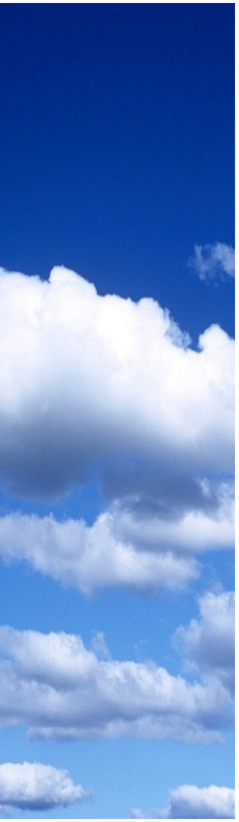


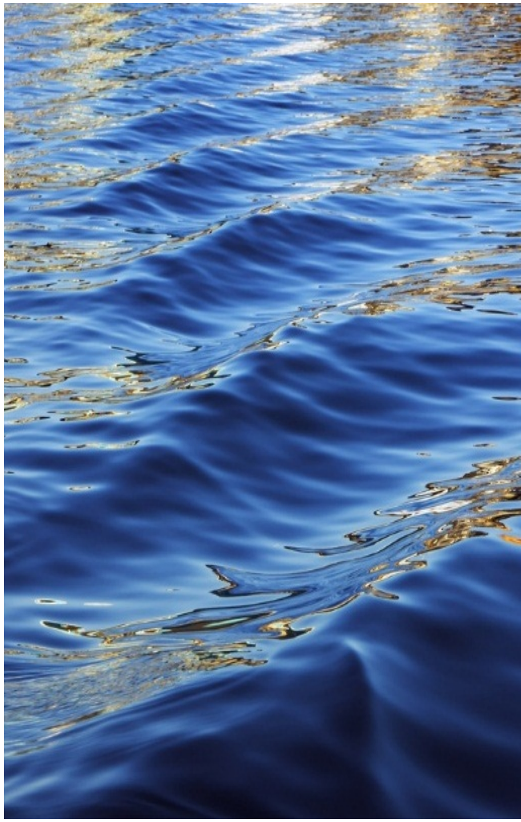
Promoting Low Impact Development in Pima County

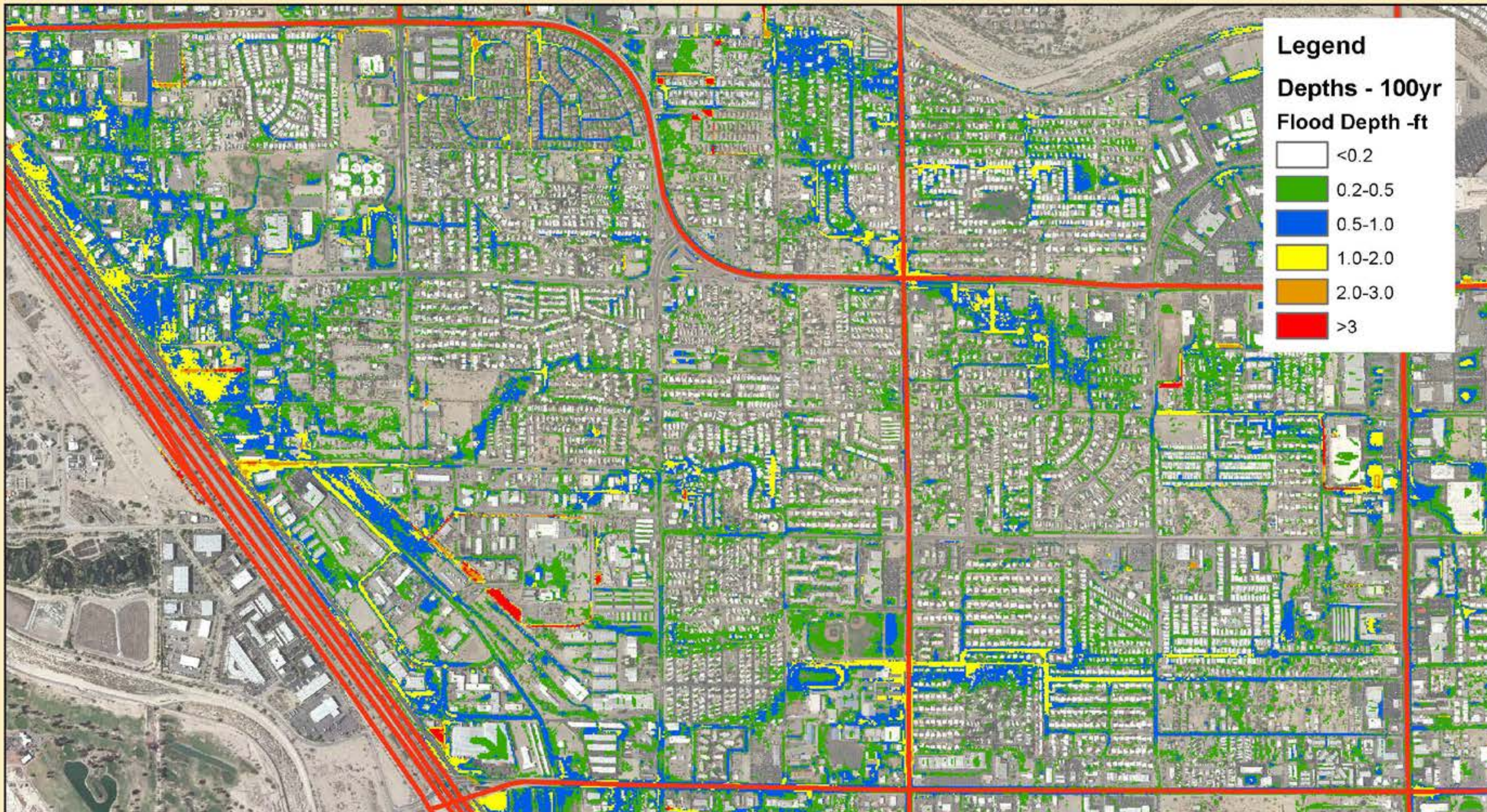
Through Site Planning and Watershed Management

Evan Canfield

PIMA COUNTY
FLOOD CONTROL

01-08-20





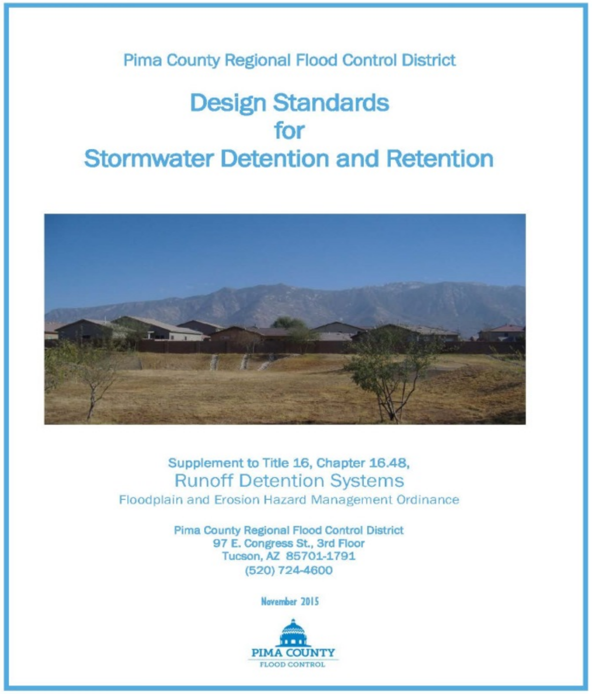
Ruthrauff Project Area - Flood Depths

1 inch = 1,000 feet

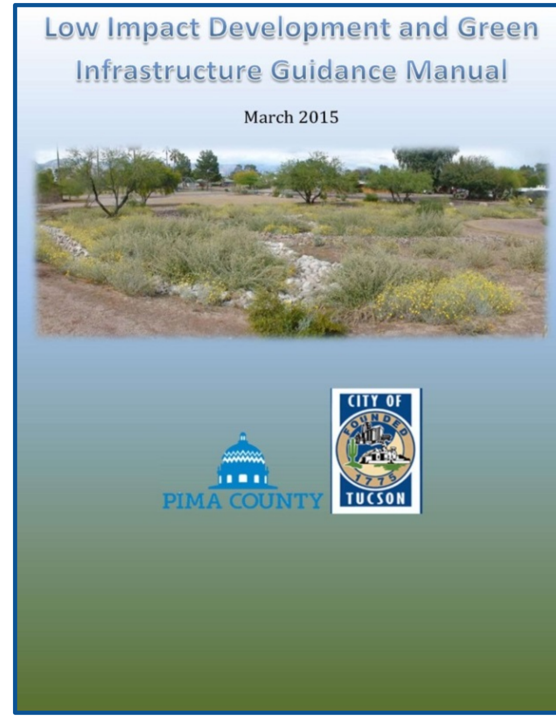
0 250 500 1,000 1,500 2,000 Feet

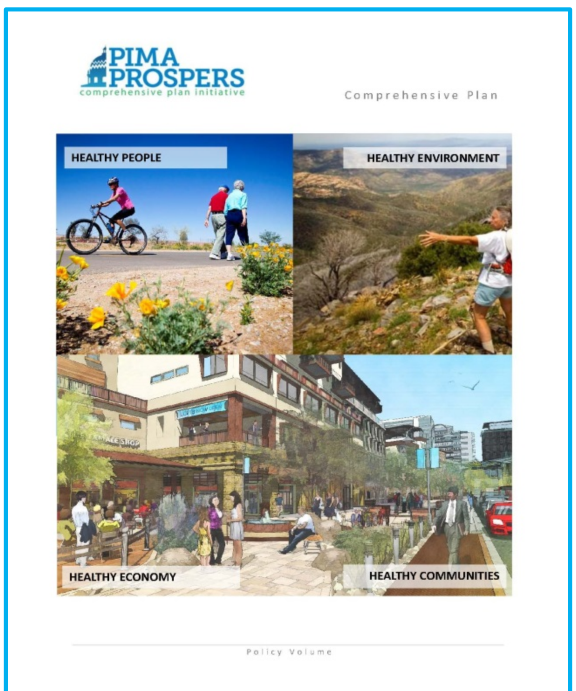
Date:

PIMA COUNTY
FLOOD CONTROL
Pima County Regional Flood Control District
97 E Congress - 3rd Floor
Tucson, Arizona 85701-1207
(520) 724-4600, FAX (520) 724-4621
http://www.rfcd.pima.gov



Pima County LID Policies





Pima County LID Guidance

Stormwater Harvesting and Management as a Supplemental Resource (2009)

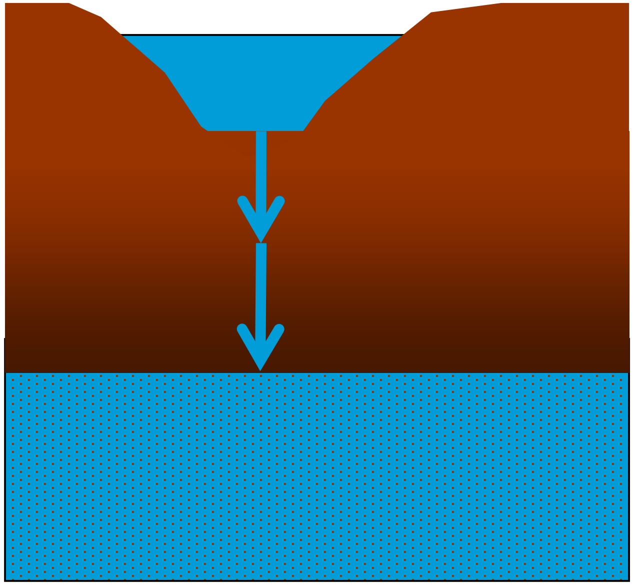
Table 1 – Best Use of Rainwater and Stormwater Described in this Paper

	Built Environment	*Future Development*
Regional Watercourses		
Recharge	X	X
Capture	X	X
Tributary Watercourses		
Recharge	X	X
Capture	X	X
Neighborhood Drainage		
Capture	X	X
Lot Scale		
Capture	X	X

Regional Watercourses: Santa Cruz River, Rillito Creek, Pantano Wash, Tanque Verde Creek, Canada Del Oro Wash, Brawley Wash, Black Wash
Tributary Watercourse is a tributary to a Regional Watercourse

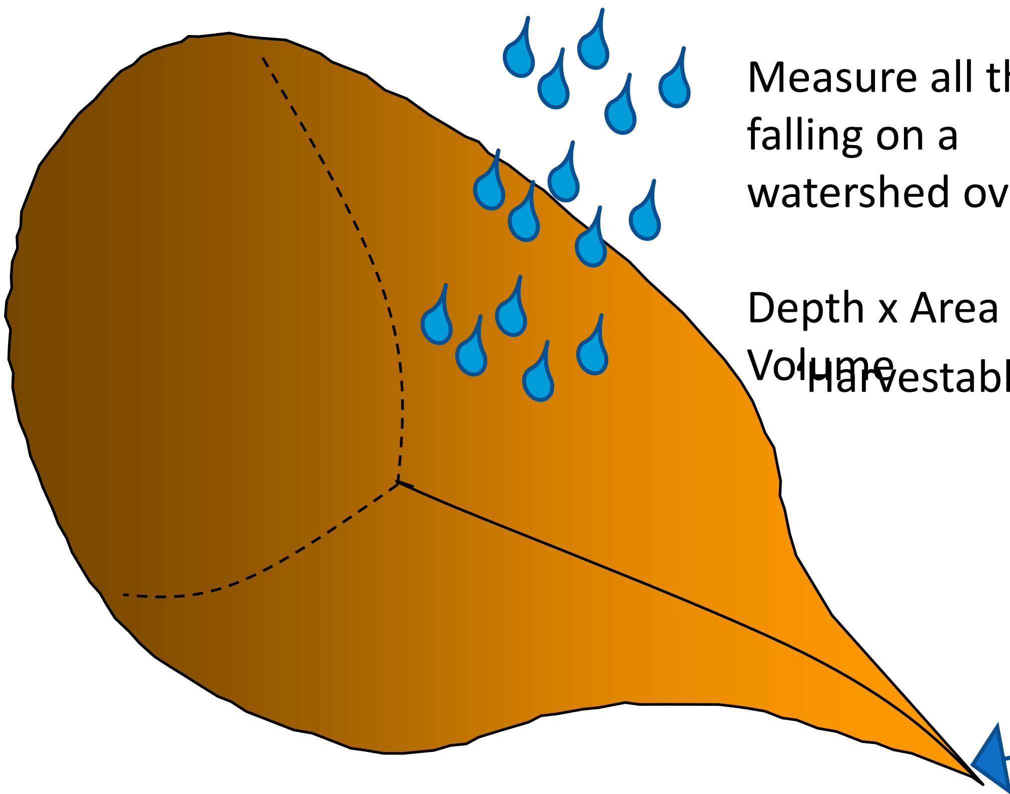
Recharge vs Capture

Recharge - Infiltrate to the regional aquifer for future use.



