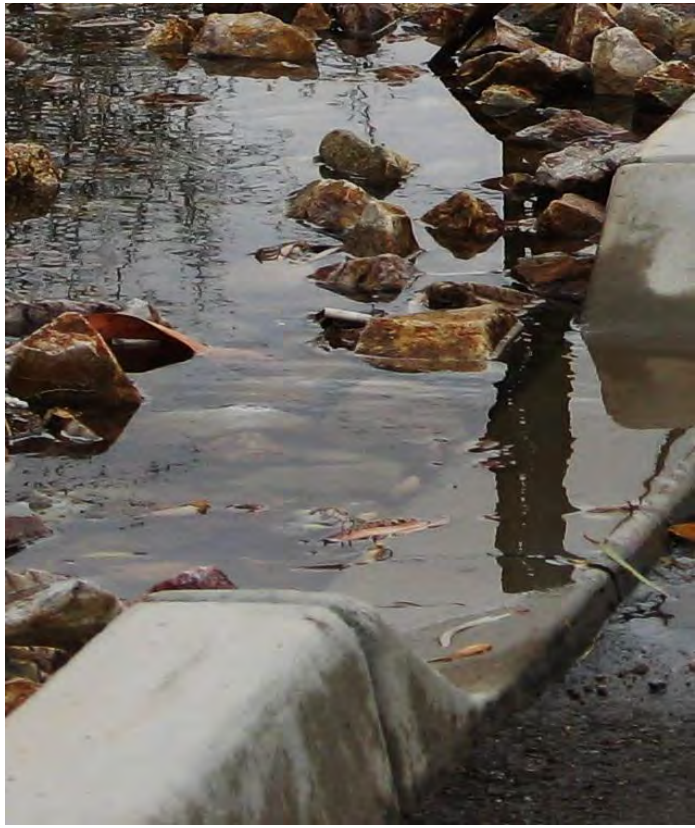
Making the Business Case
For Green Infrastructure/Low Impact Development

Irene Ogata, PLA, ASLA
Urban Landscape Manager
Office of Integrated Planning

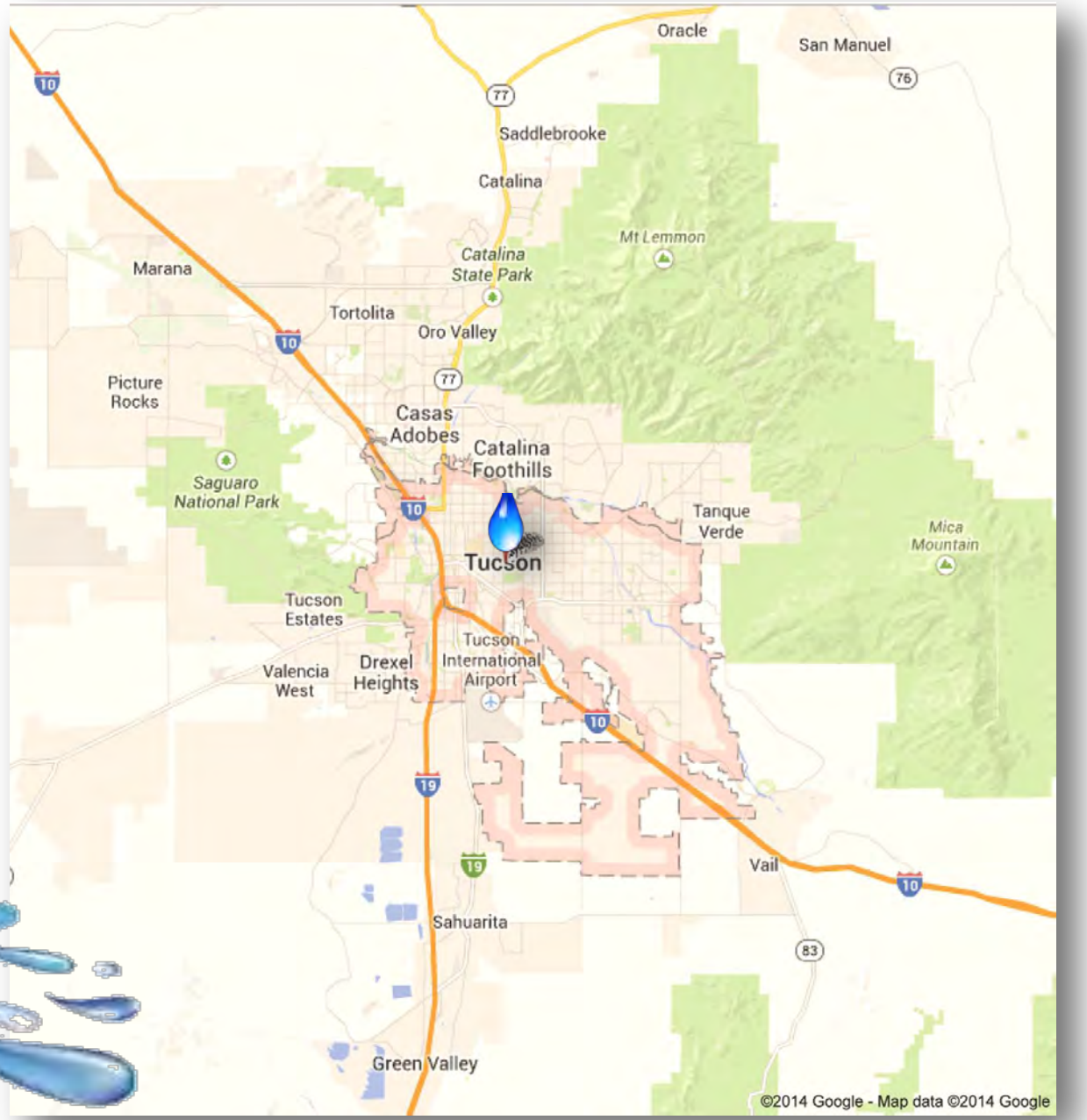
Evan Canfield, Ph.D, P.E.
Civil Engineer Manager
Pima County Regional Flood Control

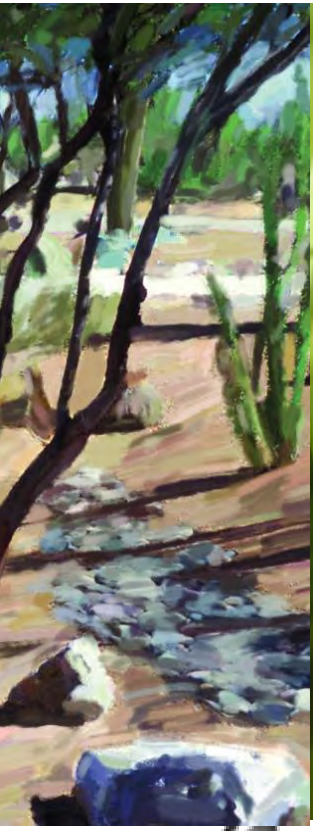
Phoenix Green Infrastructure Working Group
ASU Wrigley Hall, Rm 481
August 14, 2014



Outline of Presentation

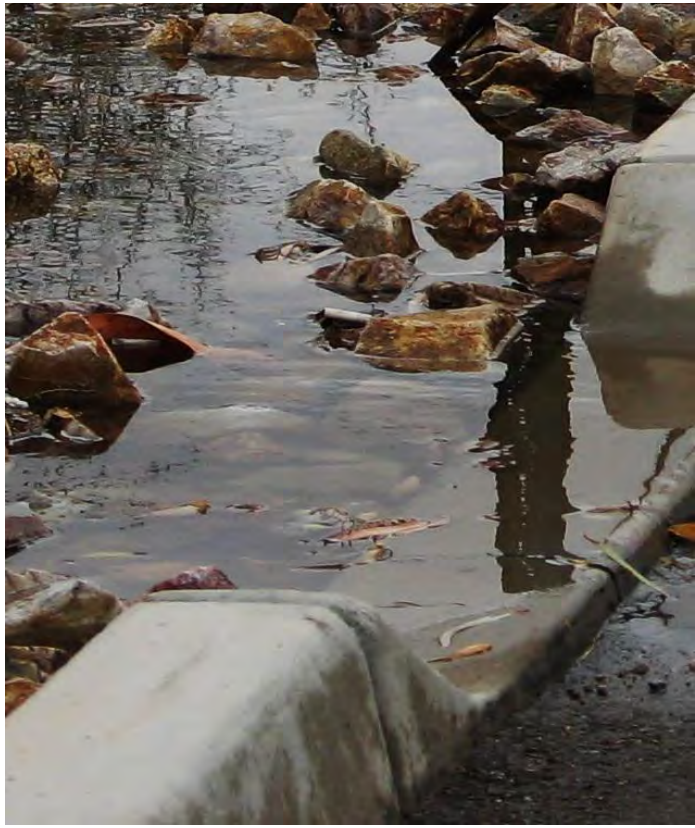
- Irene: the Economic Case
- Evan: the SROI for the Arid SW
- Joint: Urban Heat Mortality Benefit Calculation





