Resilience, Water and Tools

Technical Session 7 - June 07

NEWEA Spring Meeting 2017

Perkins+Will

Andy Bennett, Senior Associate | Senior Project Architect

AIA **College of Fellows** **Latrobe Research Prize:** 2015-2017

Drylands Resilience Initiative [DRI]:

Digital Tools for Sustainable Urban Design in Arid and Semi-Arid Urban Centers

2015-2017 LATROBE RESEARCH PRIZE TEAM

ARIDLANDSINSTITUTE

Hadley Arnold
Executive Director, Arid Lands Institute

Peter Arnold
Research Director, Arid Lands Institute

PERKINS+WILL

Justin Brechtel AIA LEED AP
Senior Computational Designer, Perkins+Will

Leigh Christy AIA LEED AP BD+C
Associate Principal, Perkins+Will

John Haymaker, PhD, AIA LEED AP
Director of Research, Senior Associate, Perkins+Will

The Nature Conservancy

Rowan Roderick-Jones PE CSci ENV SP
Director of Urban Green Infrastructure Partnerships, NatureVest at The Nature Conservancy

Deborah Weintraub AIA
Chief Deputy City Engineer, City of Los Angeles, Bureau of Engineering, Department of Public Works

WE GRATEFULLY ACKNOWLEDGE

American Institute of Architects College of Fellows

LEARNING OBJECTIVES

Understand how **climate change impacts** water supply in arid and semi-arid urban centers;

Understand new opportunities and techniques **building water supply**;

Understand **outcomes of Latrobe Prize** Research Objectives:

Research Objective 1: Tool Development: Data and Metrics; and
Research Objective 2: User Interface: Design, Testing, and Outreach;

Understand **application of digital tool** to architectural design process;

Understand decision-support tool in **public policy context**.

OUTLINE AGENDA

1. Why Hazel?
Climate Challenges to Resilient Water Supply in Drylands

2. What is Hazel? Decision-Support at Multiple Scales
Data, Metrics, and Analytics: Latrobe Research Objective 1

3. How to Hazel? Elevating the Design Process
User Interface Design, Testing, and Outreach: Latrobe Research Objective 2

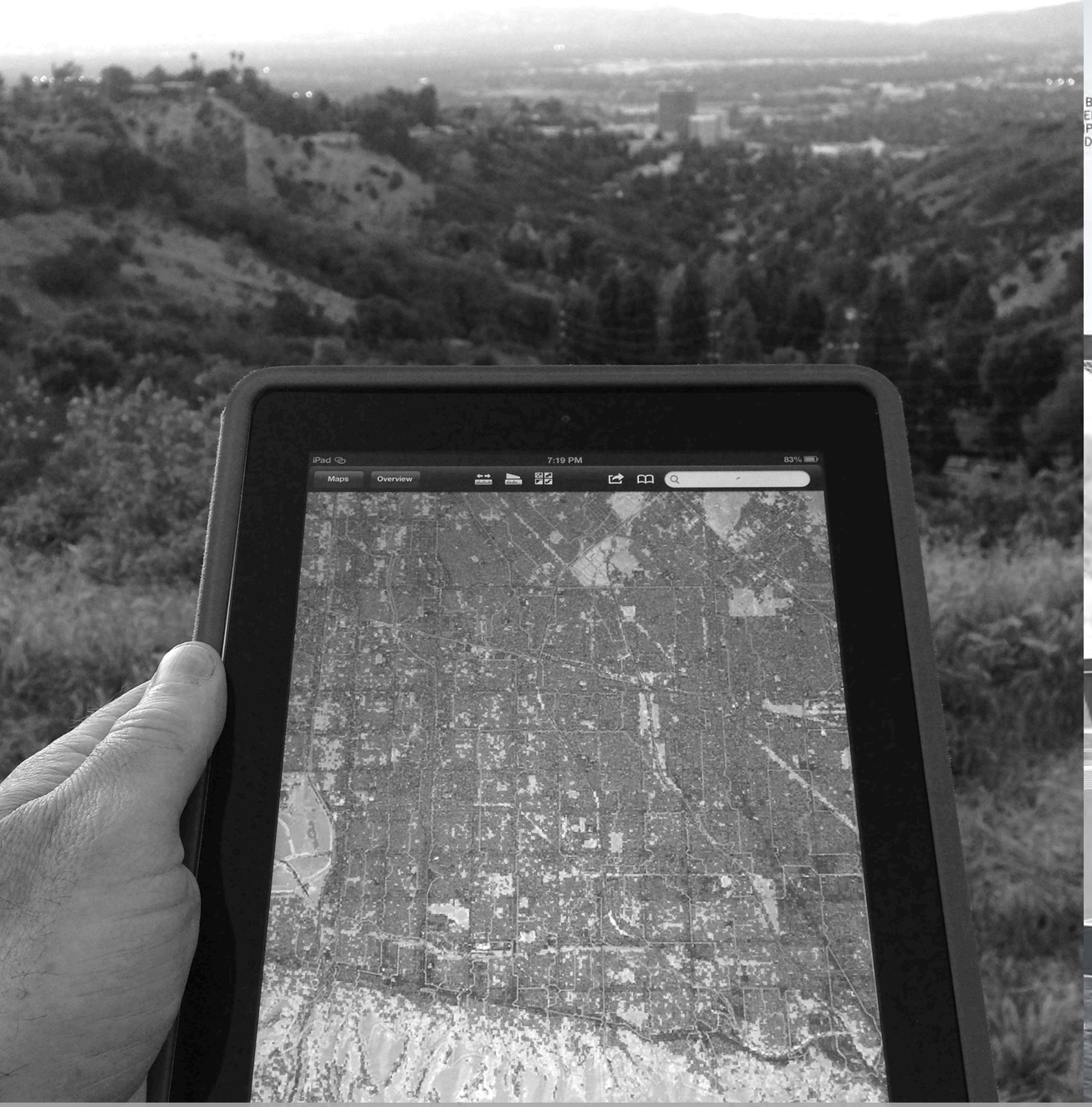
4. Hazel in Policy Context
Public-private partnerships and healthy credit markets