Capture – store for use in the near term

Use of observed data to estimate harvestable fraction for undeveloped watersheds



Measure all the Rain falling on a watershed over years

Depth x Area = Volume

'Harvestable' = Volume Runoff

Volume Rain

Santa Rita 1
28 years (4.88 acres)

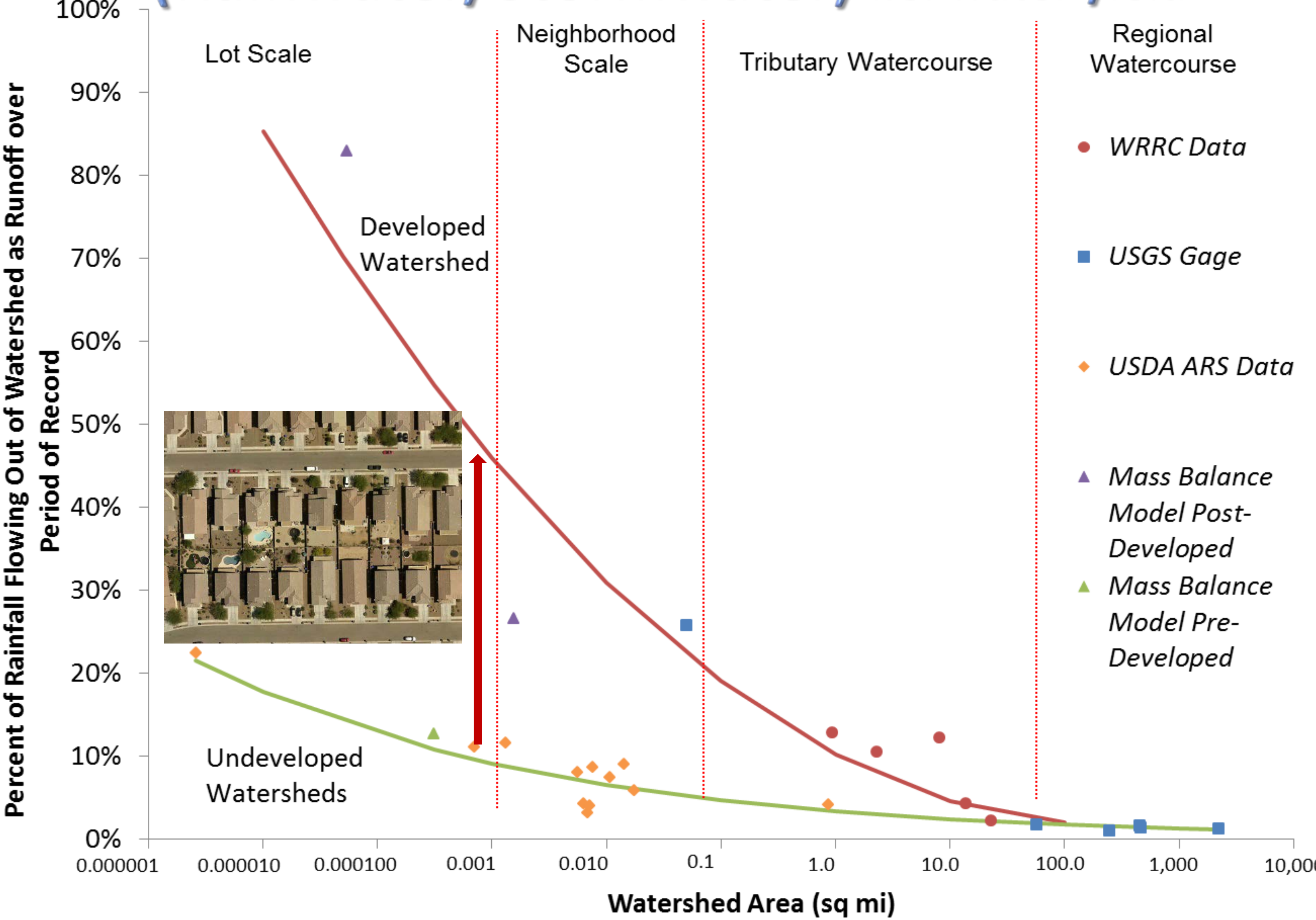
16.5 inchs
---------------- =
4.3%
387 inches

Measure all the Runoff out on a watershed over years

Volume

‘Harvestable Water’

(Rainwater/Stormwater) i.e. water yield



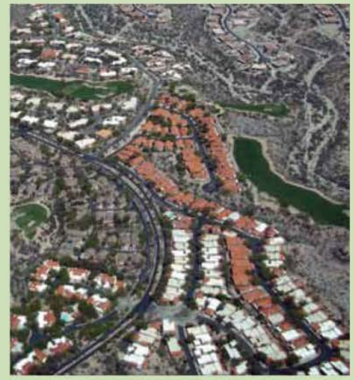
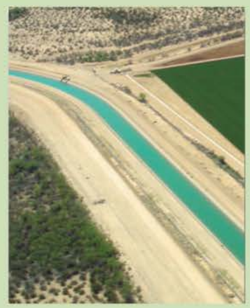
Graph updated from City/County Water Study *Stormwater as a Supplemental Water Source*, May 2009

City / County

Water & Wastewater Infrastructure, Supply and Planning Study

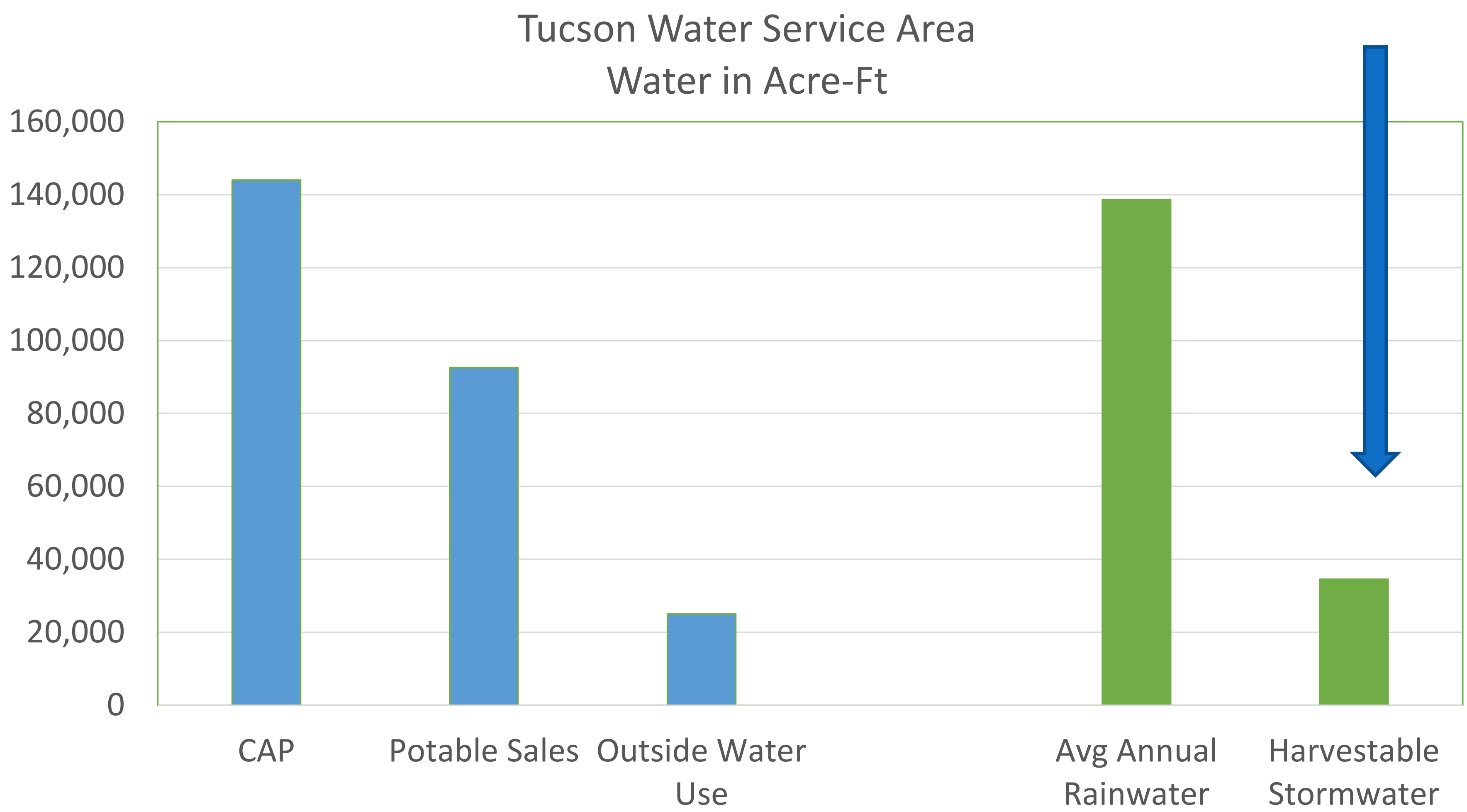
2011-2015
Action Plan for Water Sustainability



A City of Tucson and Pima County Cooperative Project

So how much stormwater do we have from impervious surfaces, and what can we do with it?



Notes: Area = 230 sq Miles, Potable Water Sales from 2014, 27% Outside Water Use
Rainfall =11.3 inch/yr, Harvestable Stormwater assumes 30% Impervious at 83% Harvestable

Calculating Volume of Harvestable Stormwater from Impervious Surfaces

	Value	Unit	Source
Tucson Area	236	square miles	*Stormwater Harvesting and Management as a Supplemental Resource (2009)*
	151,040	Acres	
Rainfall	11.3	inches	
	0.94	Feet	
Total Rainfall Volume	142,229	Acre-Ft of Rainfall	
Impervious Area	30%	Impervious	Common in TSMS HEC-1 Files
	45,312	Acres	
Harvestable	83%	Harvestable off Impervious Surface	*Stormwater Harvesting and Management as a Supplemental Resource (2009)*

35,415 Acre-Ft of Harvestable Water

Adapting LID and GI to Pima County Procedures in the Drainage Standards

Low Impact Development and Green Infrastructure

Low Impact Development (LID)

'A comprehensive stormwater management and site-design technique. . . the goal of any construction project is to design a hydrologically functional site that mimics predevelopment conditions…'

Green Infrastructure -

'As a general principal, Green Infrastructure techniques use soils and vegetation to infiltrate, evapotranspirate, and/or recycle stormwater runoff…'

EPA Green Infrastructure Homepage - Glossary


Conservation
Preserves native trees, vegetation and soils.
Maintains natural drainage patterns.
Small-scale Controls
Mimics natural hydrology and processes.
Key Elements of LID
Customized Site Design
Ensures each site helps protect the entire watershed.
Directing Runoff to Natural Areas
Encourages infiltration and recharge of streams, wetlands and aquifers.
Maintenance, Pollution Prevention and Education
Reduces pollutant loads and increases efficiency and longevity.
Educates and involves the public.

USGS Runoff gages at 1) outlet of grassland watershed (inlet to urban) and 2)outlet of urban watershed

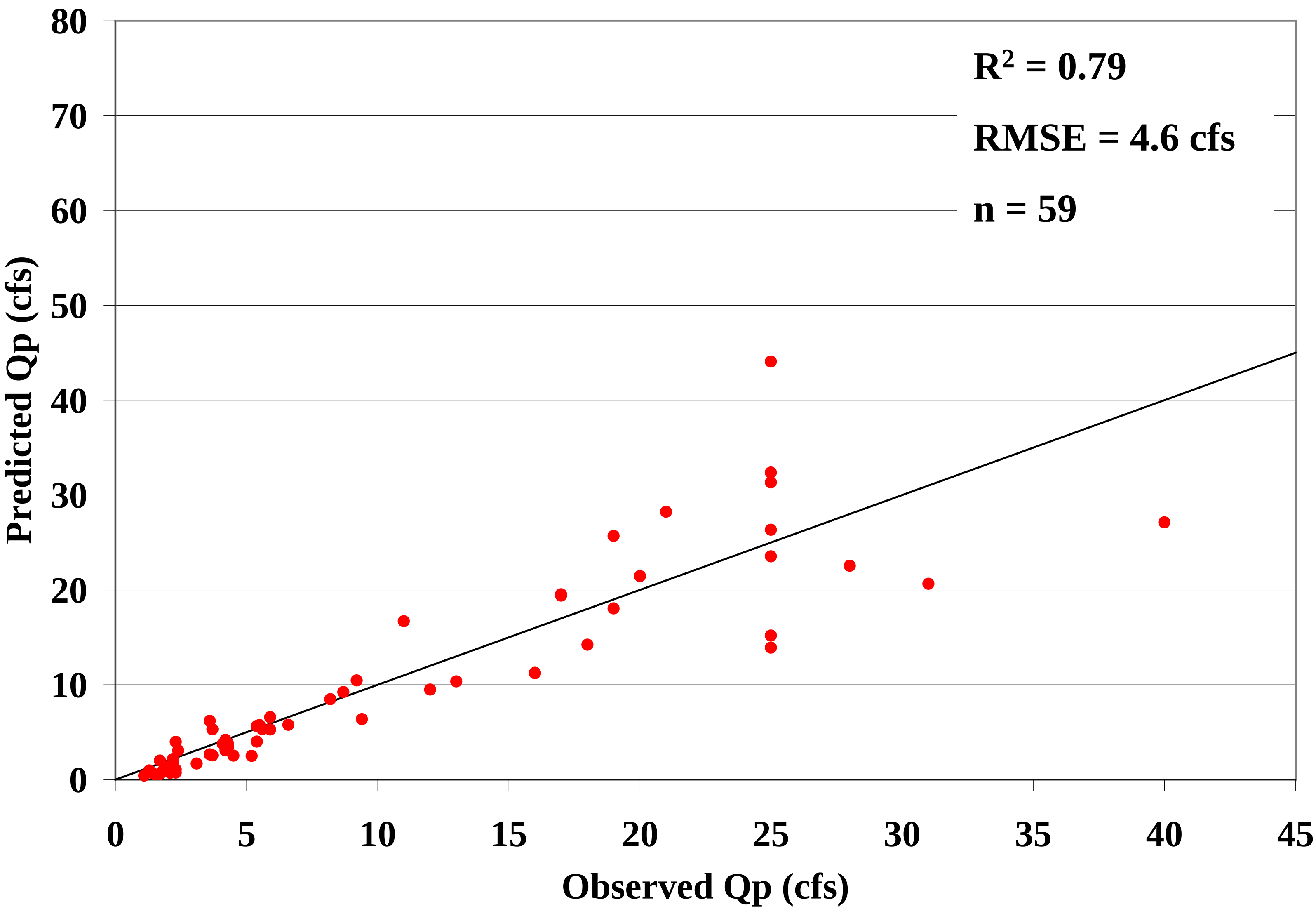
USGS Rain gages within urban and grassland watersheds

La Terraza SWMM Model

- Used variables from Jeff Kennedy's KINEROS model to create a SWMM model.
- Uses Green Ampt infiltration based on Jeff Kennedy's tensiometer measured infiltration data and parameters calibrated to runoff data at La Terraza.
- Urban soils at La Terraza – optimal Ksat = 2.5 mm/hr (0.10 in/hr)