the Economic Tool

Irene

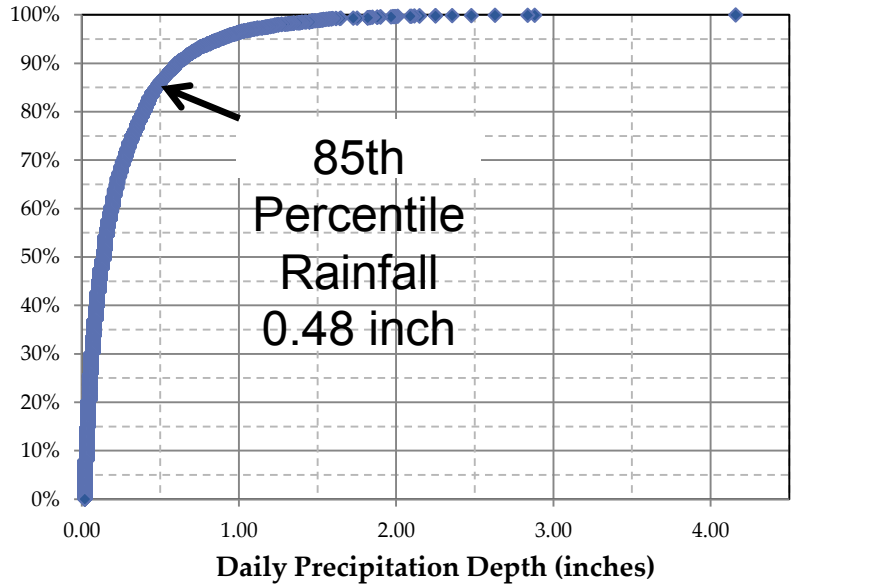


A few GI Assumptions

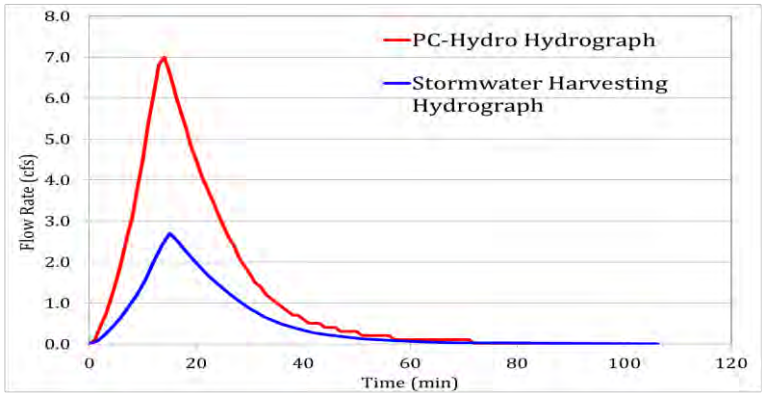
- Basic structural practices of GI

'First Flush'
Retention Requirement

(data U of A Daily rainfall 1895-2000)

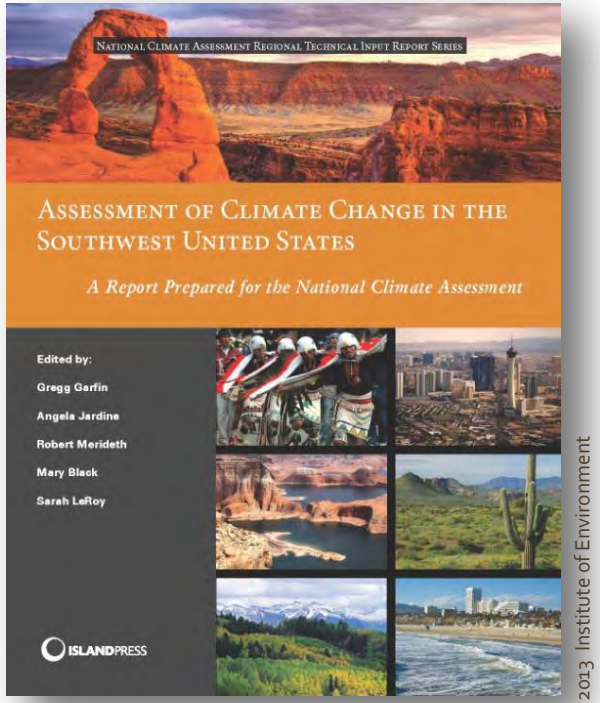


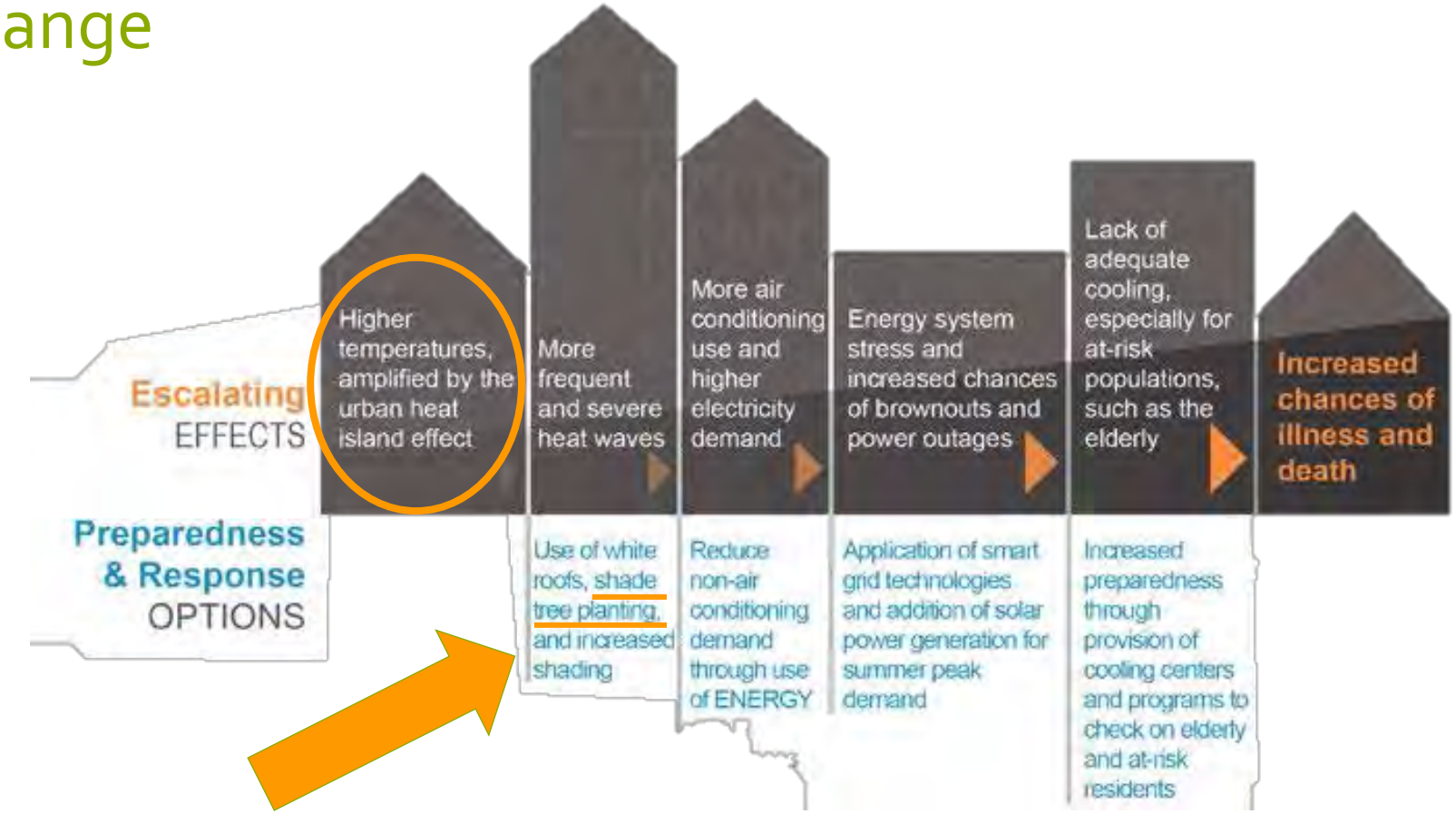
- Basic reduced peak flow post-rainfall and role of GI



Modeled Effect on Flood Mitigation
(0.8 ac watershed, 80% impervious, harvesting 1.5")