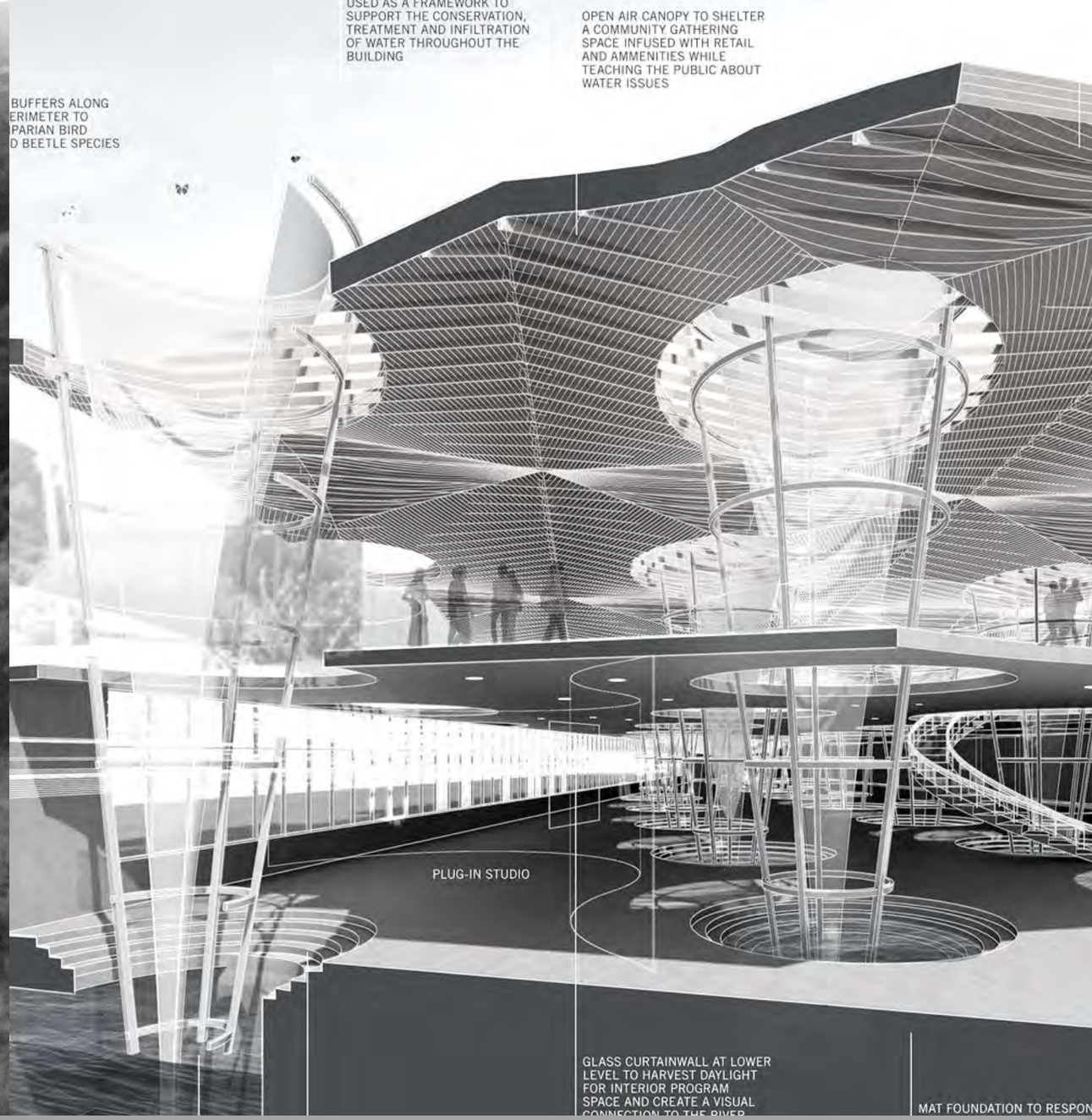
5. Q+A

1

Why Hazel? Intro and Overview