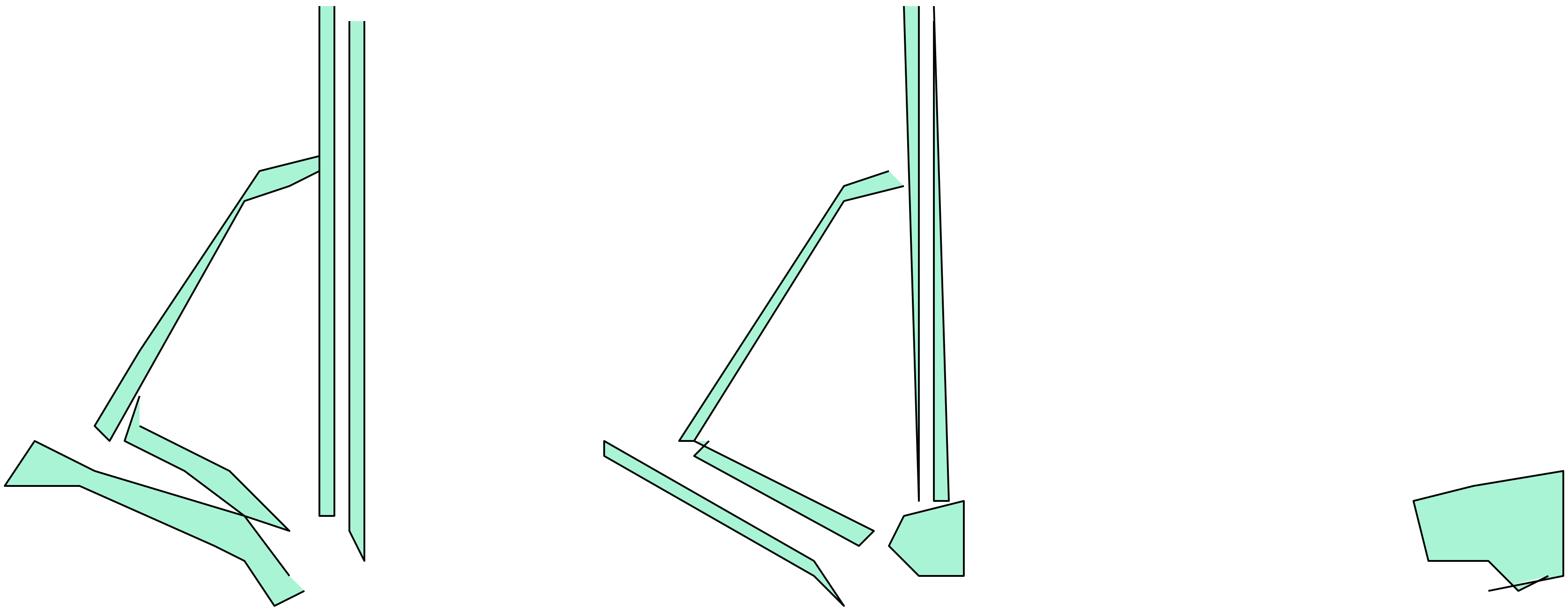
Validation Analysis

Modeling the urban runoff from rainfall data and using grassland runoff data as upstream inflow:



SITE DISTRIBUTION OF STORMWATER HARVESTING

100% distributed 50% distributed 0% distributed

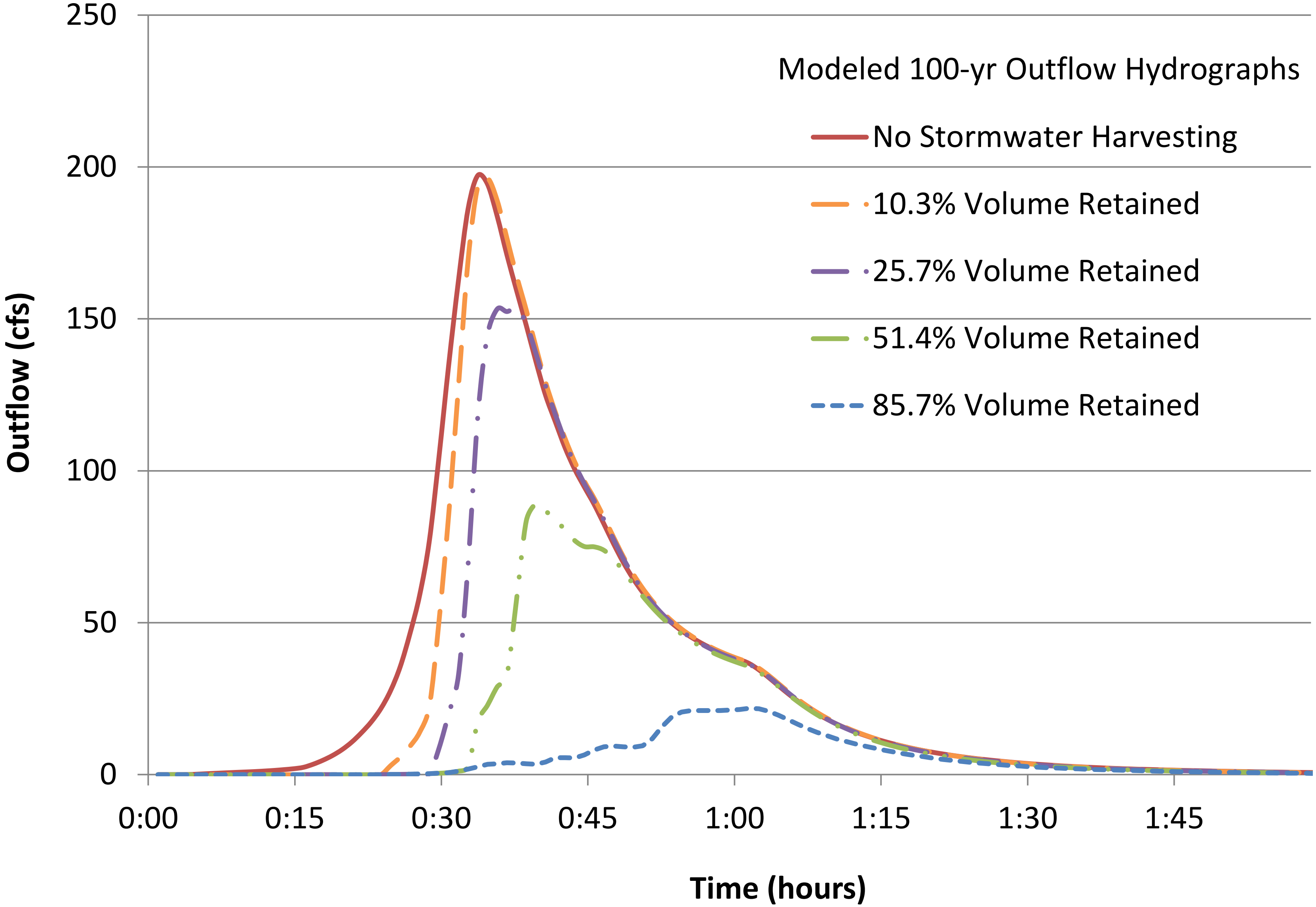


Stormwater Harvesting Effects on 100-yr Runoff

- LID and Stormwater Harvesting are particularly effective for small events. However, what are the impacts on the 100-yr event?

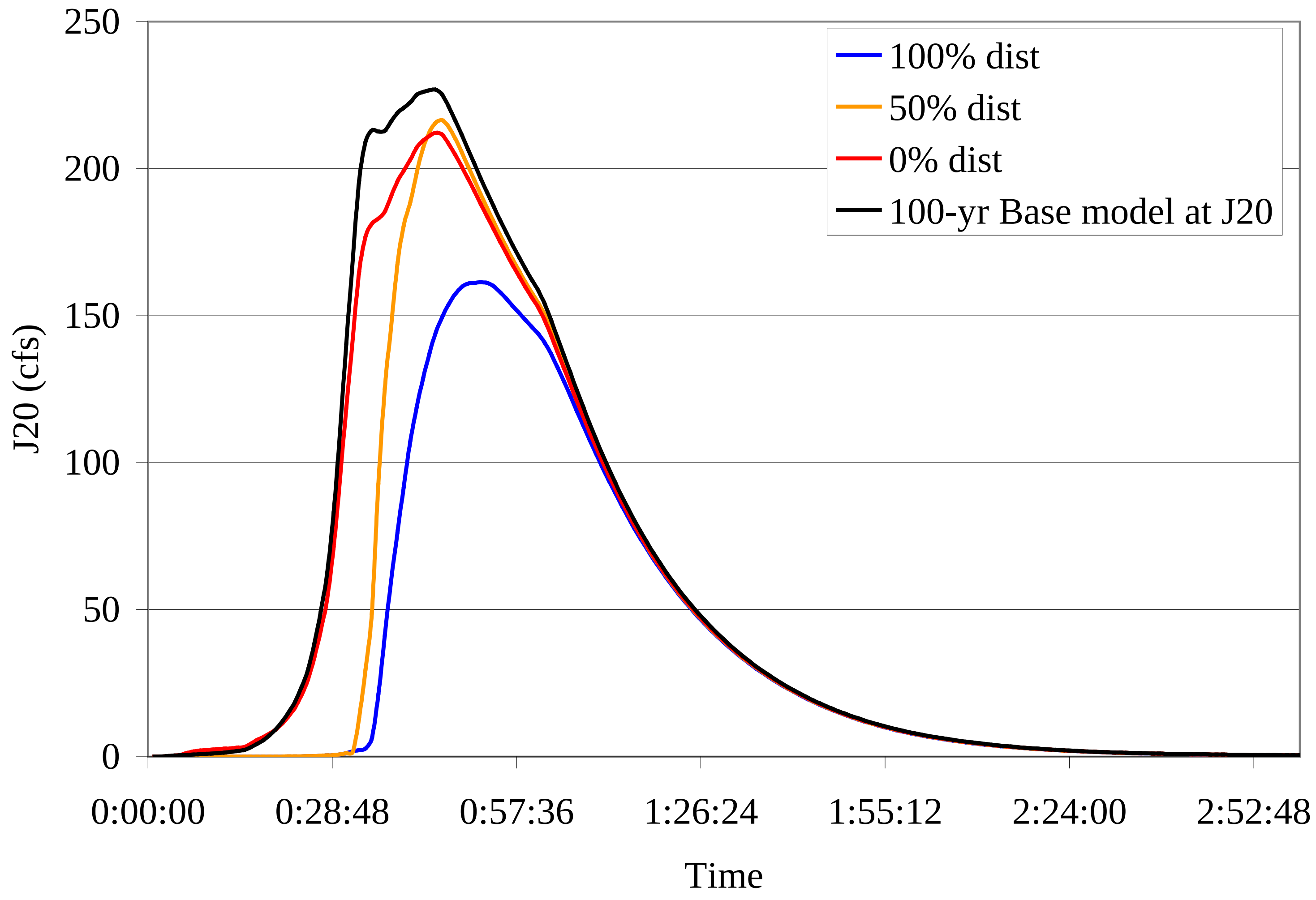
- 1-hr, 100-yr Storm applied to 12 cases
  - Varied catchment scale (2%, 5%, 10%, 16%)
    - Area of stormwater harvesting (SWH) relative to developed area diverted to SWH basin
  - Varied distribution in urban watershed
    - 100% distribution (each lot has SWH basin)
    - 50% distribution (1/2 at lot, ½ at outlet)
    - 0% distribution (all SWH at outlet)

Effect of Stormwater Harvesting on Peak

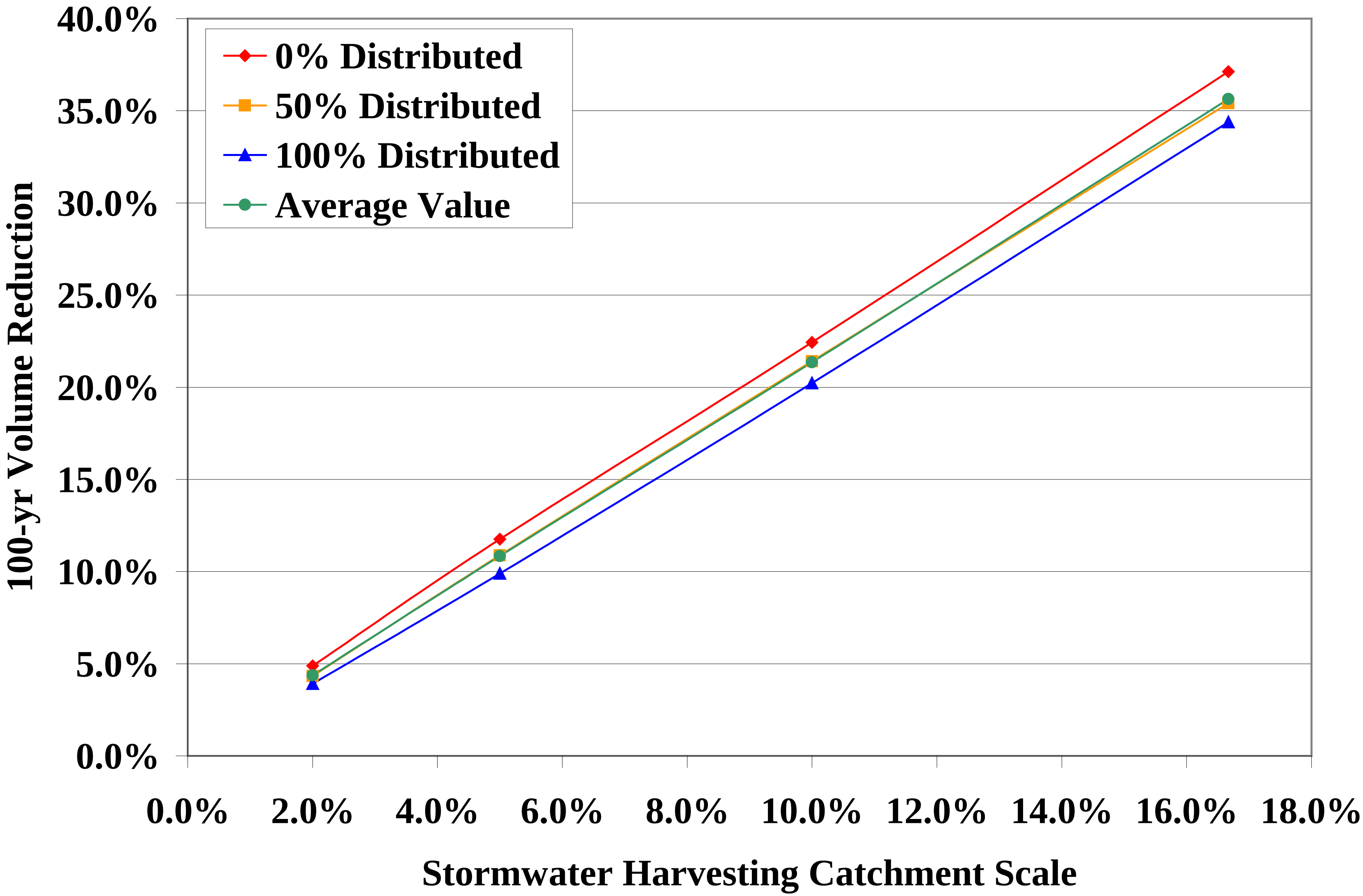


Upstream of the Outlet (Inside development)