Incorporating
The Case of Climate Change





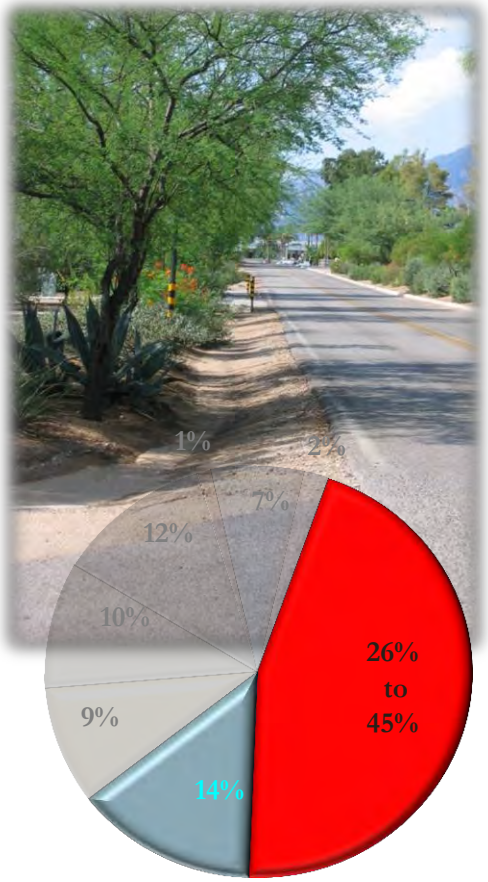
Chapter 15. Human Health

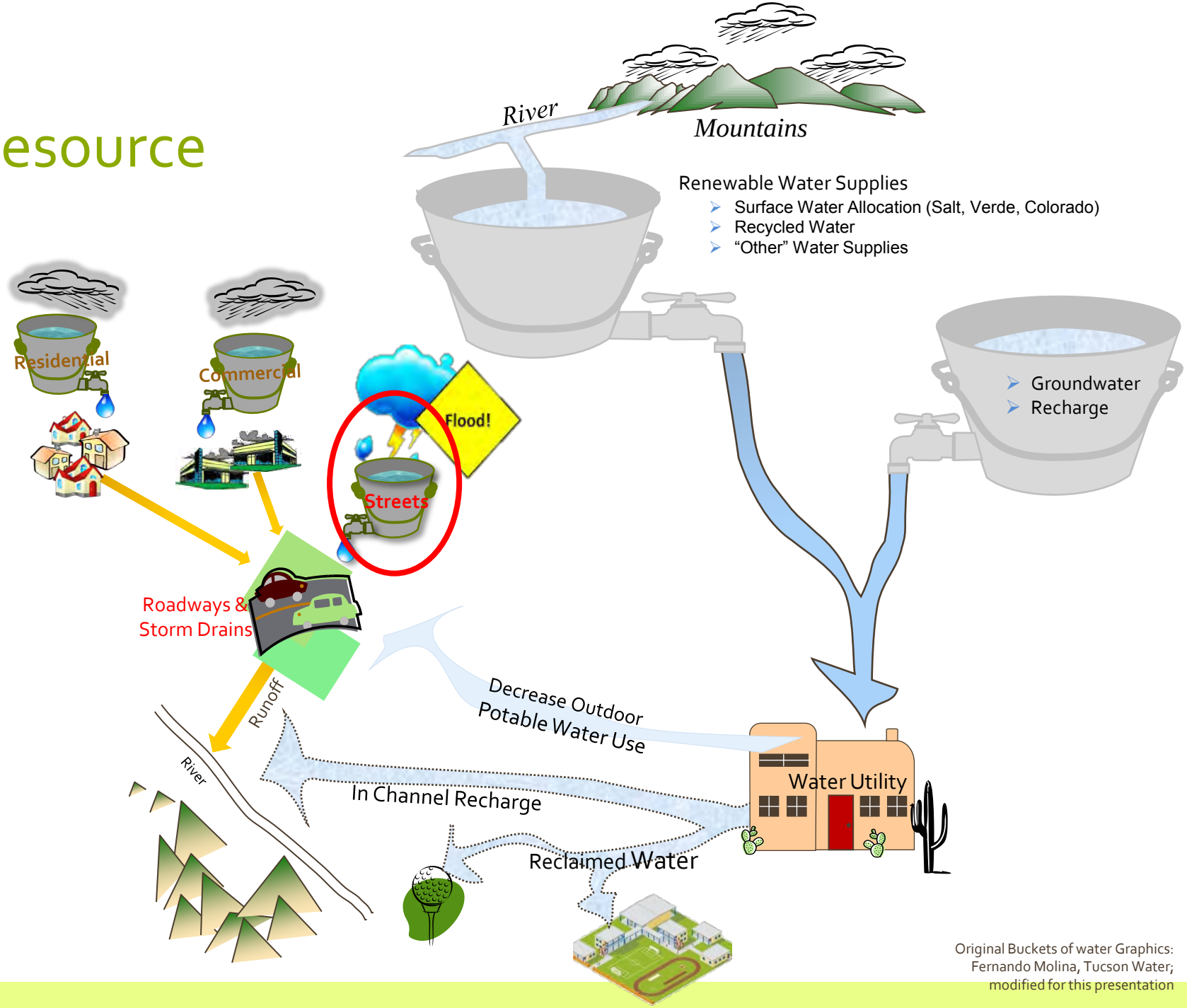
Coordinating Lead Authors: Heidi Brown (Univ. of AZ); Andrew C. Comrie (Univ. of AZ); Deborah M Dreschsler (CA Air Resources Board)

"**Heat stress**, a recurrent health **problem for urban residents,** has been the leading weather-related cause of death in the United States since 1986. . . – and the **highest rates nationally are found in Arizona.**

Garfin, G., G.Franco, H. Blanco, A.Comrie, P.Gonzalez, T.Piechota, R.Smyth, and R.Waskom, 2014: Ch. 20: Southwest. *Climate Change Impacts in the United States: The Third National Climate Assessment*, J.M.Melillo, Terese (T.C.) Richmond, and G.W.Yohe, Eds, U.S. Global Change Research Programs .

Incorporating The Case of Water Resource & UHI Mitigation





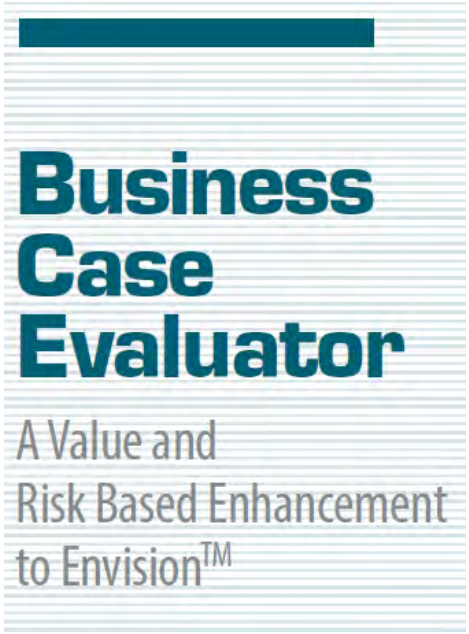
Phoenix 2011 Water Resource Plan: 45% outdoor water use

Original Buckets of water Graphics: Fernando Molina, Tucson Water; modified for this presentation

The Business Case: Developers

- Business Case Evaluator (BCE) and AutoCASE
  - Developed by Impact Infrastructure, LLC
    - Partners: P.E. and economist
  - BCE is excel format, free, available on-line
    - Developed in conjunction with Institute for Sustainable Infrastructure Envision, Economics Committee
  - AutoCASE is a commercial software
    - Stormwater module set for release in August
    - Transportation (Roads and Bridges) target release in early 2015 (?)

The Business Case: BCE & AutoCASE



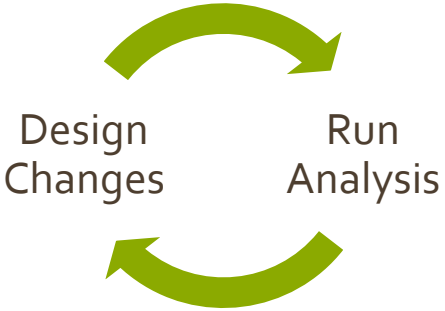
- Infrastructure decision process
  - Some economic values & impacts ignored
  - Custom economic analysis can be costly

- Business Case Evaluator
  - Aid decision-making process
  - Economic matrix
  - Universal industry standards
  - Includes government mandated regional & national data
  - Can be used at various stages of a project, from initial conceptual design stage to points when change orders need to occur

AutoCASE™

Automation

The Next Step



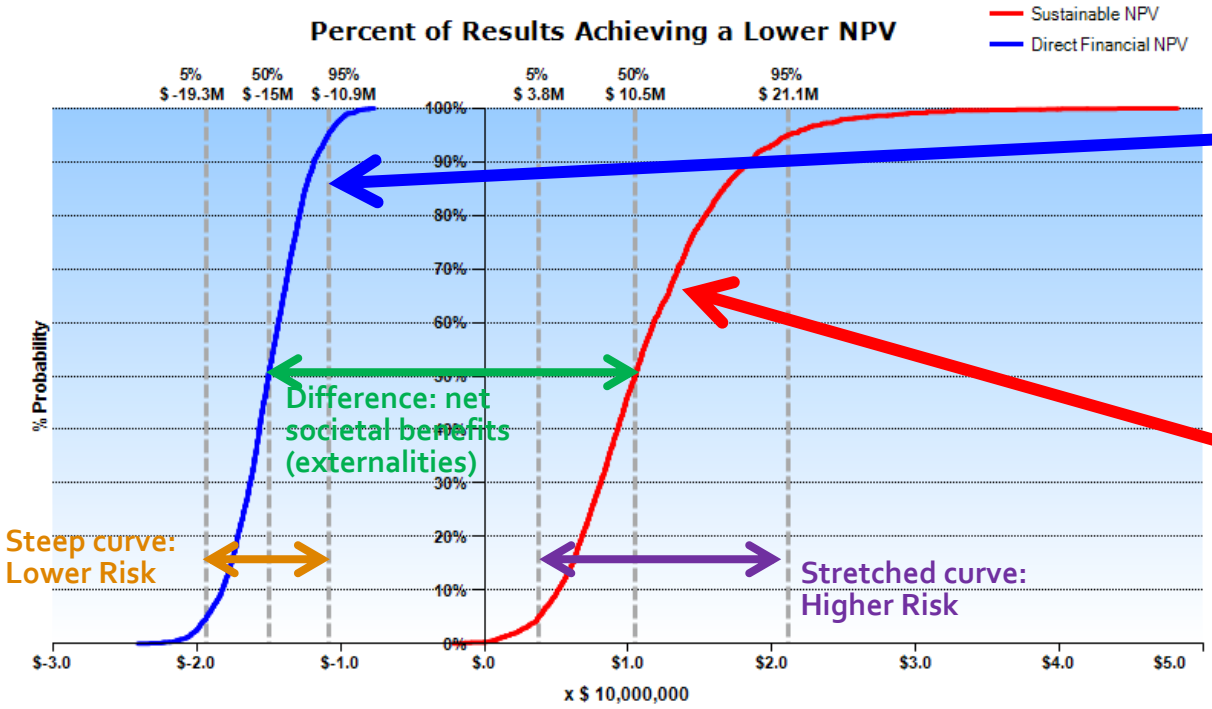
AutoCASE™

Stantec

The Business Case: BCE & AutoCASE

Example of the probability curve output of a project

	NPV	Breakeven (Years)	SROI	SIRR
Ave:	$11,301,060.87	12.78	189.08%	2212.49%
St Dev:	$5,636,891.32	3.32	74.79%	20864.39%

