but essentially same
- Whole City is seeing trend to mixed and sparse landscape parcels – more uniform than previously thought

Remaining Landscape Research Challenges (1)

- Variance within ‘sparse’ category is huge, with some using a lot of water, and some using little; more research needed
- Need for reduced subjectivity in coding of landscapes (source of variation within codes)
- So far no correlation between plant types and water use – overall density appears to be key, but more research needed on mix and density
- Need to continue coding and/or use satellite imagery to get estimates for all of Phoenix

Remaining Landscape Research Challenges (2)

Need to understand more about:

- Role of nurseries and plant suppliers in landscaping decisions (limited choice issue)
- Role of neighbors, local culture and environmental goals in transition decisions
- Relationship between retail price of water and overall ‘bundle’ cost of different landscapes
- Green to moderate or sparse, or green to moderate and then to sparse?