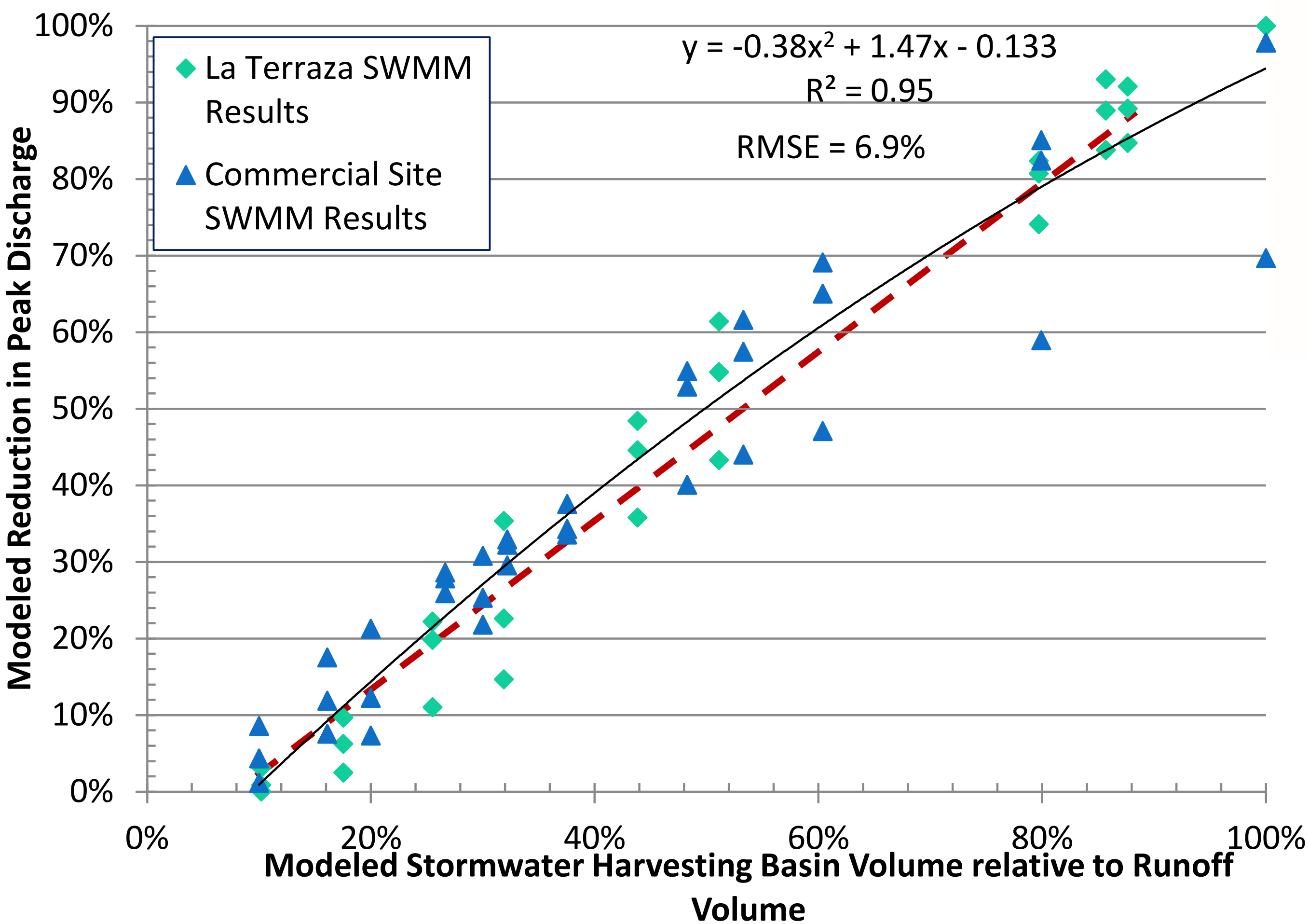
Distribution of SWH basins has a large effect on runoff volume and peak discharge.

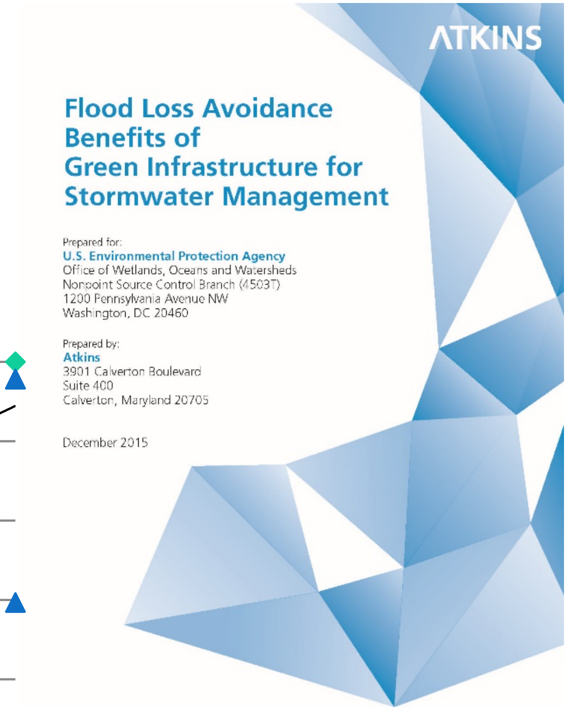


100-yr Runoff Volume Reduction for 1-ft Deep SWH Basins



Comparison vs. EPA




ATKINS

Flood Loss Avoidance Benefits of Green Infrastructure for Stormwater Management

Prepared for:
U.S. Environmental Protection Agency
Office of Wetlands, Oceans and Watersheds
Nonpoint Source Control Branch (4503T)
1200 Pennsylvania Avenue NW
Washington, DC 20460

Prepared by:
Atkins
3901 Calverton Boulevard
Suite 400
Calverton, Maryland 20705

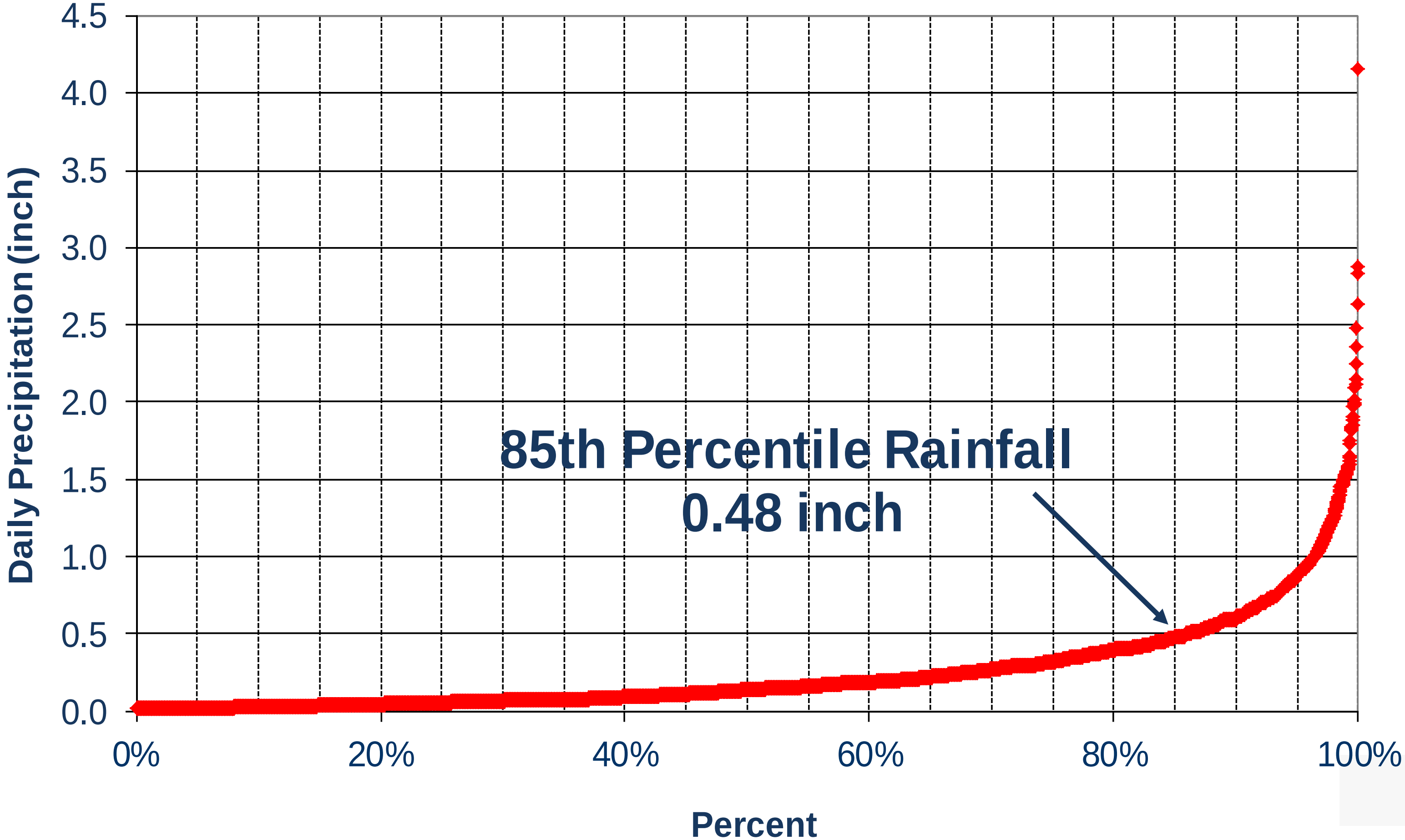
December 2015

$$Qp_{GI} = Qp\frac{V_{GI}}{V}$$

Equation 4-9

Pima County:
Detention-Retention Manual

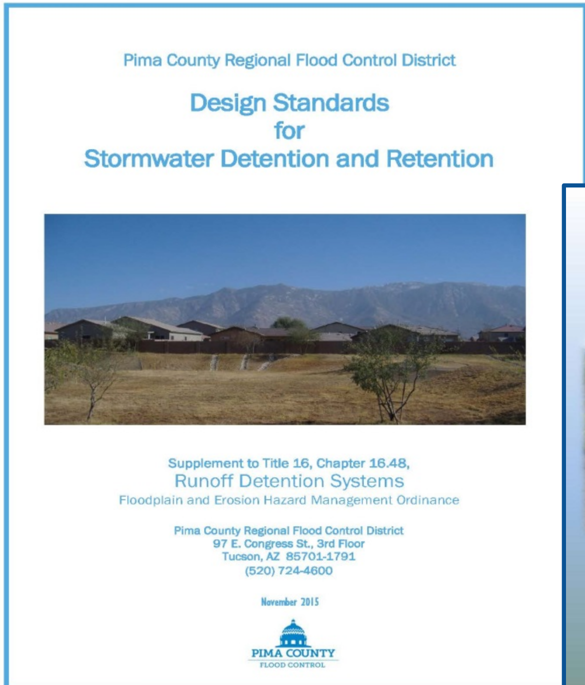
Replace Retention Requirement with a
'First Flush' Retention Requirement
(data U of A Daily rainfall 1895-2000)

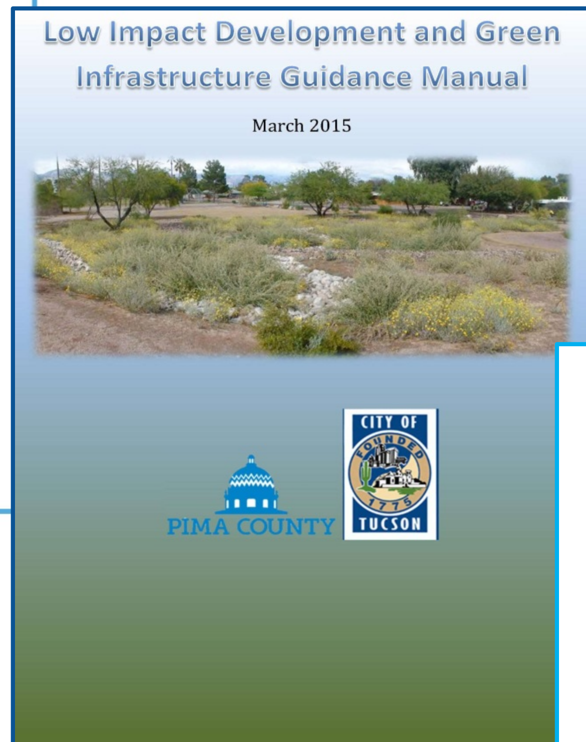


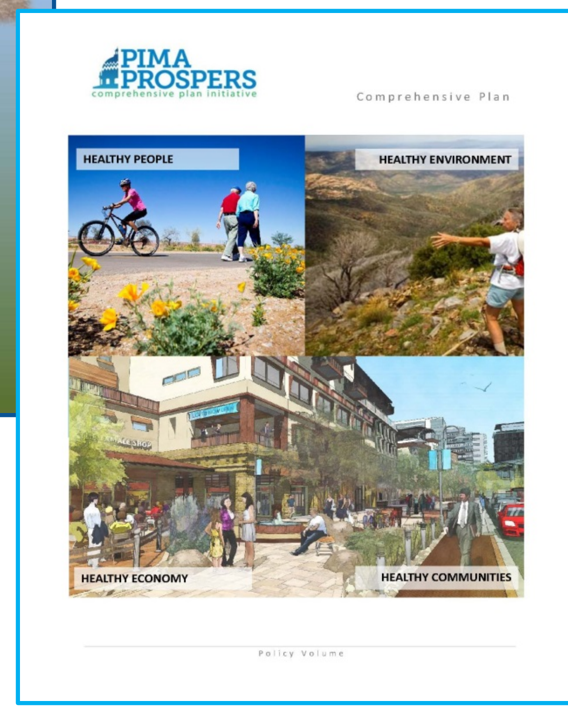
First Flush Requirements

Classification of Watershed vs Proposed Use	Volume ft^3/ac Table 2.1	Area of Proposed Use (ac)	First Flush Required Volume (ft^3)
Riparian/High Permeability, Proposed Impervious Area	1815		0
Nonriparian/lLow Permeability, Proposed Impervious Area	1440	2.100	3024
Riparian/High Permeability, Proposed Disturbed Area	245	0.300	74
NonRiparian/Low)Permeability, Proposed Disturbed Area	140		0
Remaining Undisturbed Area, Pre-Developed Watershed (Info Only)		0.000	
Total Required First Flush Volume			3098

Pima County LID Policies







LID Techniques

Beneficial Alternatives to Traditional Practices

Low Impact Development Benefits

- Flood Control
- Stormwater Management
- Pollution Prevention
- Energy Efficiency
- Supports Landscape Amenities