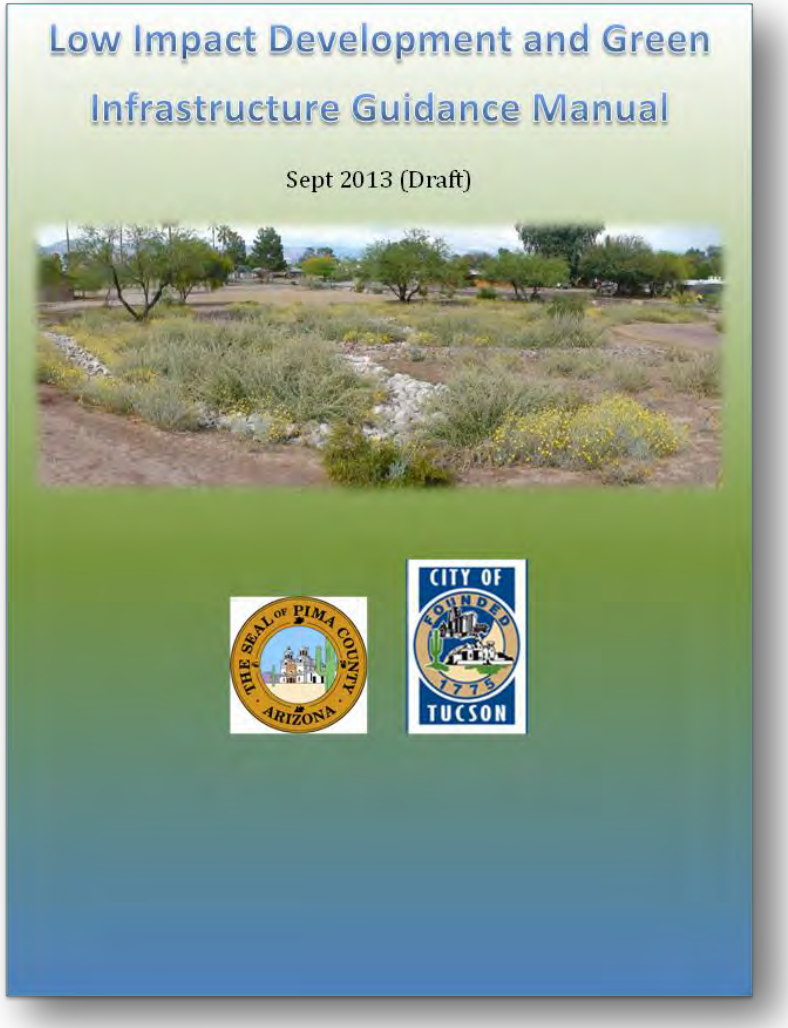


Probability of Achieving a Lower NPV		
Percentile and associated minimum Direct Financial NPV:	5%	-$19,304,313
	50%	-$15,021,351
	95%	-$10,863,310

- Direct Financial Net Present Value (NPV)
  - Direct costs – cash inflow and outflow
  - Benefits: capital expenditures, revenues, other
  - Does not include: air pollution, carbon emissions, water quality, other
- Sustainable Return on Investment (SROI)
  - Incorporates impacts including local:
    - Economy
    - Society
    - Environment

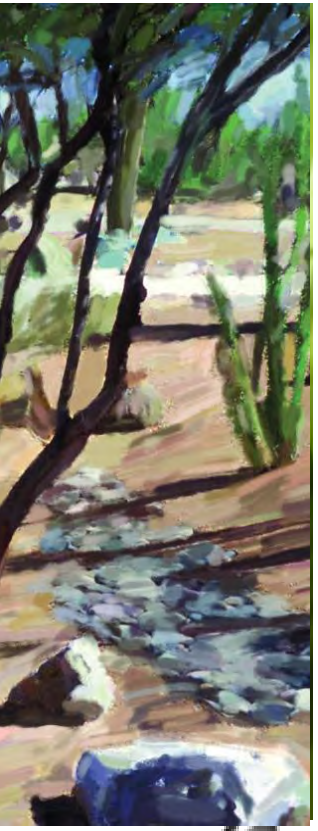
Graph & Infromation: Impact Infrustructure, LLC; AutoCASE presentation Pima County, 7-15-2014

The Business Case: AutoCASE Stormwater Beta Testing



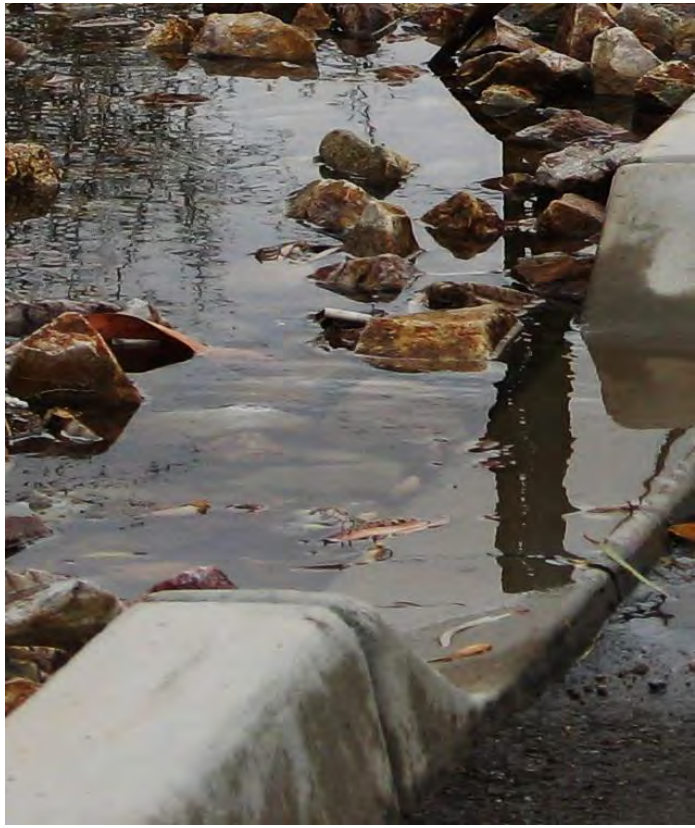
- Cost Benefit Analysis for elements in Manual
  - 8 GI features evaluated
  - 2 sites with clustered GI features
    - Small Commercial site
    - Roadway section
  - AutoCASE can be utilized as plug-in to Audesk's Civil3D CADD

- Data input
  - Project specific
  - Local data used when available



The SROI for arid SW

Evan



Collaborative Effort: AutoCASE Review Team

Public: Pima County

Regional Flood Control District

Public: Other

Pima Association of Governments

. Public: City of Tucson

Office of Conservation & Sustainable Development

Dept. of Transportation: Stormwater Division

Professional/Trade

Stantec

Education: Univ. of Arizona

Water Research Resource Center

The Business Case: AutoCASE Stormwater Beta Testing

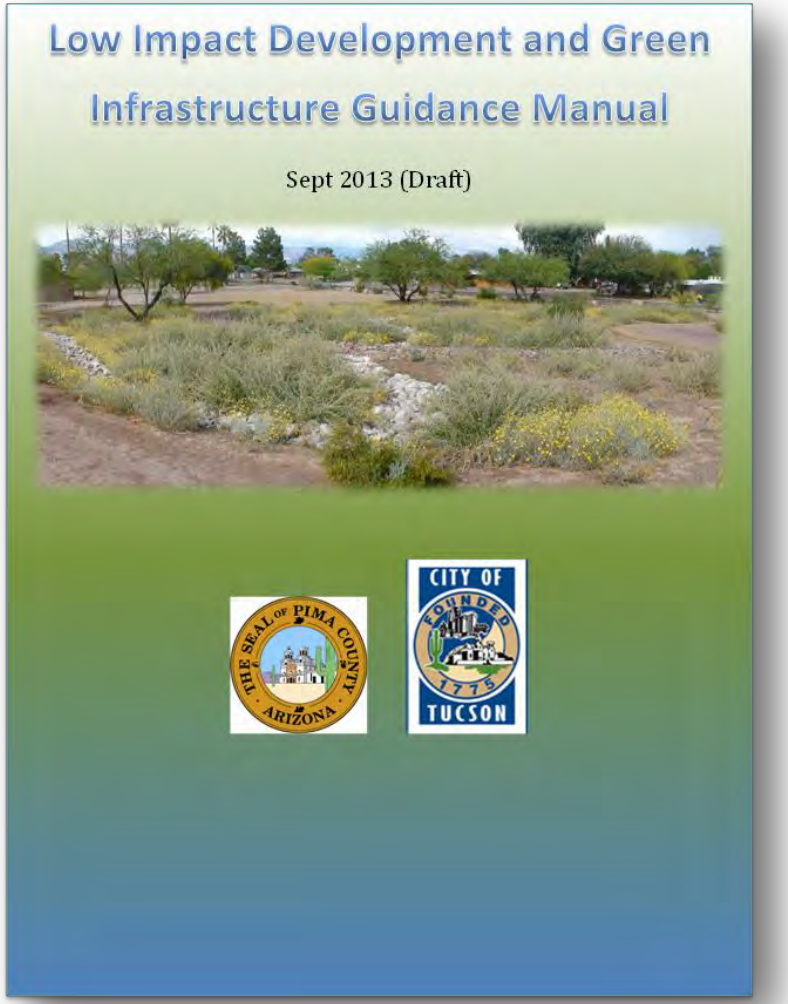
Review of AutoCASE™

- **Values the (1) costs, (2) benefits and (3) risks** of infrastructure projects
- Provides **different stakeholder's** perspectives of value
- Can be used throughout the **planning and design phases**