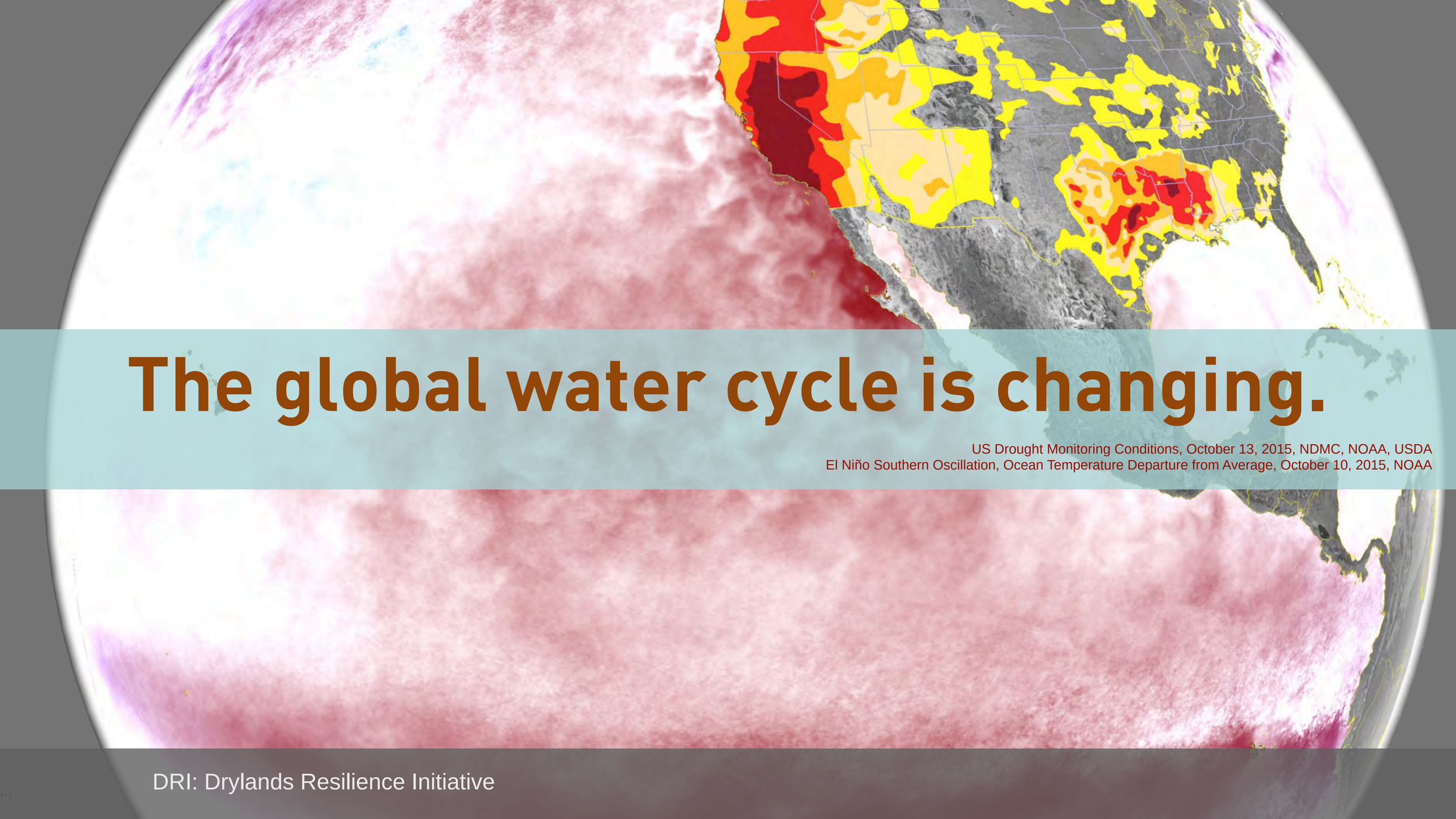
Climate Challenges to Resilient Water Supply in Drylands