Site Planning

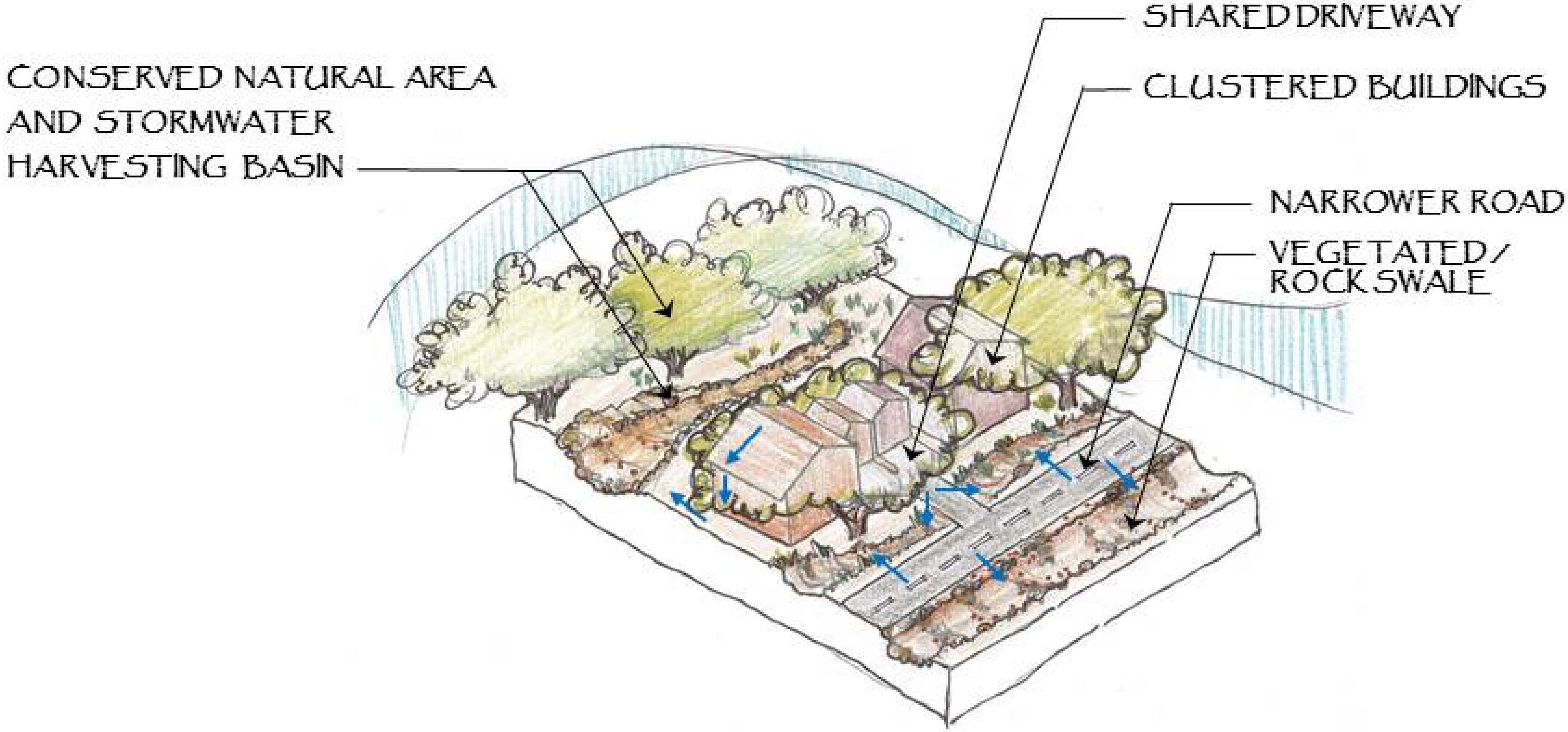
(Avoidance and Prevention)

- Preserve Natural Flow Paths
- Minimize Impervious area
- Reduce Disturbance

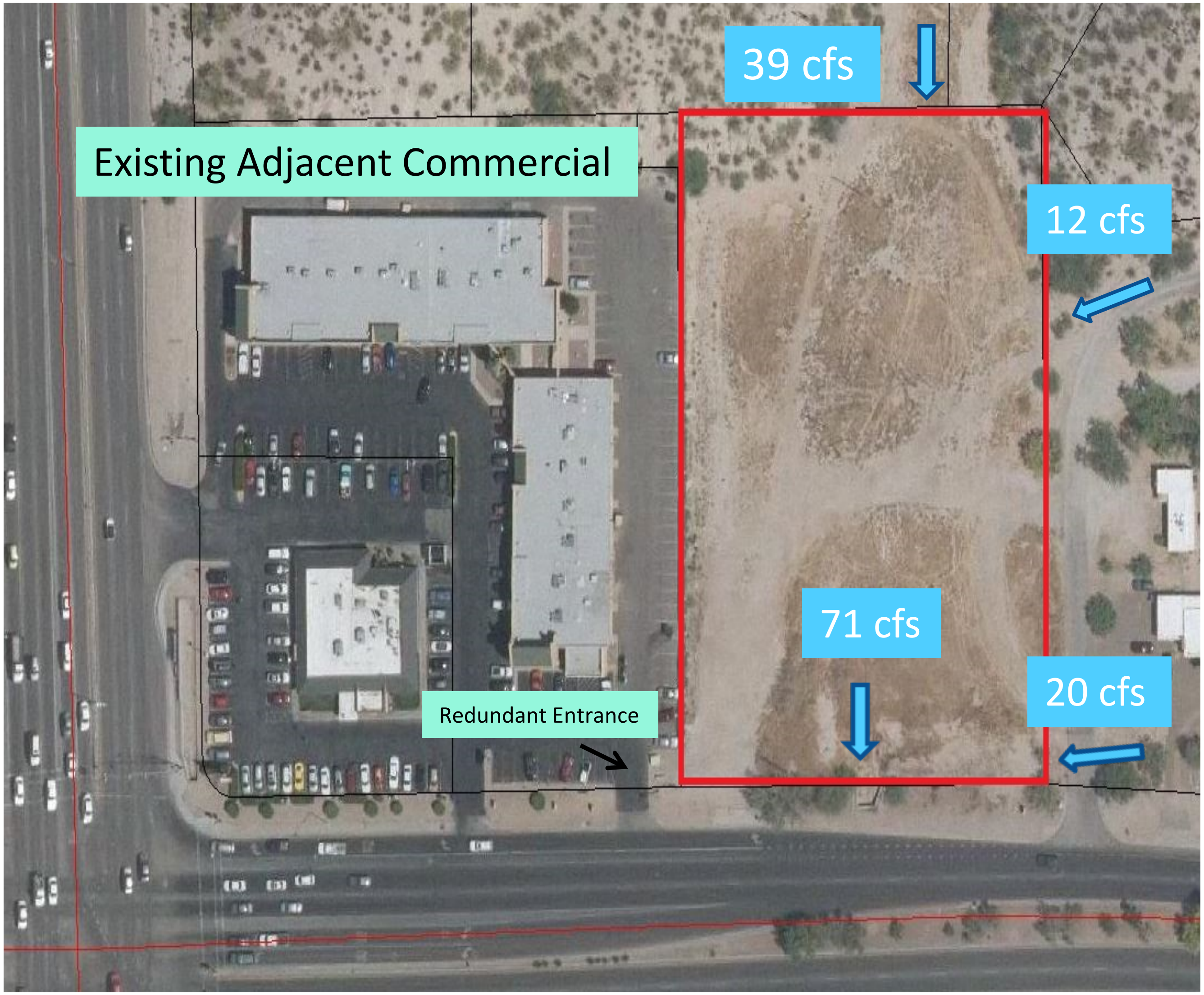
Green Infrastructure

(Structural)