- AutoCASE™ decision support suite:
  - **Design for maximum overall benefit** as defined by the Sustainable Return On Investment (financial, social and environmental)
  - **Ability to run business cases** on alternative green infrastructure stormwater designs testing whether the overall benefits exceed the costs – **adjusted for risk**.
  - The economic analysis will be used to **determine which GI features give the greatest benefits** in Tucson and how they can be used to comply with:
    - Commercial rainwater harvesting ordinance
    - Green streets guidelines

Slide: John Wise – Urban Heat Island presentation 5-8-2014 based on Impact Infrustructure, LLC information

The Business Case: AutoCASE Stormwater Beta Testing



- **GI/LID Practices Evaluated**
  - **8 GI features evaluated**
    - Water Harvesting Basins
    - Bio Retention Basin
    - Xeriscape Swale
    - Cistern
    - Infiltration Trench
    - Detention Basins (or Extended Detention Basin
    - Pervious Pavers
    - Curb Extentions (chicanes, medians, traffic circles and road diets with inlets to collect stormwater

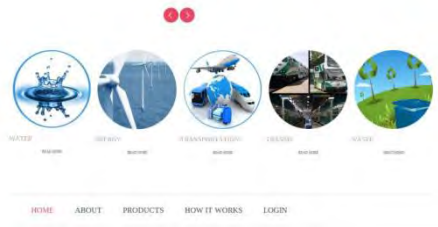
- **Commercial with clustered GI features**
  - Porous paving
  - Cistern
  - Water harvesting basins
  - Extended Detention
  - Bio Retention Basin

- **Roadway section with clustered GI features**
  - Infiltration Trenches
  - Water Harvesting Basins
  - Curb extensions
  - Trees

The Business Case: AutoCASE Stormwater Beta Testing

GI/LID Results

	Net Present Values – Median (50th Percentile)								
	Costs		Benefits						
	CapEx Cost	O&M Costs	Flood Risk Reduction	Property Value Uplift	Heat Mortality Risk Reduction	Reduced CO_2 Emissions	Reduced Other Costs	Direct Financial NPV	Total SNPV
Bioretention	-$2,096	-$377	$169	$49	$515	$0	$0	-$2,473	-$1,740
Pervious Pavers, relative to asphalt	-$2,496	-$834	$168	$51	$513	$0	$0	-$3,330	-$2,597
Detention Basin / Extended Detention	-$1,215	-$194	$234	$50	$514	$0	$0	-$1,409	-$612
Water Harvesting Basin*	-$132	-$7	$200	$52	$518	$0	$0	-$139	$631
Cistern	-$2,685	$0	$95	$0	$0	$0	$448	-$2,685	-$2,142
Xeriscape Swale	-$383	-$173	$159	$51	$512	$0	$0	-$556	$167
Infiltration Trench	-$701	-$167	$200	$50	$515	$0	$0	-$868	-$102
Pavement	-$10,817	$0	-$424	$0	$0	$0	$0	-$10,817	-$11,241
Concrete	-$14,106	$0	-$379	$0	$0	-$1,346	$0	-$14,106	-$15,831
	*Entered as Infiltration Basin								

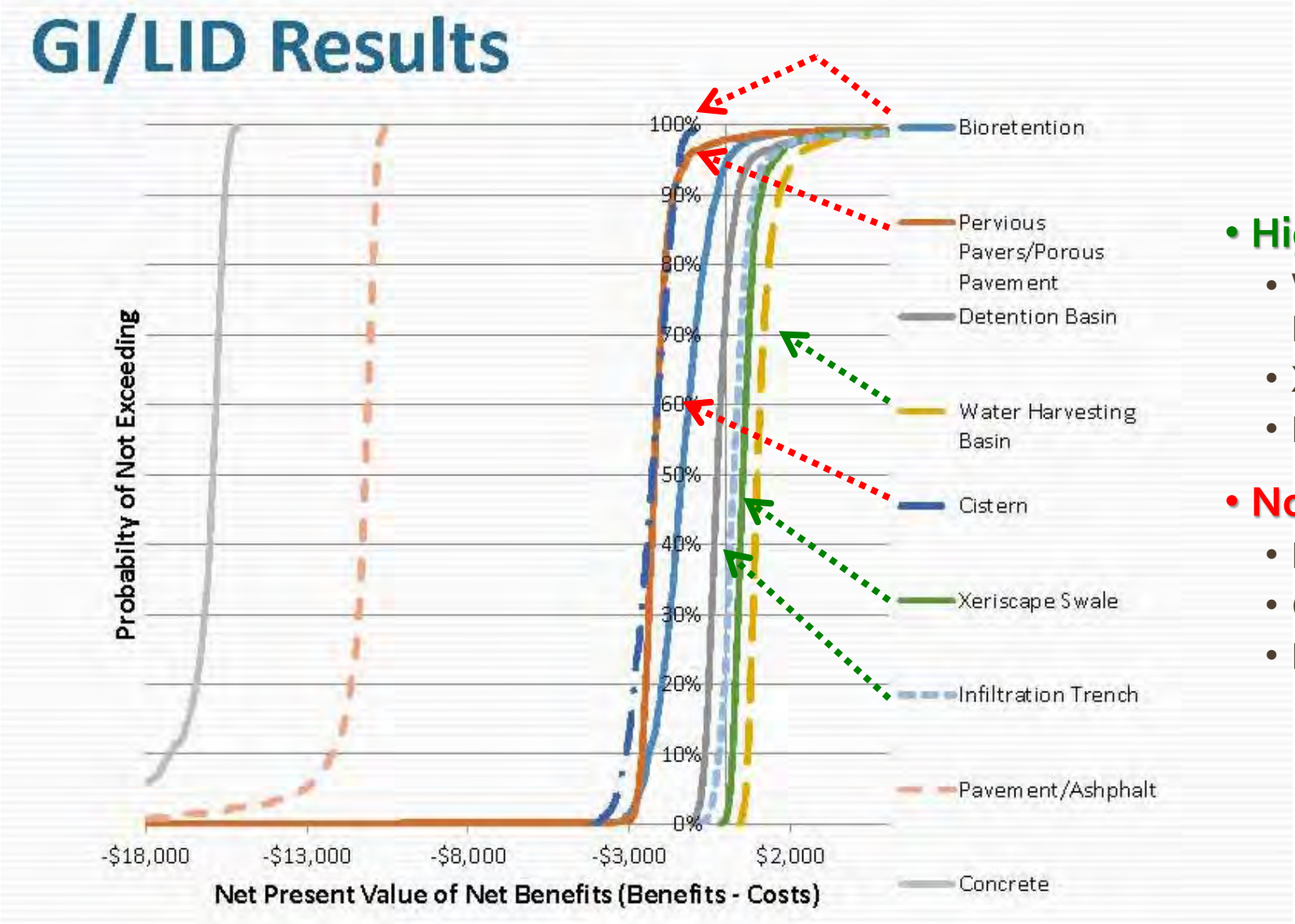


Not Beneficial

Beneficial

Table: Impact Infrustructure, LLC AutoCASE final report 7-2014

The Business Case: AutoCASE Stormwater Beta Testing



- **Highest Beneficial GI features**
  - Water Harvesting Basin / Infiltration Basin
  - Xeriscape Swale
  - Infiltration trench
- **Not as cost Beneficial GI features**
  - Pervious Pavers/Porous Pavement
  - Cistern
  - Biorention

Graph: Impact Infrustructure, LLC AutoCASE final report 7-2014

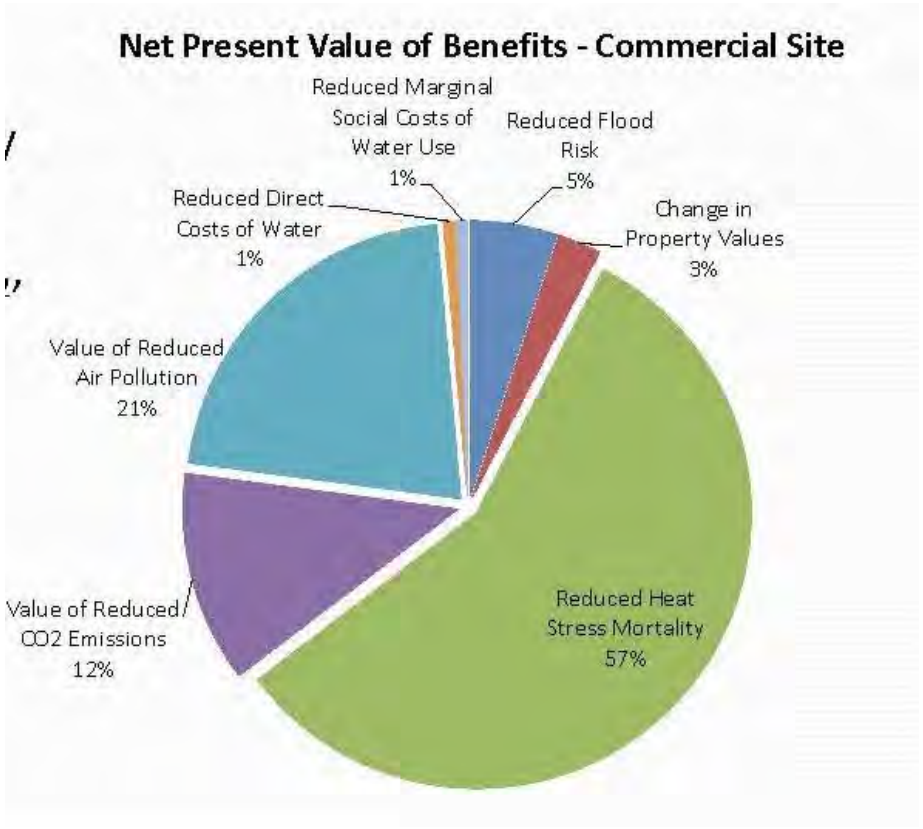
The Business Case: AutoCASE Stormwater Beta Testing