DRI: Drylands Resilience Initiative

ALI [left], Doug Bergert, Anne Smith, Alex Sands, Water Towers, Perkins+Will, DLC First Prize Winner, 2014 [right]



The global water cycle is changing.

US Drought Monitoring Conditions, October 13, 2015, NDMC, NOAA, USDA
El Niño Southern Oscillation, Ocean Temperature Departure from Average, October 10, 2015, NOAA

Dry will be dryer.

DRI: Drylands Resilience Initiative

Wet will be wetter.

Conservation, recycling, and stormwater can meet 82% of LA's water needs.

Nearly half will come from stormwater.

DRI: Drylands Resilience Initiative

Where? How?

Where do we prioritize investment in distributed green infrastructure?

DRI: Drylands Resilience Initiative

How do we evaluate impacts and outcomes?

How do we make disparate data integrated and accessible for designers?

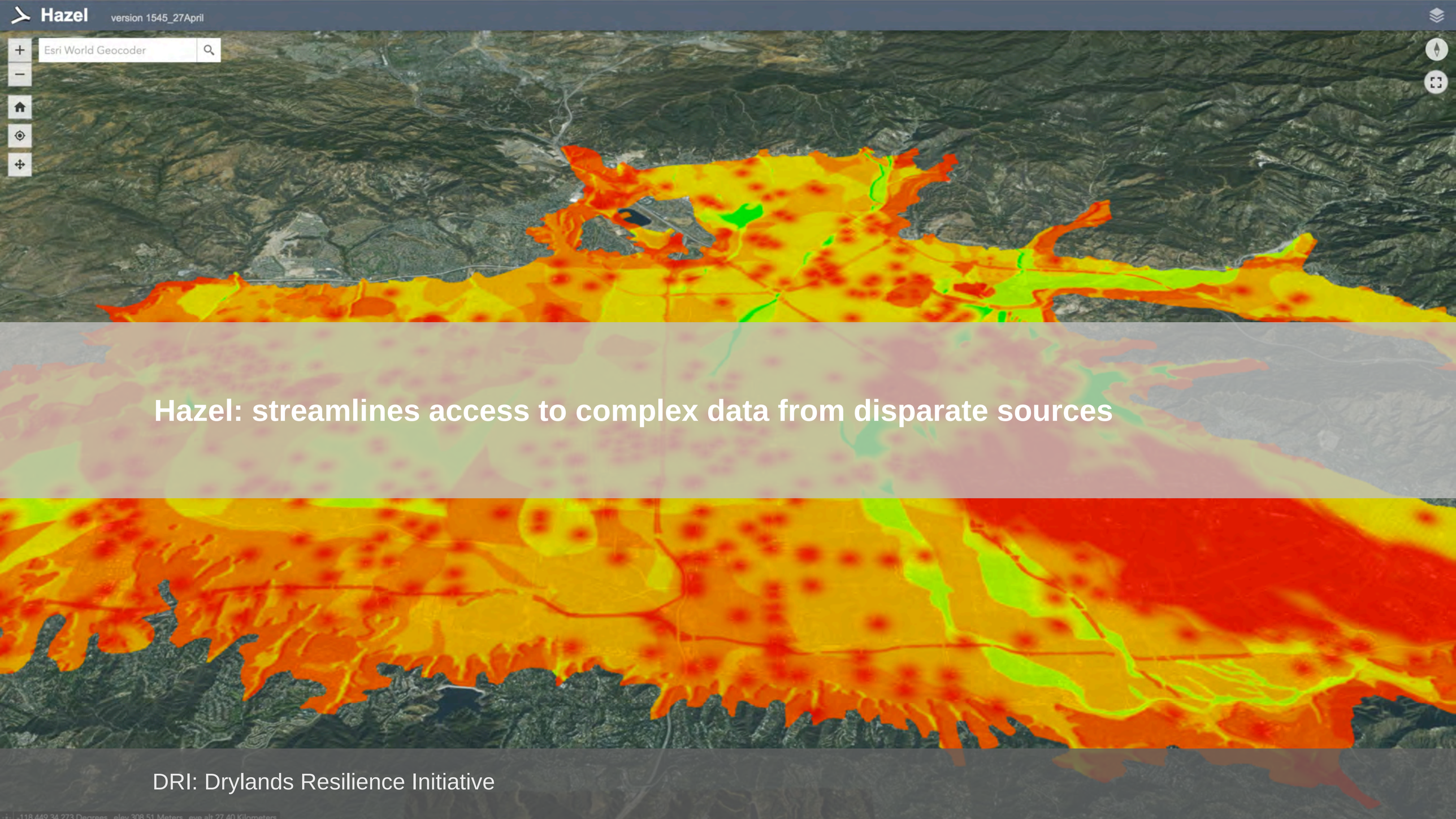
2

What is Hazel?

Decision-Support at Multiple Scales

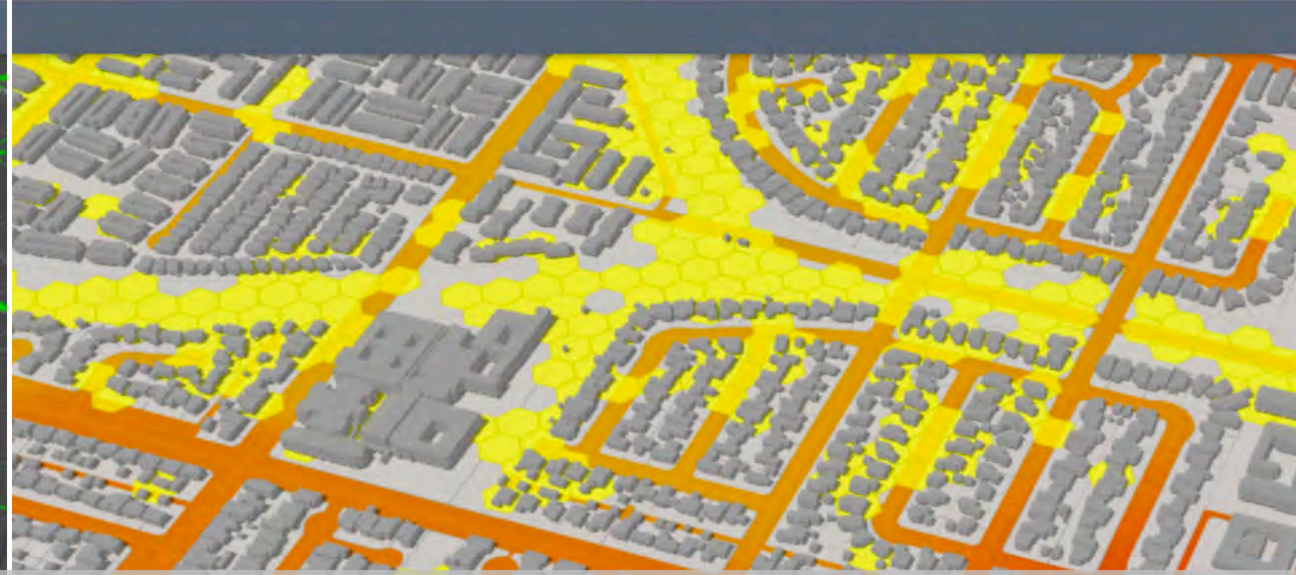
Hazel is:

A digital decision support tool for optimizing distributed **stormwater capture** within arid urban centers.