- Rainwater and Stormwater Harvesting Features
- Naturalized Conveyance Features

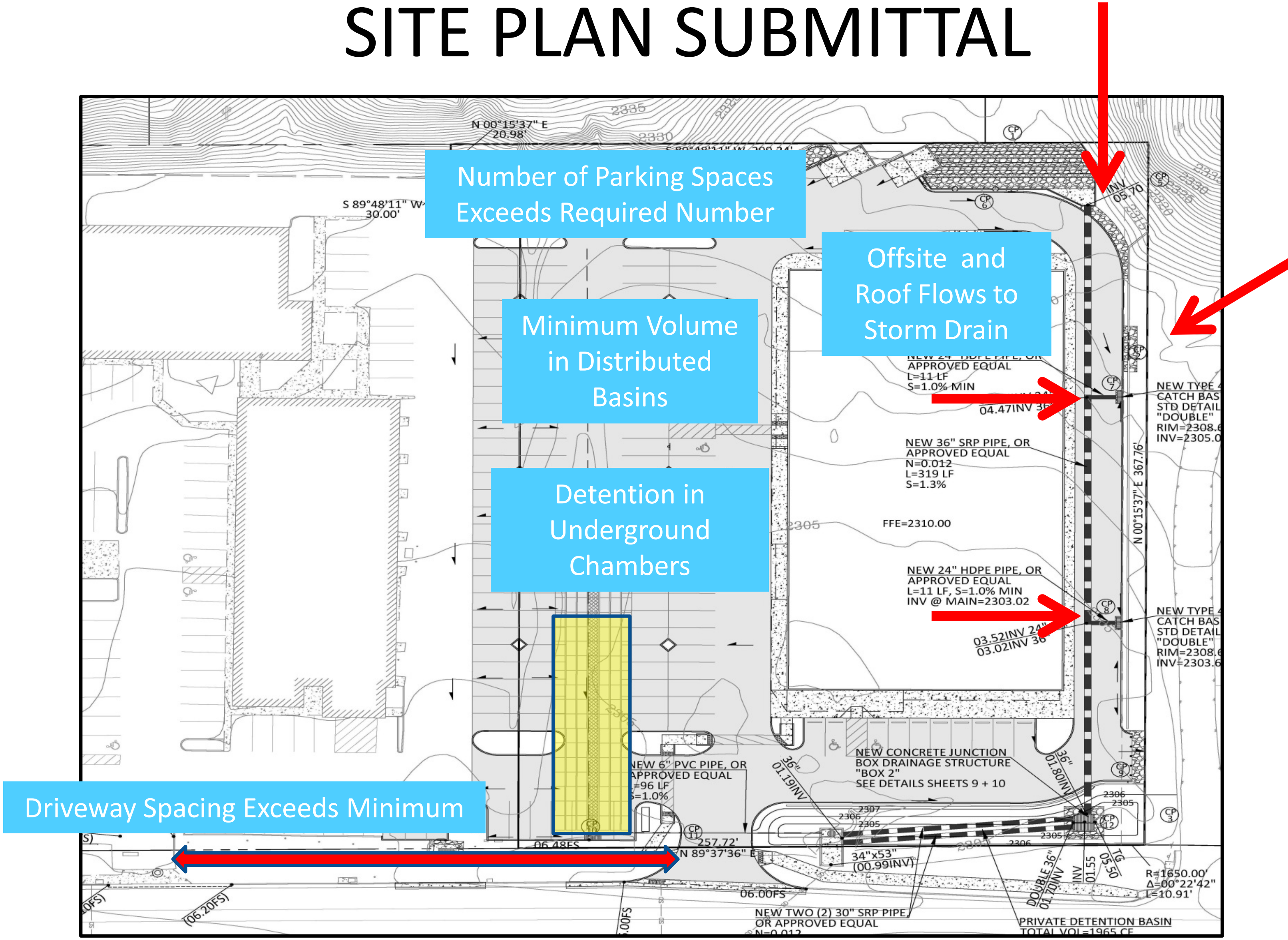


DISCONNECTION IMPERVIOUS AREAS AND THE COMPATIBILITY WITH OTHER LID PRACTICES



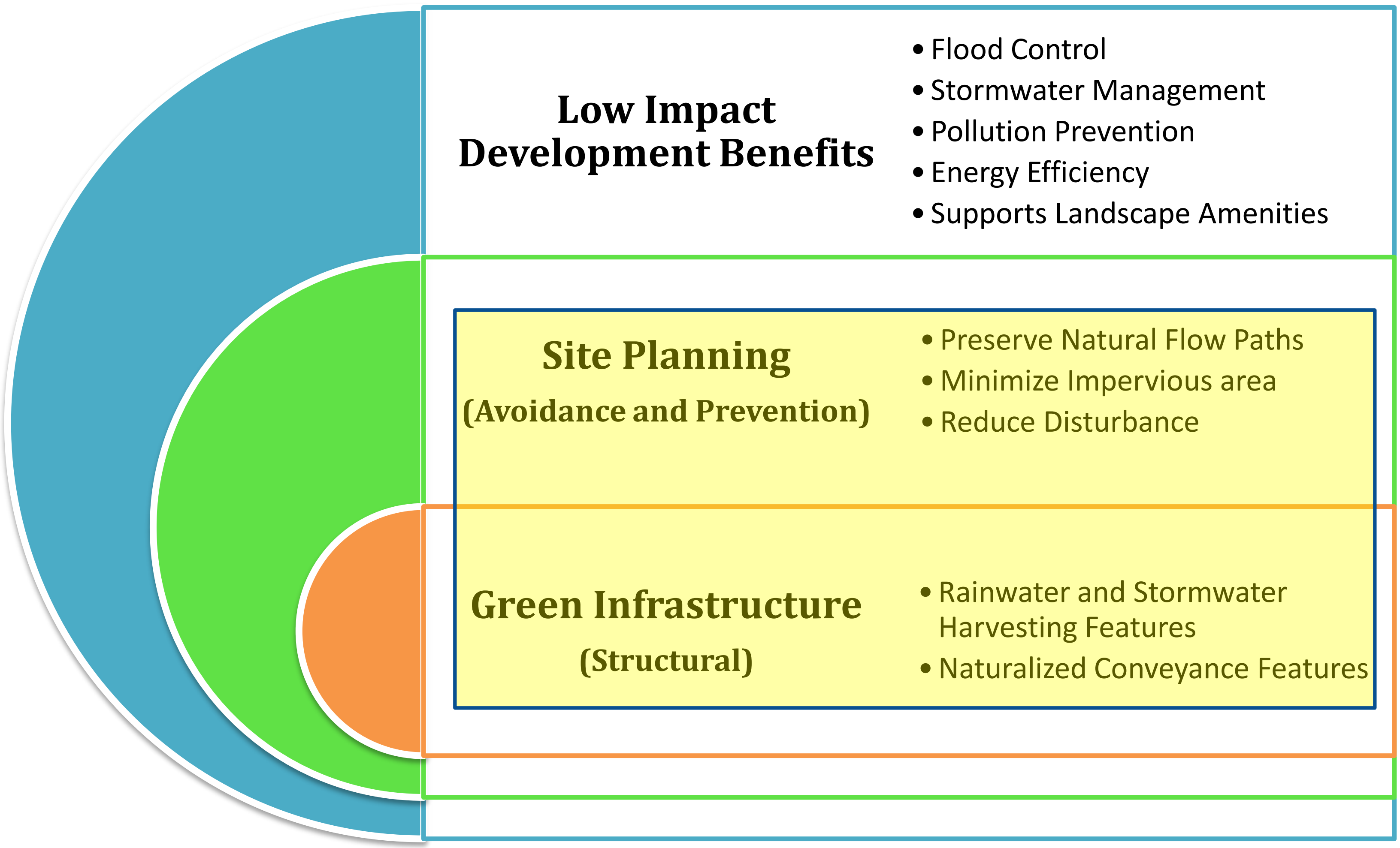
Example Commercial Site

SITE PLAN SUBMITTAL

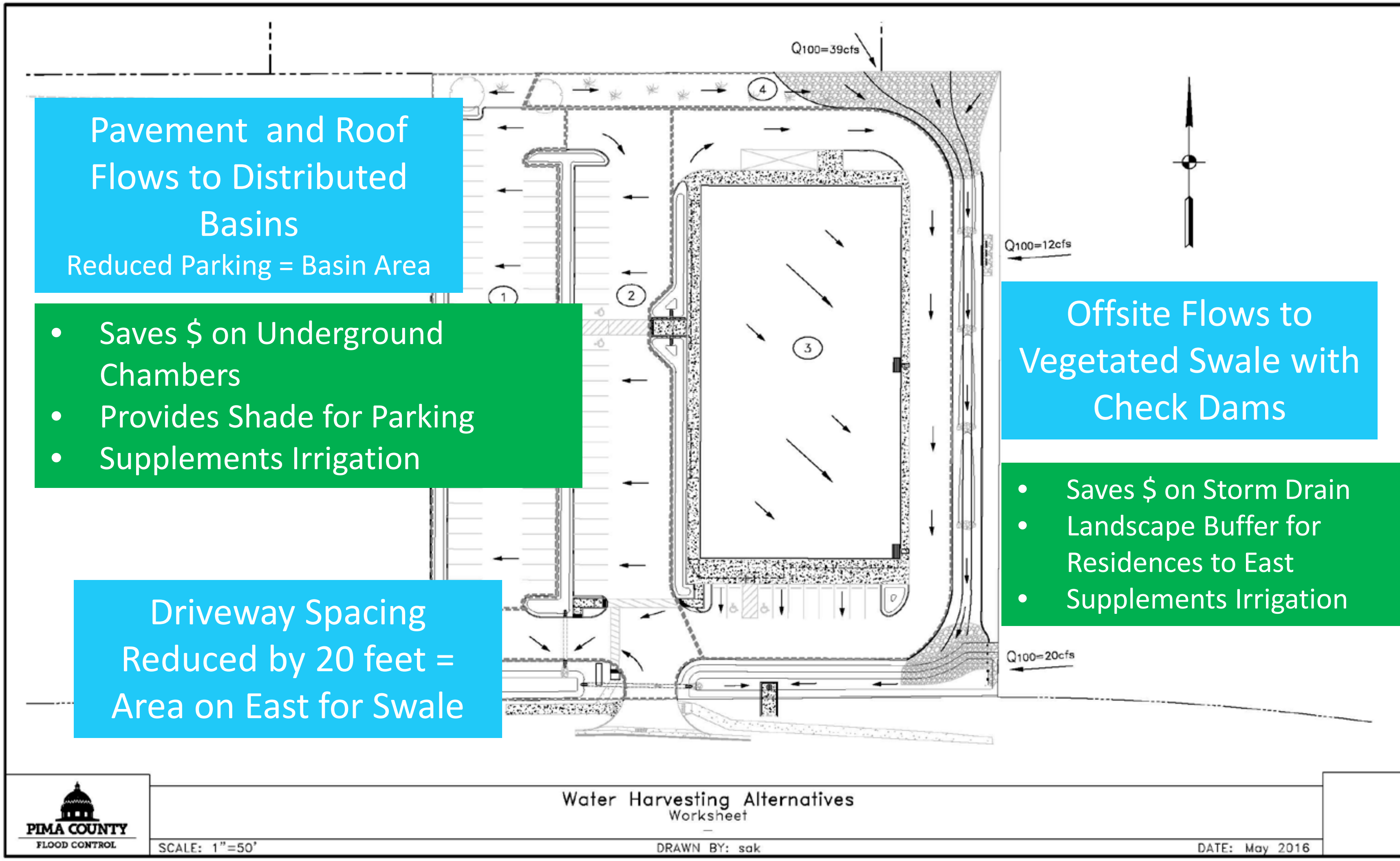


LID Techniques

Beneficial Alternatives to Traditional Practices



Making this Project More LID-Friendly



Pavement and Roof Flows to Distributed Basins

Reduced Parking = Basin Area

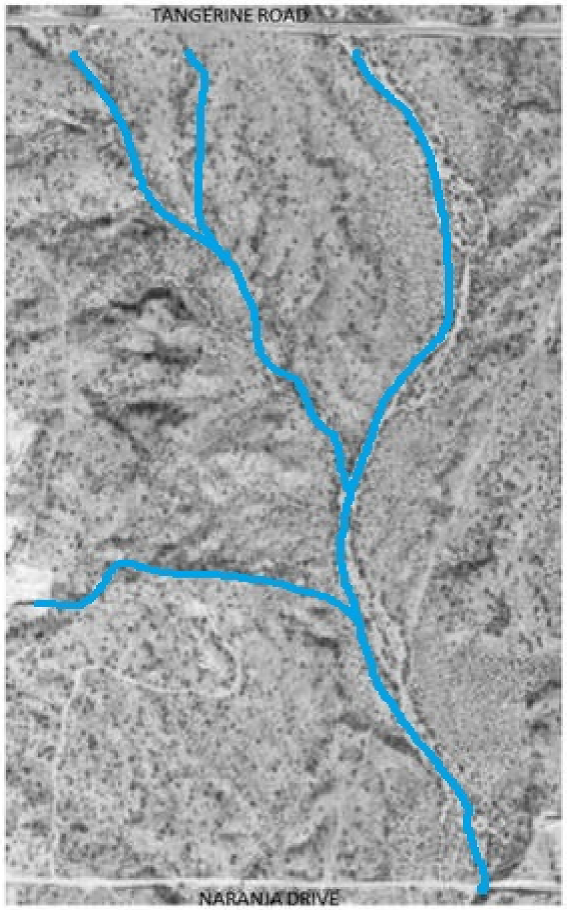
- Saves $ on Underground Chambers
- Provides Shade for Parking
- Supplements Irrigation

Driveway Spacing Reduced by 20 feet = Area on East for Swale

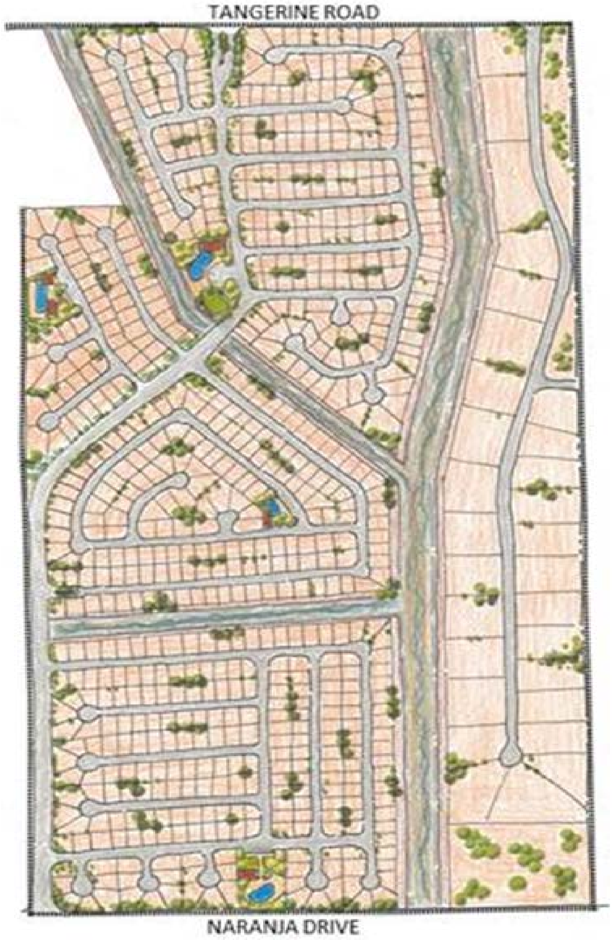
Offsite Flows to Vegetated Swale with Check Dams

- Saves $ on Storm Drain
- Landscape Buffer for Residences to East
- Supplements Irrigation

Applying these planning principles to larger-scale residential projects results in preservation of flow corridors and riparian habitat, both associated with reduced flood risk

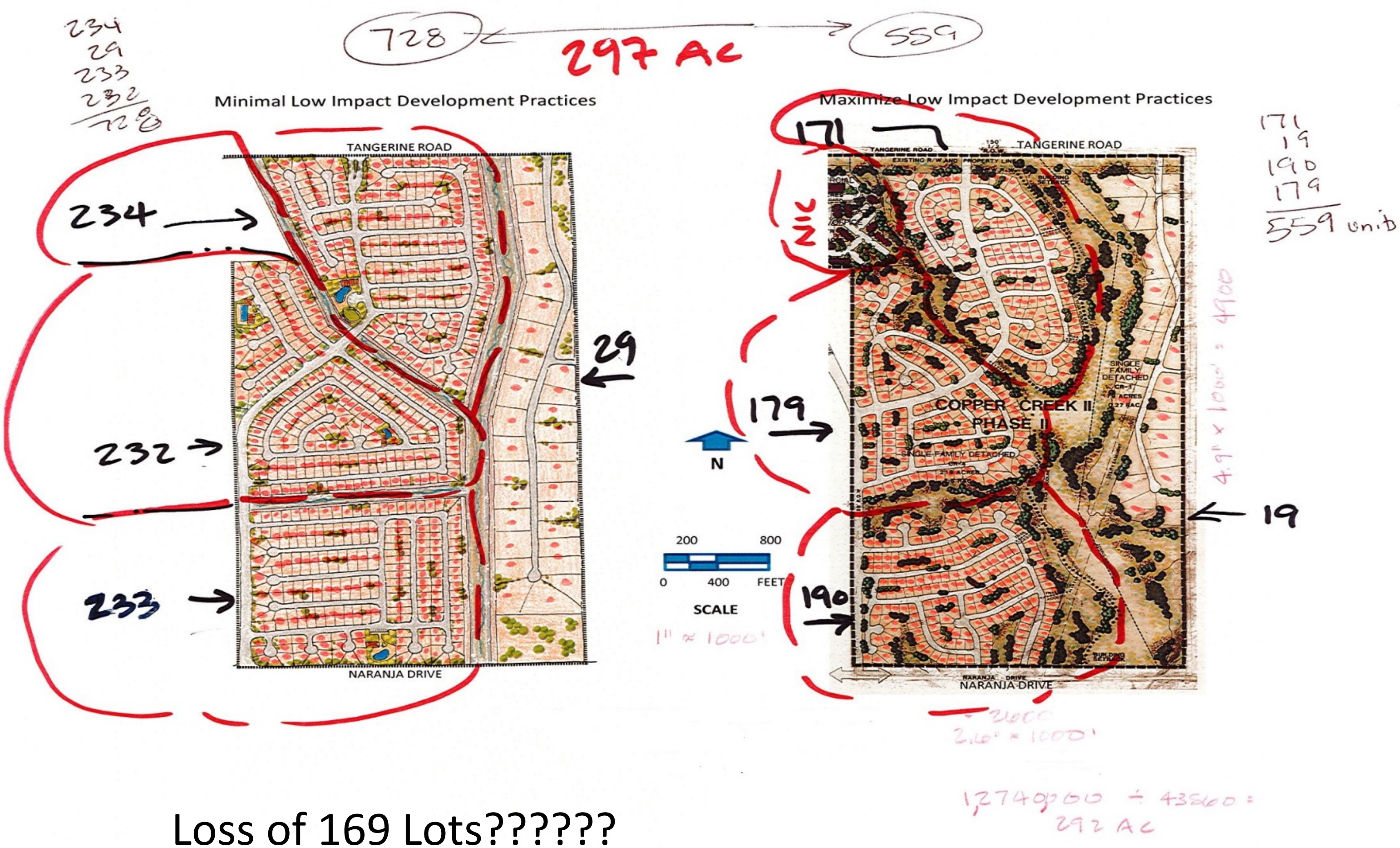


Parcel Existing Conditions



Traditional Maximized Grading Concept

Lot Yield Comparison
When Flow Corridors are Preserved



Loss of 169 Lots??????

Take a Look at Cost Offsets

$$$ $2,675 x 559 Lots = $1.5 Million

$$$ Reduced Grading Costs

$$$ Reduced Cost of Constructing Drainage Channels

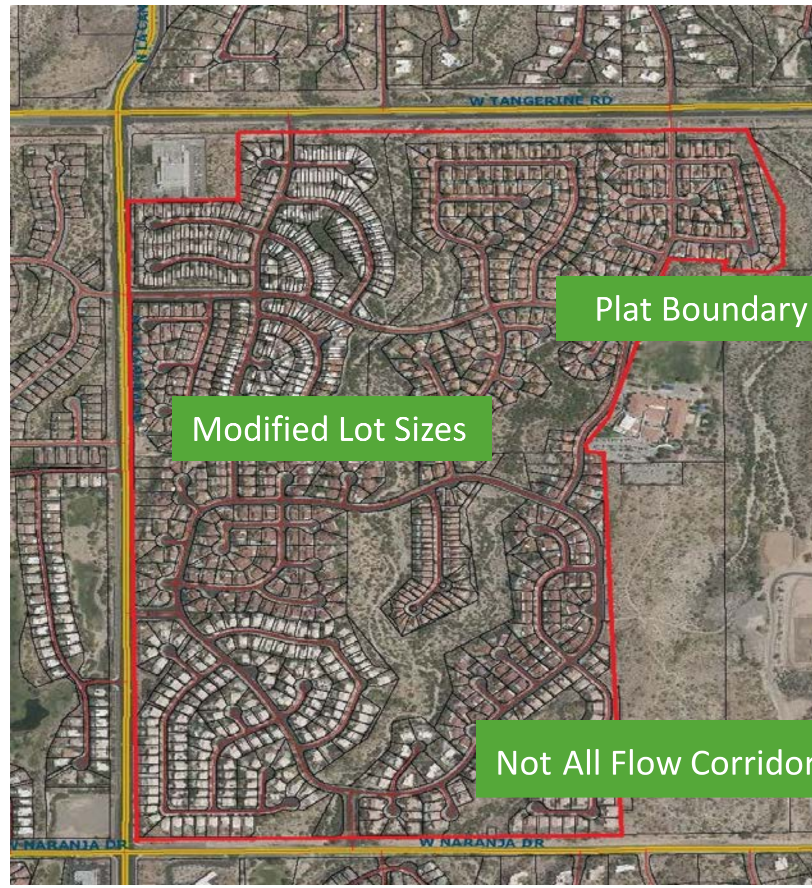
$$$ Reduced Cost of Landscape Installation

$$$ Reduced Cost of Detention and Other Flood Works

$$$ Reduced Cost of Riparian Habitat Mitigation

$$$ Reduced Cost of Salvaging and Relocating
Protected Species such as Saguaros

Final Construction Merged Lot-Yield and Open Space Drivers



Lot Yield = 953 Lots = + 225 Lots

LID and GI Impact on Retrofits

10% & 25% Scenario:
Green Stormwater Infrastructure Retrofits

1. Residential Parcels: ~1/3 of available landscape for selected parcels delineated as rain gardens. Included streetside basins if appropriate for the space.