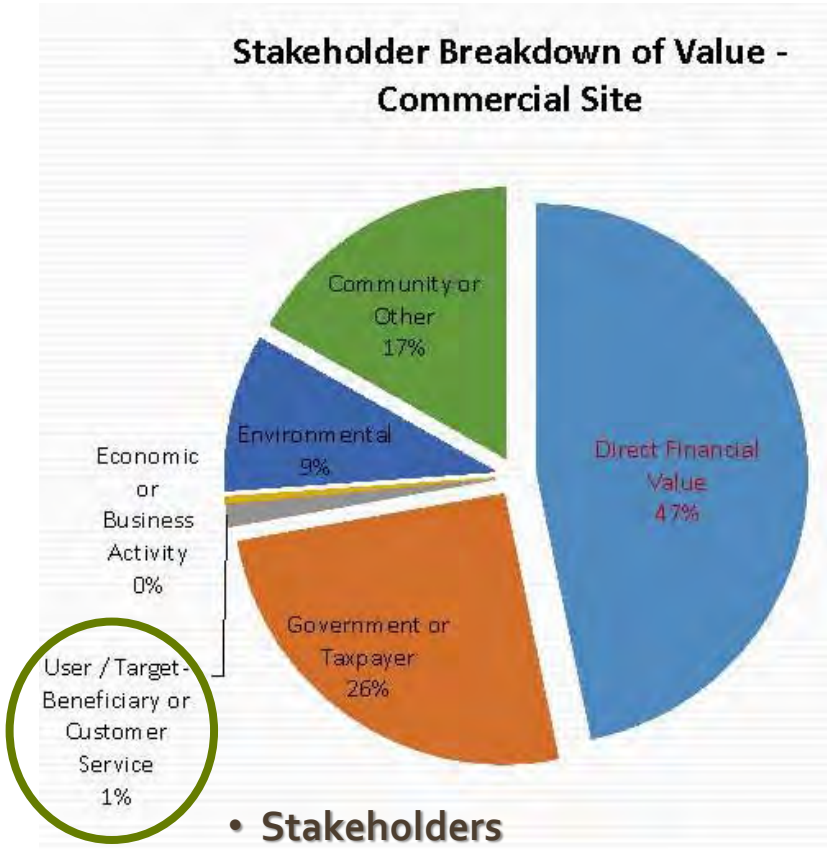
Reduced Electricity Costs
Reduced Natural Gas Costs
Reduced Flood Risk
Change in Property Values
Reduced Heat Stress Mortality
Value of Reduced CO_2 Emissions
Value of Reduced Air Pollution
Reduced Direct Costs of Water
Reduced Marginal Social Costs of Water Use
Increased Pavement Longevity Benefit
Traffic Calming - Roundabouts and Curb Extension

- Added GI/LID features to commercial site & road re-design provide net benefits to the Tucson Region
- Largest benefits:
  - Heat related mortality
  - Traffic calming
  - Flooding
  - Reduced water costs
  - Air pollution

Graph: Impact Infrustructure, LLC AutoCASE final report 7-2014

The Business Case: AutoCASE Stormwater Beta Testing



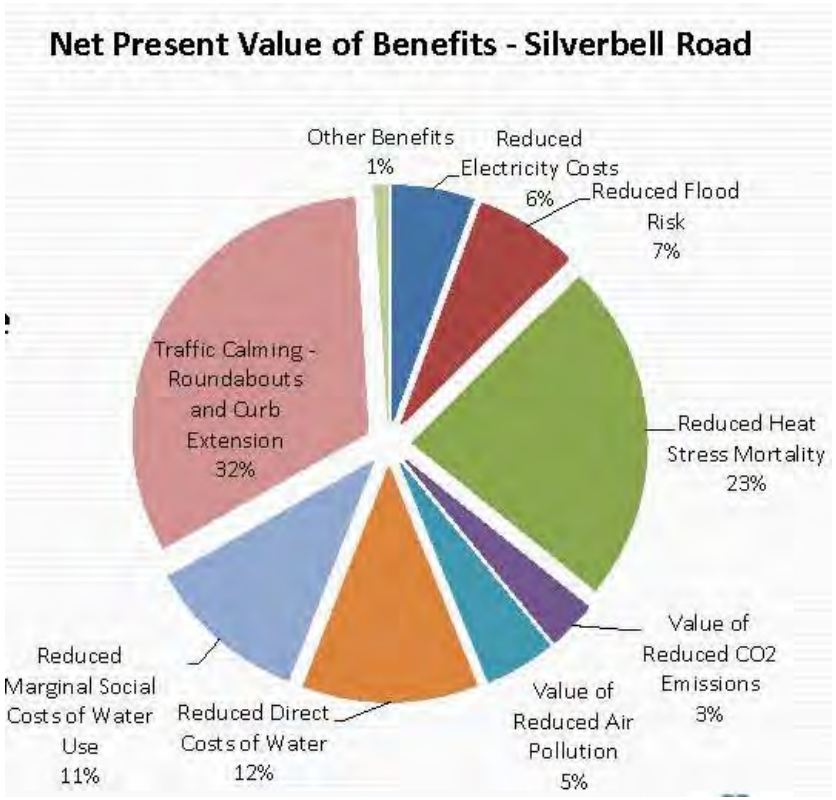


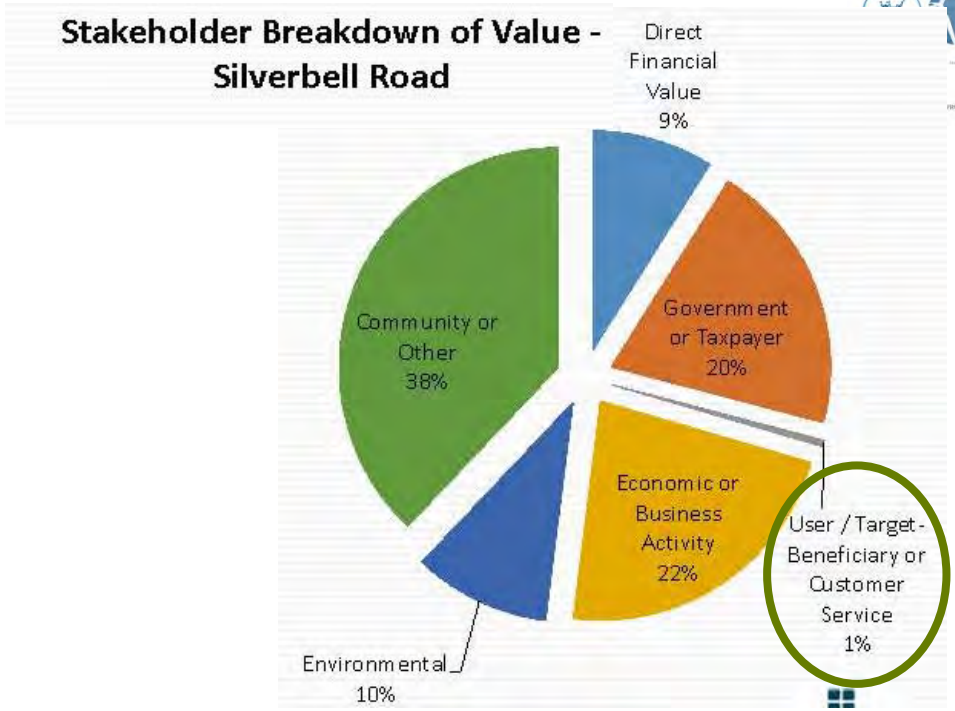
- **Commercial Site Benefits**
  - Heat related mortality largest benefit
  - Air pollution: CO, SO_2, NO_2, PM, O_3
  - CO_2

- **Stakeholders**
  - Government, community and environment benefit
  - Government: lower water irrigation water, higher economic activity, reduced heat mortality, lower health costs (lower air pollution)
  - Community: lower mortatlity; better health
  - Environment: reduced pollution; reduced carbon emissions

Graph: Impact Infrustructure, LLC AutoCASE final report 7-2014

The Business Case: AutoCASE Stormwater Beta Testing

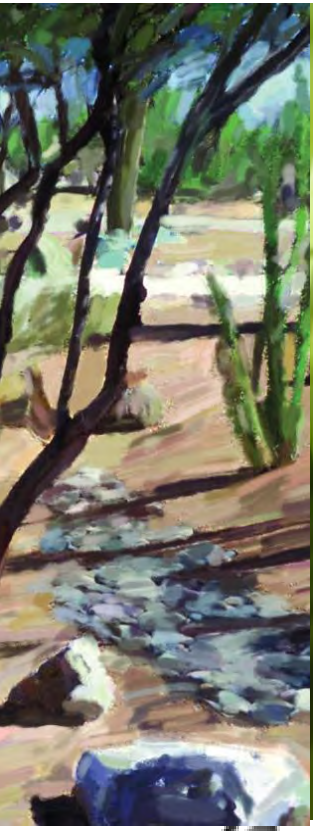




- **Road Re-design Benefits**
  - Largest benefit: (a) reduced accidents, (b) heat-related mortality, (c) reduced water use (financial + social costs)
  - **Value of Statiscal Life**: range $5-13 million, median of $9.1 million (US DOT 2014 Guidance