Model representation

On-the-ground potential practice

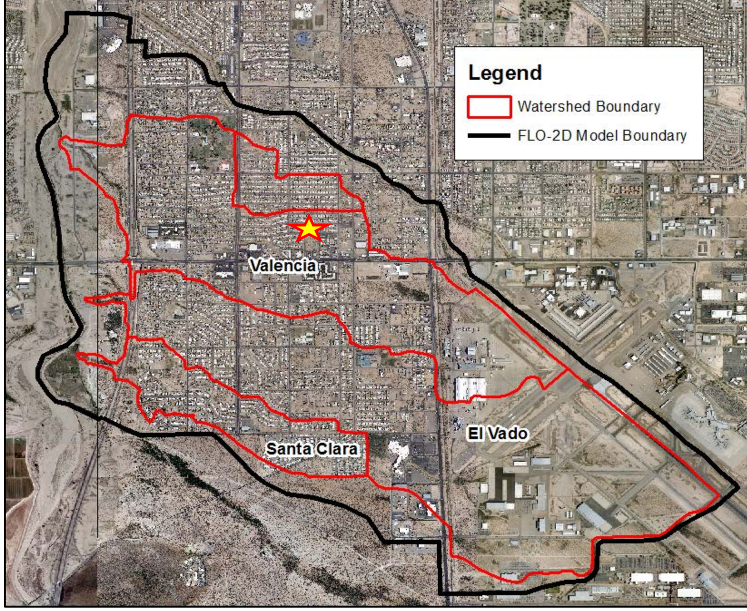
PIMA COUNTY
FLOOD CONTROL

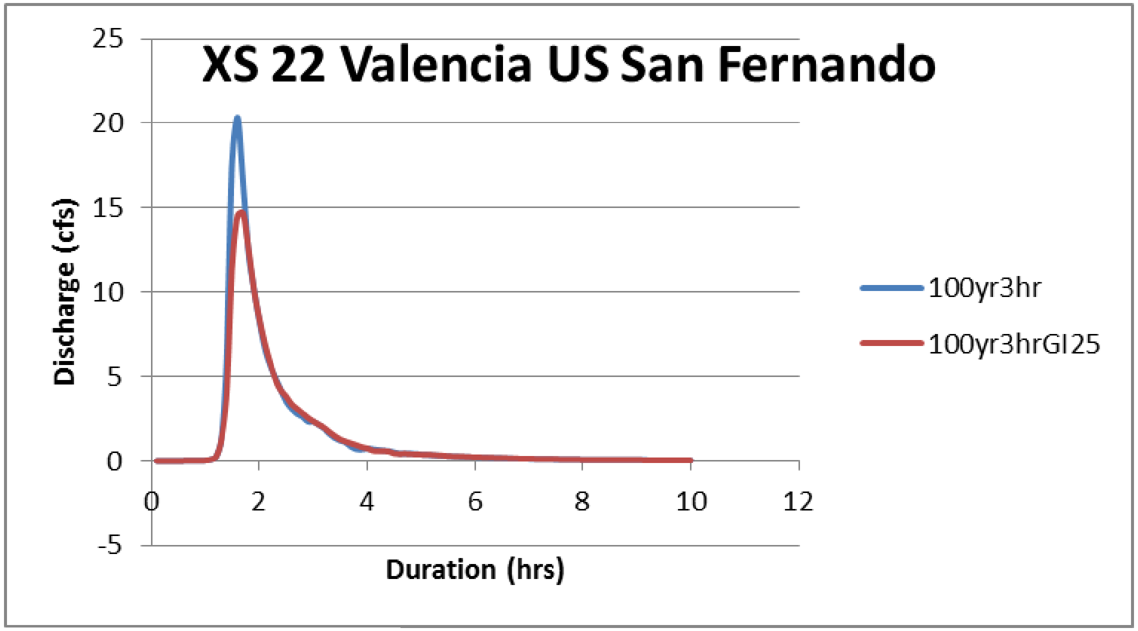
Watershed Management Group

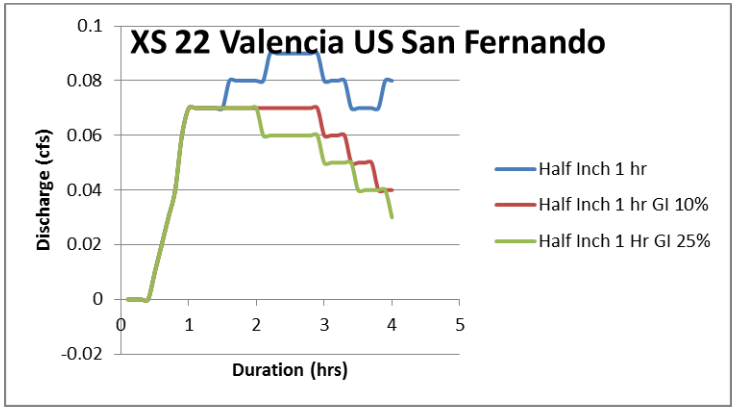
Valencia Residential

Drainage Area:

7 Acres







PIMA COUNTY FLOOD CONTROL

Watershed Management Group

Evaluation of Flood Reduction in Ruthrauff Basin from Installation of GI/LID Only in Right of Way

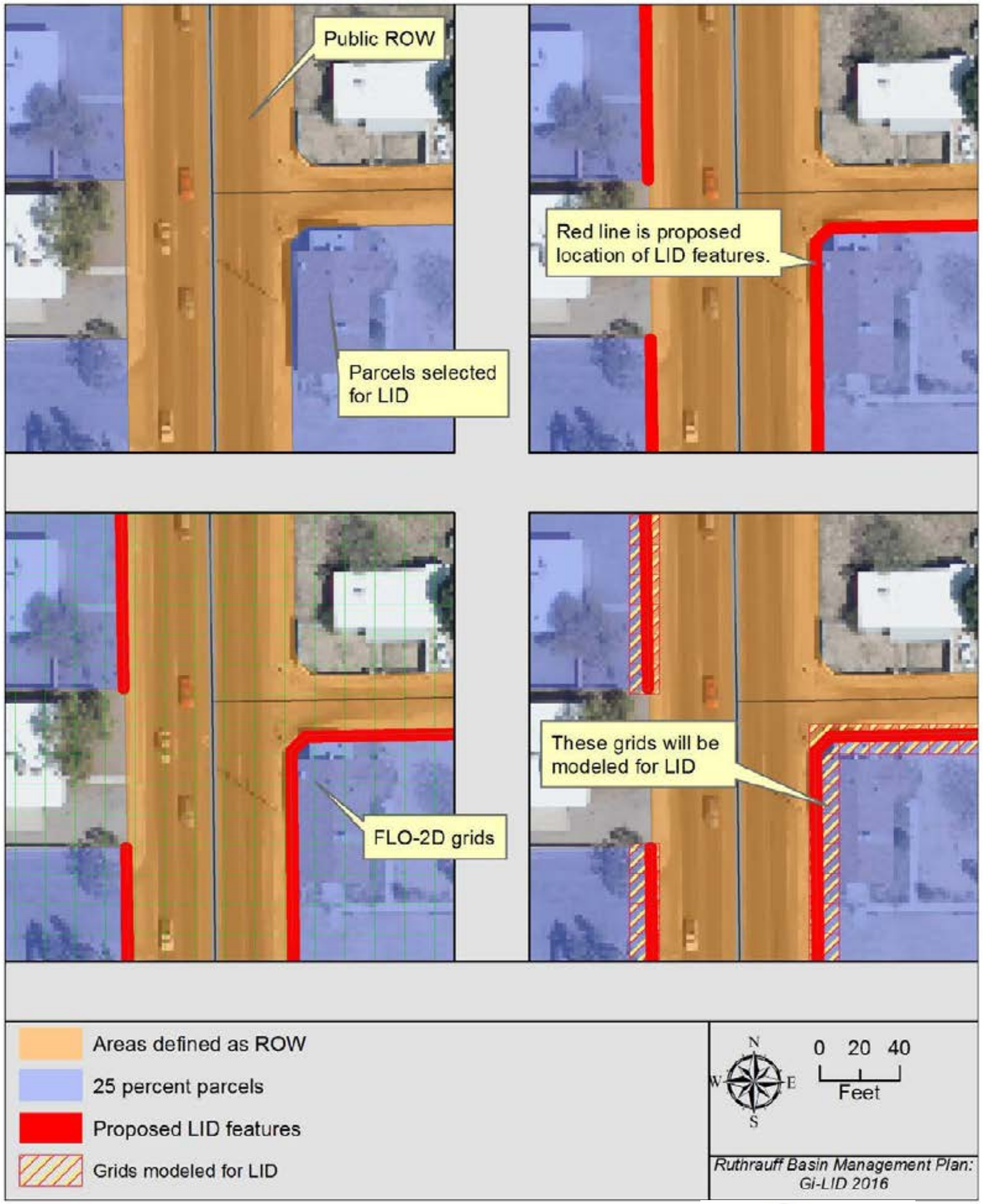
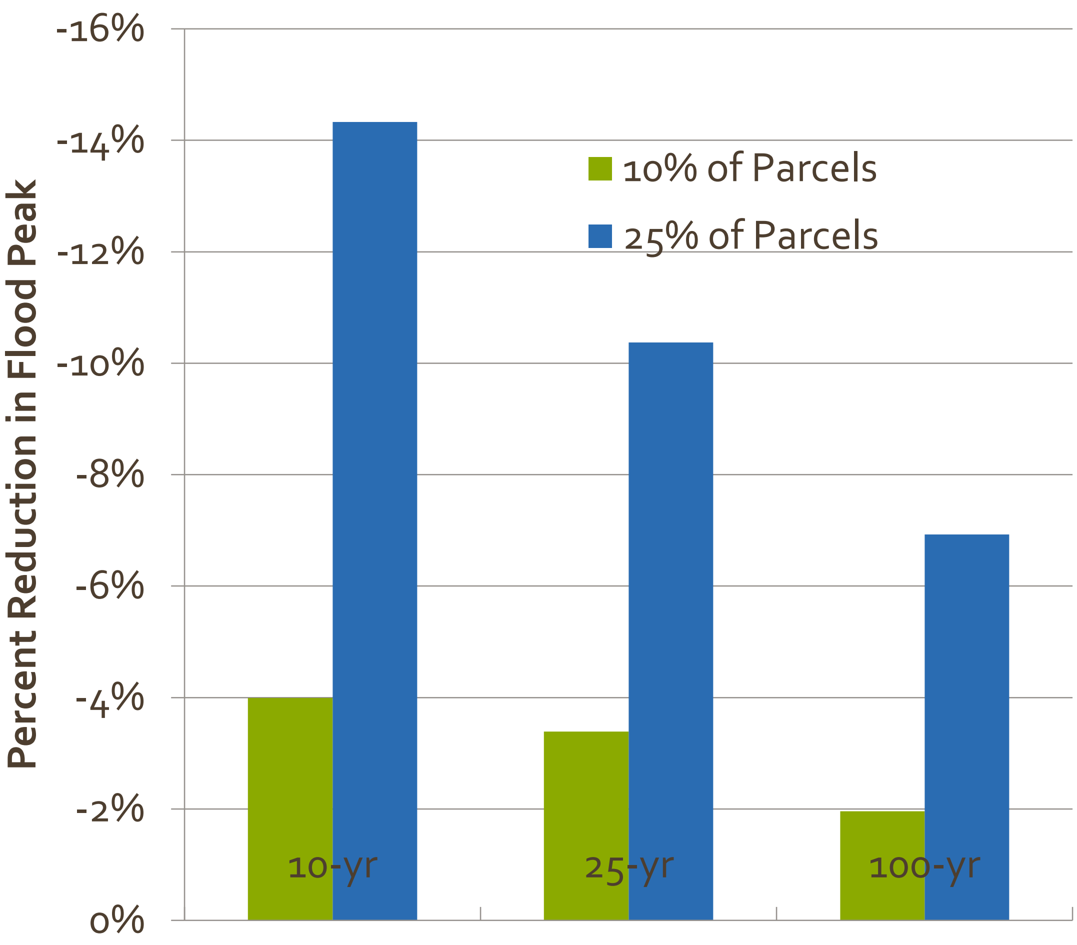


Figure 4. Overview of how FLO-2D grids were selected to model LID

JE FULLER
hydrology • geomorphology

Impact of GI/LID on Flood Peak Reduction in Ruthrauff Basin



		10% of Parcels	
	10-yr	25-yr	100-yr
Mean	-4.0%	-3.4%	-2.0%
Min	-15.5%	-11.4%	-11.1%
Max	17.6%	20.3%	25.7%
Outflow Volume Reduction	2.5%	1.9%	1.3%
		25% of Parcels	
	10-yr	25-yr	100-yr
Mean	-14.3%	-10.4%	-6.9%
Min	-33.3%	-28.9%	-22.3%
Max	0.0%	1.4%	7.1%
Outflow Volume Reduction	6.1%	4.7%	3.3%

JE FULLER hydrology • geomorphology

Evaluating a Silverbell Road Green Infrastructure Retrofit

GI Feature Added:

- Bioretention
- Water Harvesting basins
- Trees
- Traffic Calming

Analysis:

- Evaluate Green vs Gray Drainage

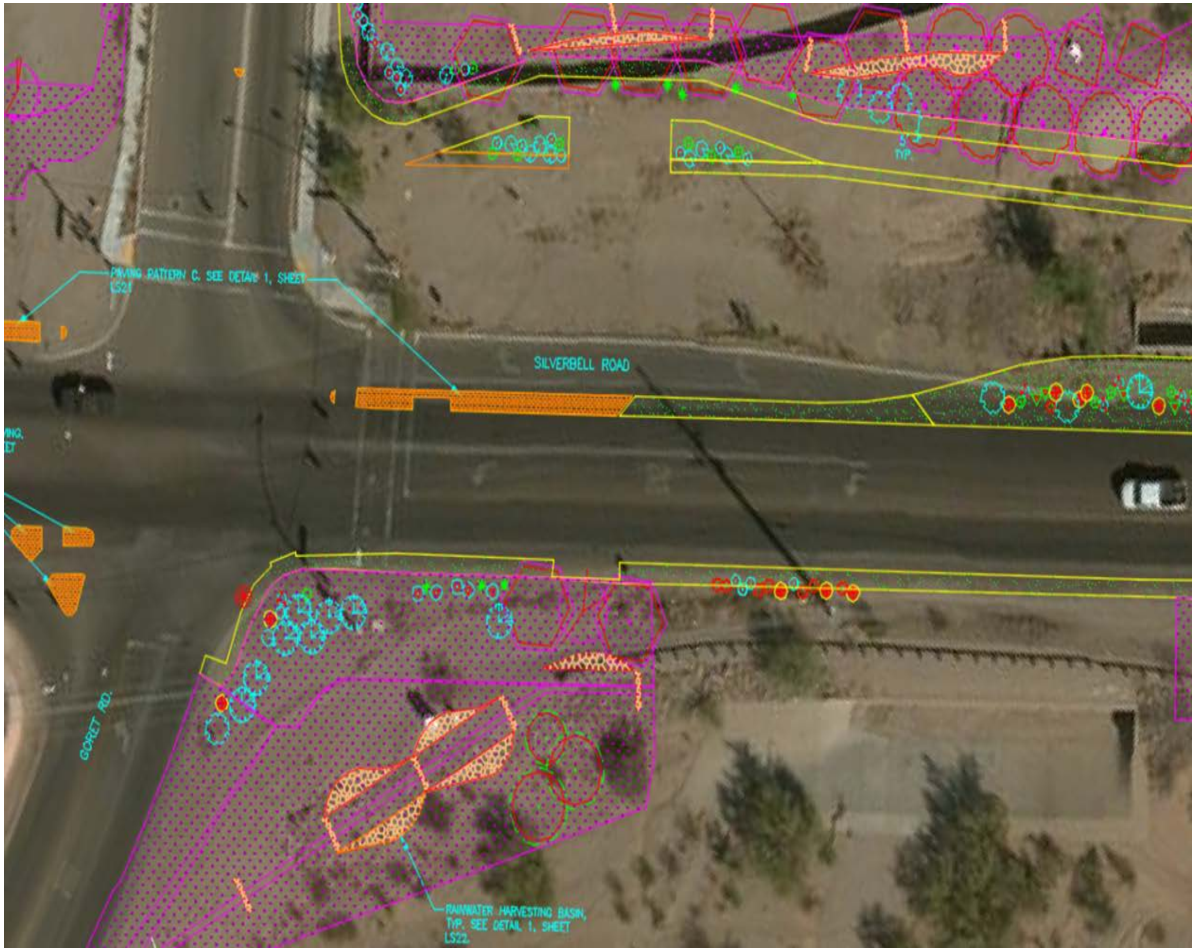
Stantec

- Evaluate Multiple Benefits

Impact Infrastructure, LLC
INFORMING IMPACT INVESTMENTS

Tool: AutoCASE®
(Envision ® Rating)

APWA Institute for Sustainable Infrastructure ASCE

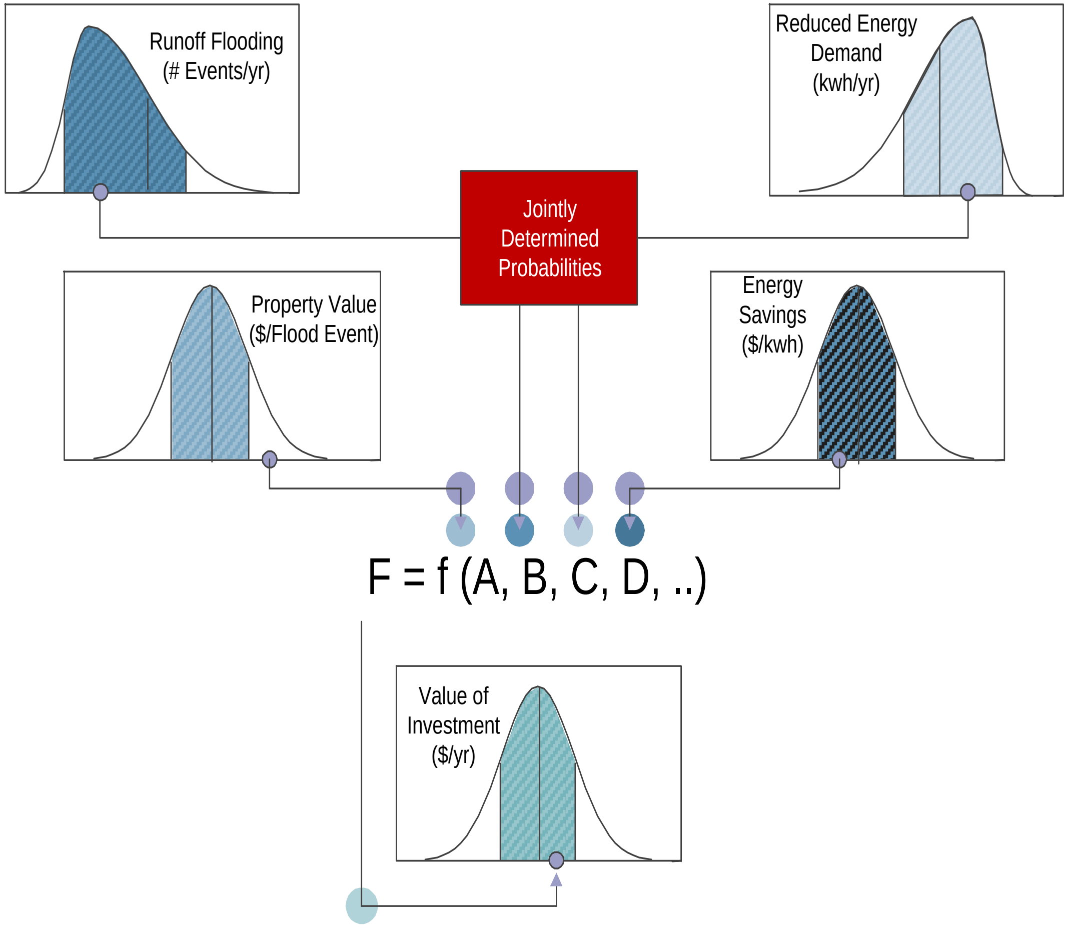


The Triple Bottom Line Framework (e.g. for a road project)

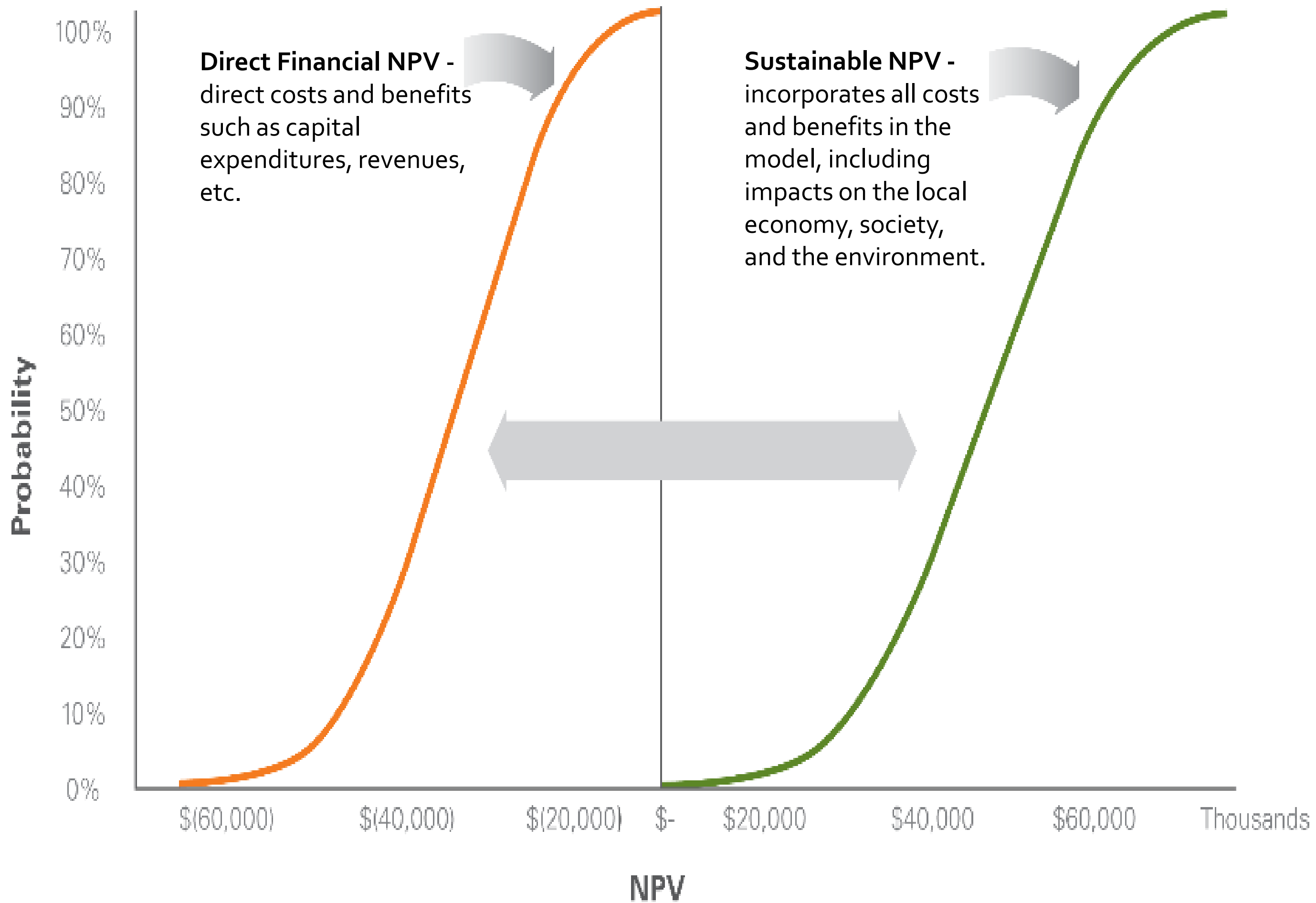
Impact Infrastructure, LLC
INFORMING IMPACT INVESTMENTS

Probabilistic Assessment produces more resilient projects

- Risk analysis is the systematic use of available data to determine how often specific events may occur and what the magnitude of their consequences is.
- Probability distributions account for uncertainty in key drivers
- Monte Carlo simulation integrates uncertainties to reveal comprehensive perspective



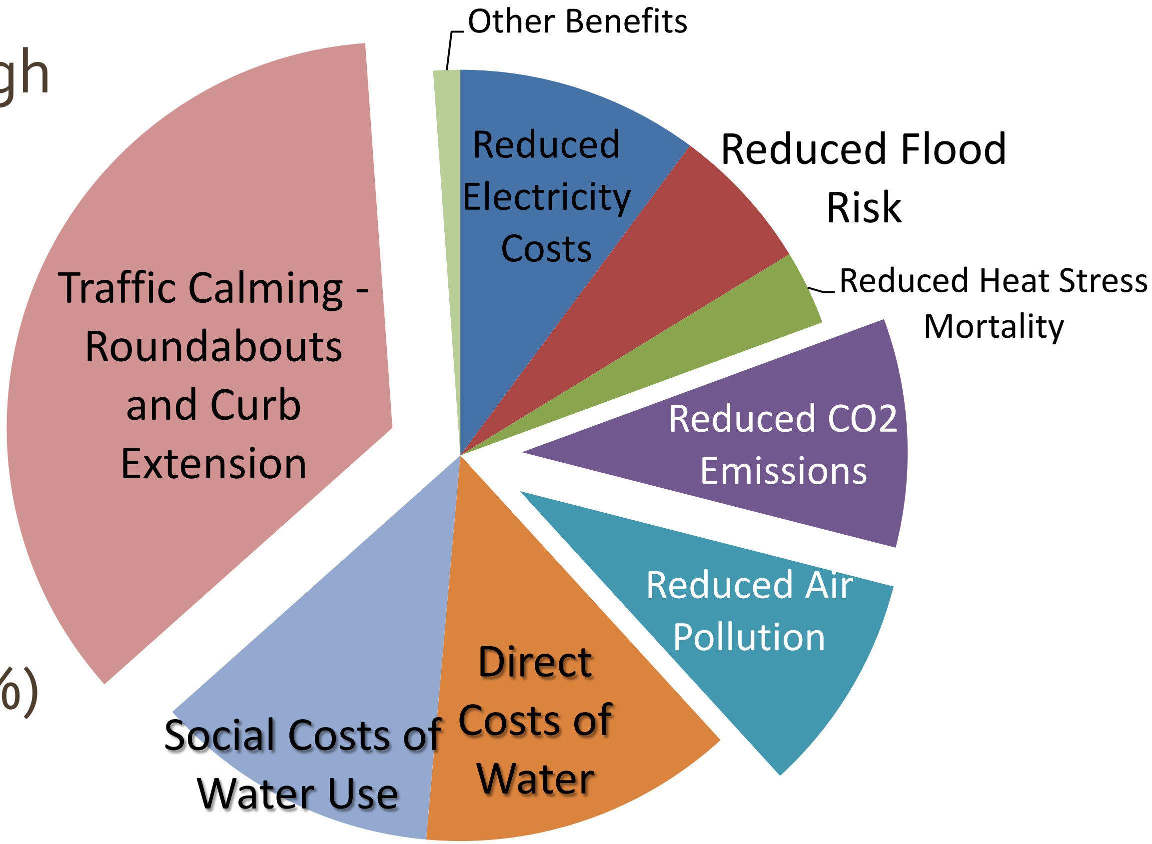
Risk-adjusted outcomes



The difference between the curves is the (net) non-market or societal benefits (externalities) such as lower carbon emissions, less urban heat island effect and other impacts.

Sustainable Net Present Value Benefits

1. Improved Safety through Traffic Calming (36%)
2. Financial and social benefits of reduced water use (25%)
3. Improved air quality (20%)
4. Energy Savings (10%)
5. Reduced Flood Risk (6%)



Impact Infrastructure, LLC
INFORMING IMPACT INVESTMENTS

Conclusions

- Pima County, Pima County Regional Flood Control District, City of Tucson and Stakeholders have been evaluating Green Infrastructure (GI) and Low Impact Development (LID) to determine it's value in:
  - Flood reduction
  - Reduction of potable water use
  - Value of co-benefits
- LID/GI is integrated into new drainage development standards
- Pima County, Pima County Regional Flood Control District, City of Tucson and Stakeholders have supported regulatory standards with Guidance
  - Green Infrastructure Manual
  - Case Studies

Acknowledgements

EPA

Tamara Mittman
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Sandy Bolduc
Ann Moynihan
Marie Light
Jennifer Becker

PAG Pima Association of Governments

Mead Mier

Stantec

Akitsu Kimoto

Tetra Tech

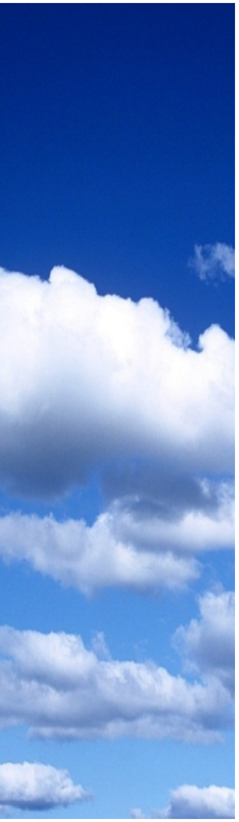
Martina Frey
Jason Wright

JE Fuller hydrology • geomorphology

Ian Sharp

Impact Infrastructure, LLC
Informing Impact Investments

John Williams
John Parker
Ryan Myers



Thank you!

Evan Canfield
evan.canfield@pima.gov

Questions?