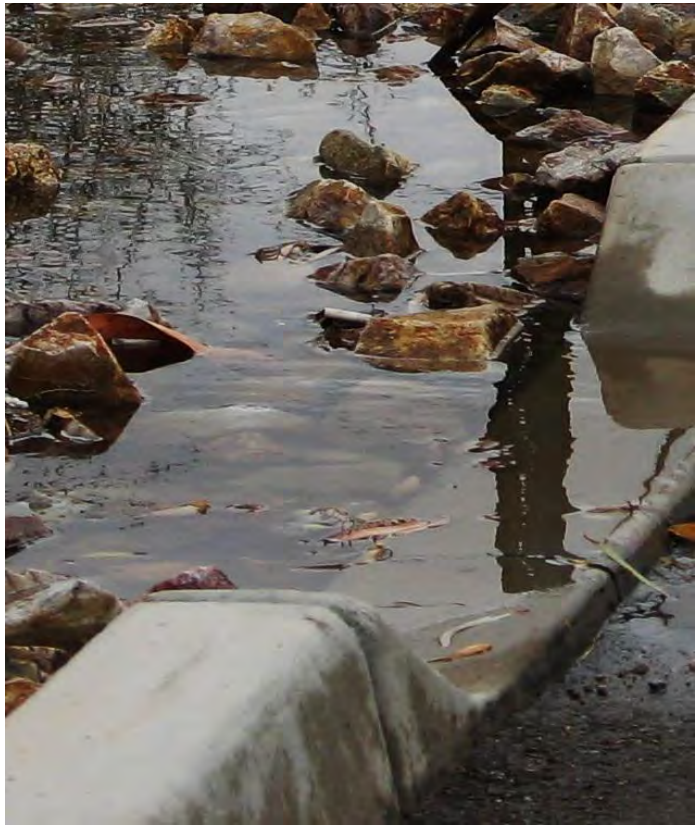
- **Stakeholders**
  - Public works project: user (driver) does not get as much value as community, government or business
  - Community: (a) reduced risk of water shortages, (c) reduced water use (financial + social costs)
  - Economics (a) reduced social cost of water; (b) increase economic activity due to accident reductio
  - Government: (a) reduced heat mortality; (b) decreaded flooding risk; (c) reduced carbon + air pollution

Graph: Impact Infrustructure, LLC AutoCASE final report 7-2014



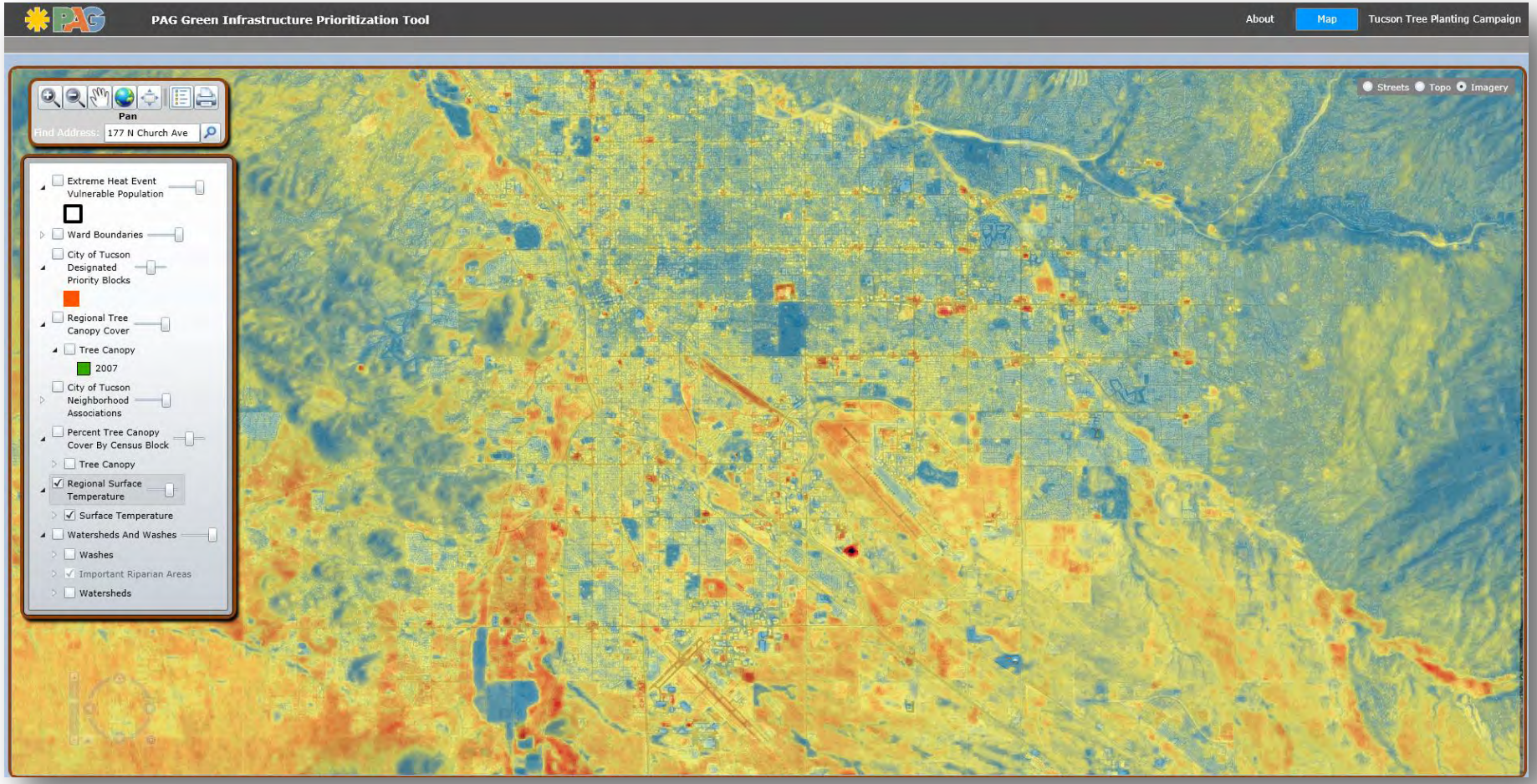
Urban Heat Mortality Benefit Calculation

AutoCASE final report, Impact Infrastructure, LLC



Benefit Calculation Example

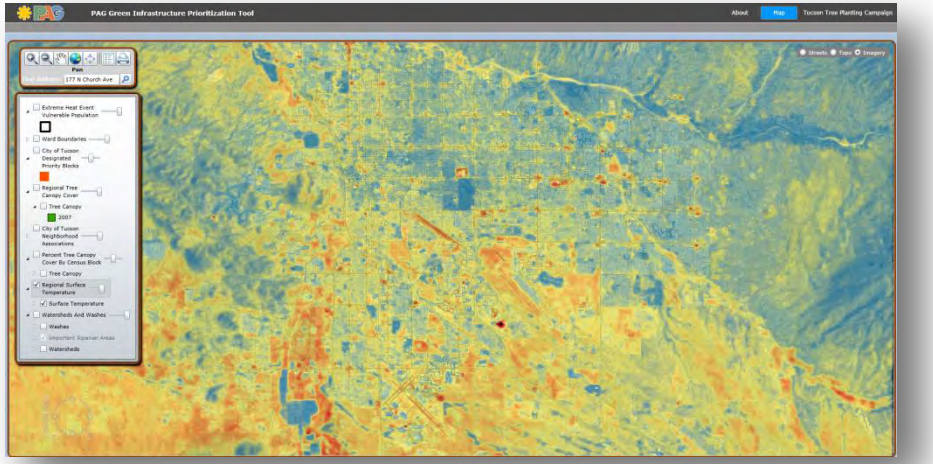
Urban Heat Island and Mortality



Urban Heat Island Map

Pima Association of Governments

Benefit Calculation Example:
Increased Vegetation & Reduced Mortality

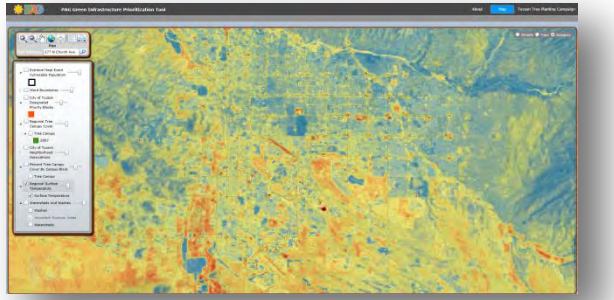


- Episodes of extremely hot (or cold) temperatures are associated with increased mortality.
- The authors[1] found a strong association of the temperature and a mortality relation with latitude.
- The model developed in this analysis is used for projecting the **change in mortality as a result of reducing the heat island effect.**
- We determine the percentage increase in vegetation from the GI features.
- Then we calculate the overall reduction in temperature as a result of the project based on percent increase is vegetated area.
  - General association used: a **10% increase in vegetation reduces temperatures in a region by 0.39 to 0.70 °F**.[2,3]

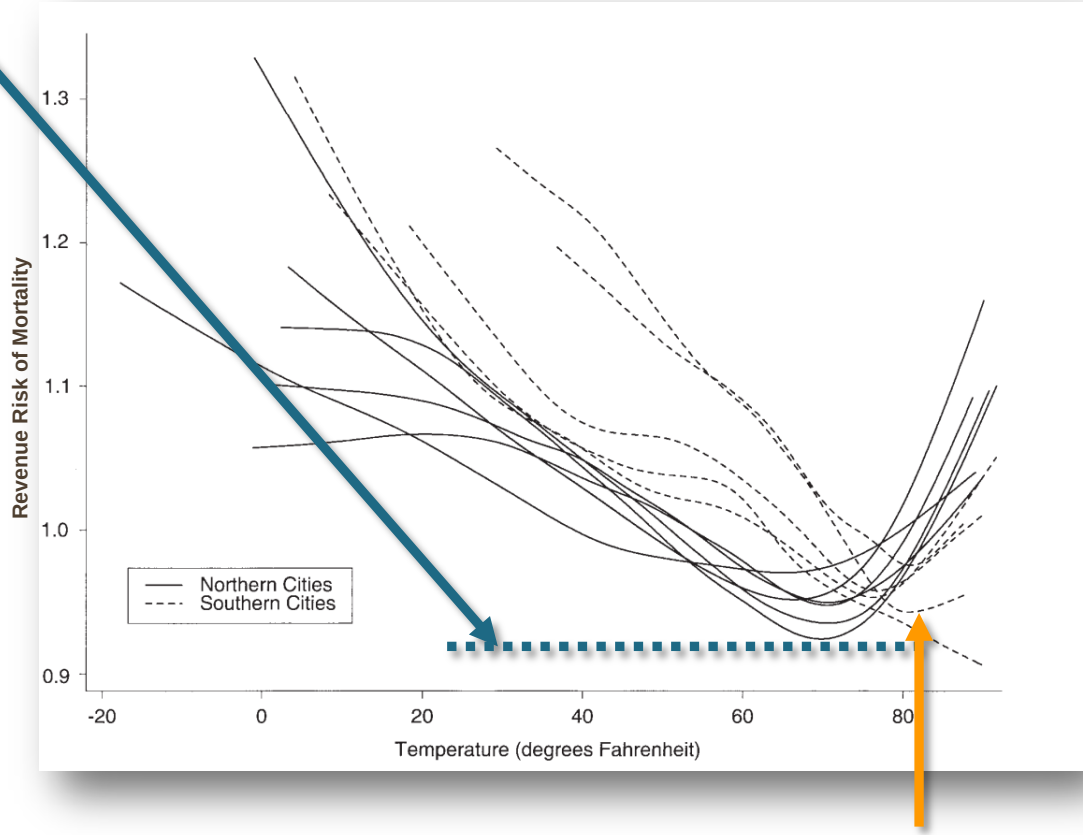
[1] "Temperature and Mortality in 11 Cities of the Eastern United States", Curriero et al., Am J Epidemiol Vol. 155, No. 1, 2002
[2] "Meteorological and Air Quality Modeling", Hudischewskyj et al., 2001
[3] "Streamlined Mesoscale Modeling of Air Temperature Impacts of Heat Island Mitigation Strategies", Sailor, D., 2003

Information: Impact Infrustructure, LLC AutoCASE
Pima County GI/LID Working Group presentation 7-15-2014

Benefit Calculation Example:
Increased Vegetation & Reduced Mortality



- **Minimum Mortality Temperature (MMT): local temperature threshold at which mortality rises due to high temperatures**
  - Reduction in average annual mortality rate based on local Tucson weather, the local mortality rate, and the MMT
  - Average annual mortality rate:
    - Change in days over MMT and
    - Change in the temperature for days over the MMT to calculate the change in.
- Annual lives saved from the project calculated
- **Value of Statistical Life (VSL)** quantify the benefit of reduced heat mortality rates in dollar value.



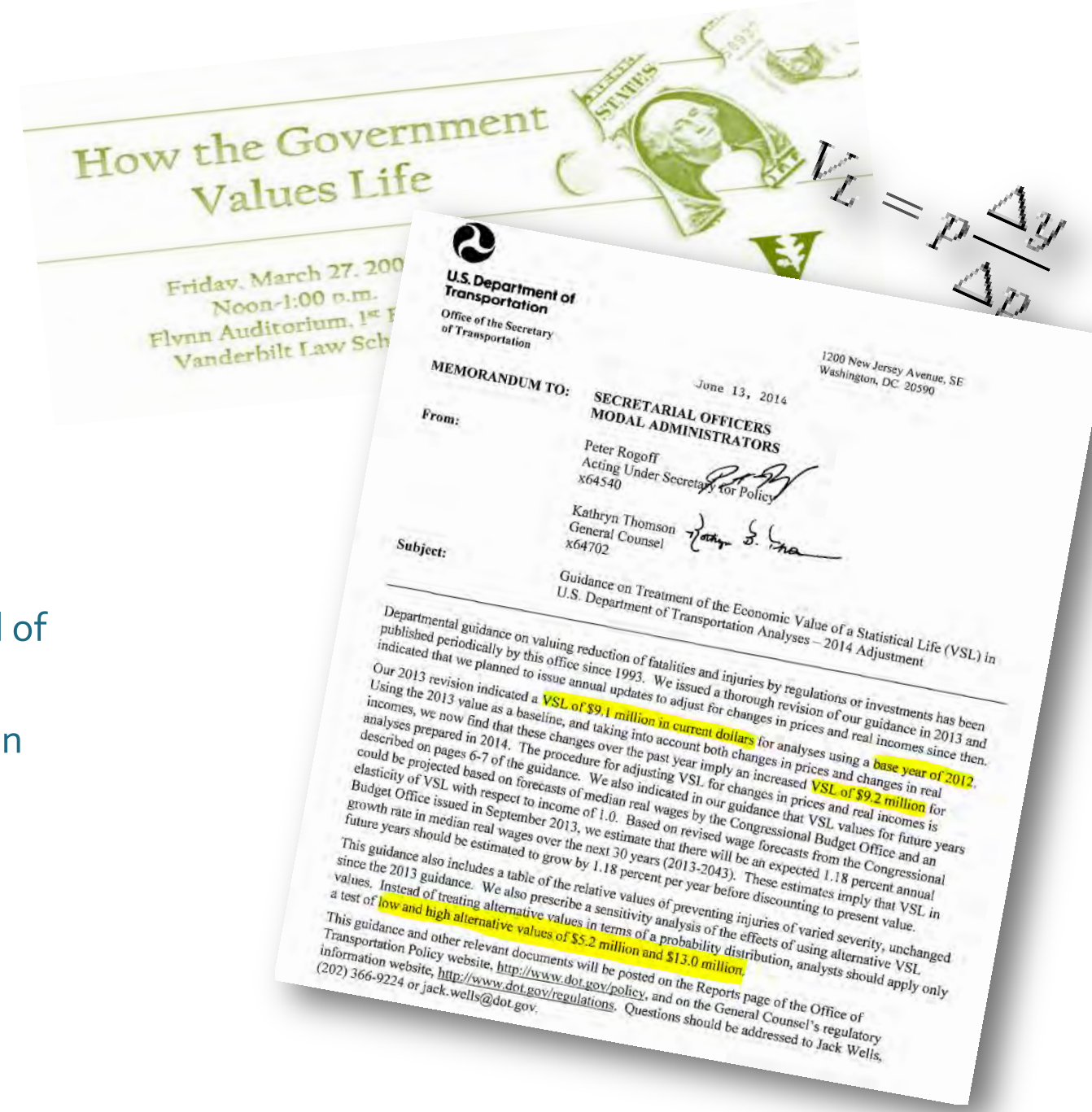
Information: Impact Infrustructure, LLC AutoCASE
Pima County GI/LID Working Group presentation 7-15-2014

Value of Statistical Life

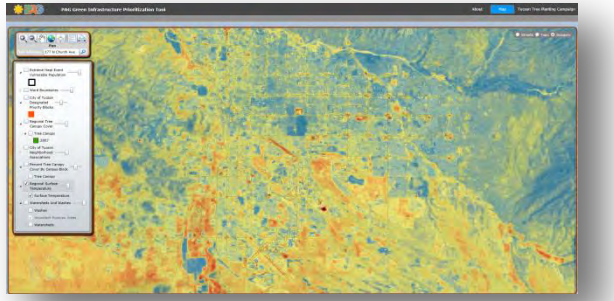
- Definition: the value that an individual places on a marginal change in their likelihood of death.

- The VSL is **NOT** the value of an actual life.
  - It is the value placed on changes in the likelihood of death,
  - Not the price someone would pay to avoid certain death.

- Empirical studies published in recent years indicate a **VSL of $9.1 million (2012 $).**
  - **Low and high values of $5.2 million and $12.9 million** are also used.



Summary: Heat Island Calculations



How Heat Mortality Reduction is Valued:

1. GI related to temperature changes
2. Temperature related to mortality rate changes
3. Valuing the dollar value of the VSL, a dollar value is put on the benefit the GI has in reducing the heat island effect.

- This is one of several benefits associated with GI that was quantify.
  - Example: This is one of the multiple benefits quantified for a water harvesting basin.

Information: Impact Infrustructure, LLC AutoCASE
Pima County GI/LID Working Group presentation 7-15-2014

Green Infrastructure

- **Provides multiple benefits:**
  - Reduces the urban heat island
  - Increases property values
  - Reduces flooding
  - May provide recreational opportunities
  - Reduces pollution
  - Reduces CO_2 emissions

Information: Impact Infrustructure, LLC AutoCASE
Pima County GI/LID Working Group presentation 7-15-2014

RESOURCES

AutoCASE™ Beta Testing Project: Evaluation of GI/LID Benefits in the Pima County Environment:
http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Flood%20Control/Floodplain%20Management/Low%20Impact%20Development/autocase-testing-final-report-20140711.pdf

Business Case Evaluator for Stormwater Management Website:
http://impactinfrastructurellc.com/blog/?p=233

Economic Companion Tools to Envision (BCE; Manual; BCE Example) – ISI Website:
https://sustainableinfrastructure.org/downloads/index.cfm

Pima County LID Working Group Website:
https://rfcd.pima.gov/pdd/lid/workinggroup.htm

Irene Ogata, PLA, ASLA, AzAPA
irene.ogata@tucsonaz.gov
Office of Integrated Planning
City of Tucson

Evan Canfield, Ph.D, P.E.
evan.canfield@pima.gov
Pima County Regional Flood Control District
Pima County