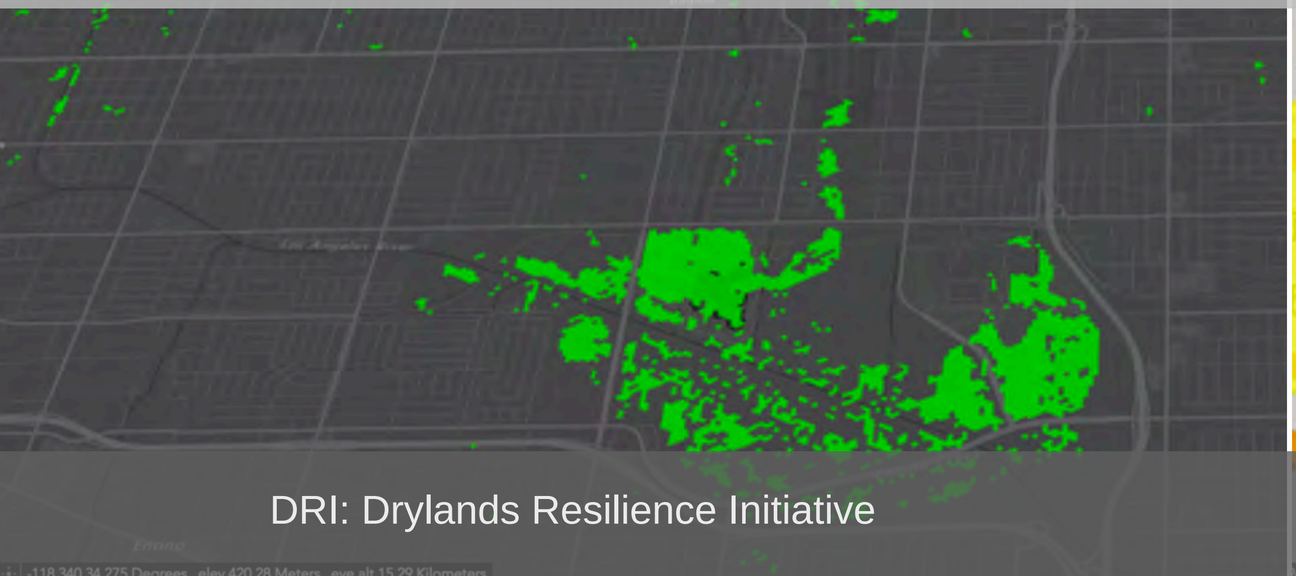


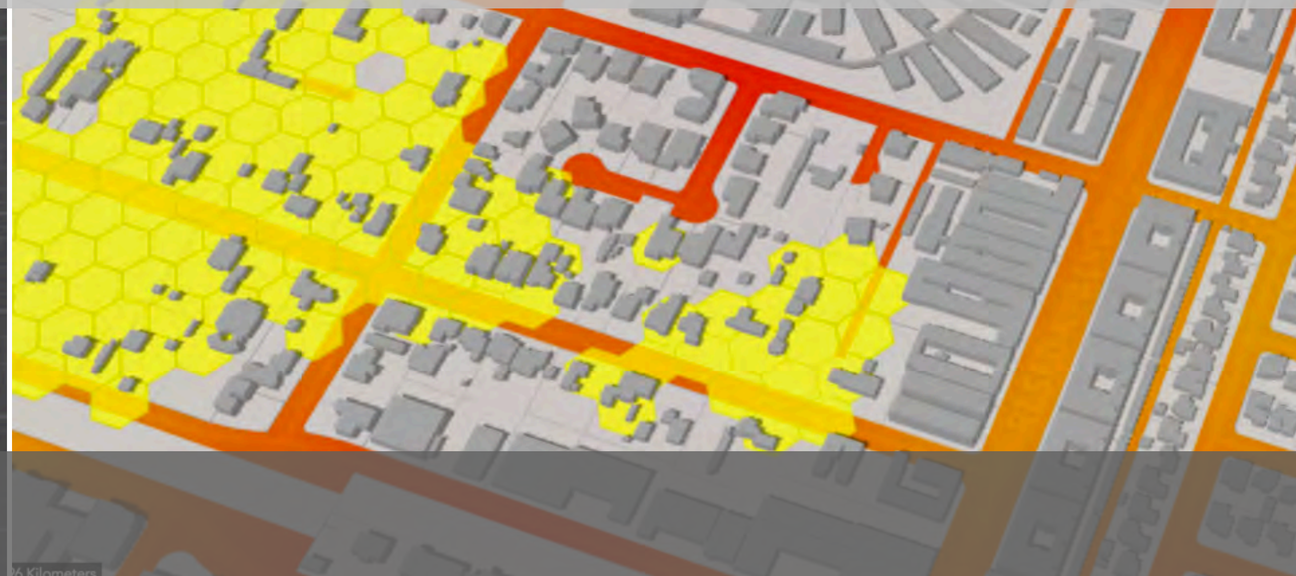
Hazel: streamlines access to complex data from disparate sources

DRI: Drylands Resilience Initiative



Hazel: operates at both local and regional scales

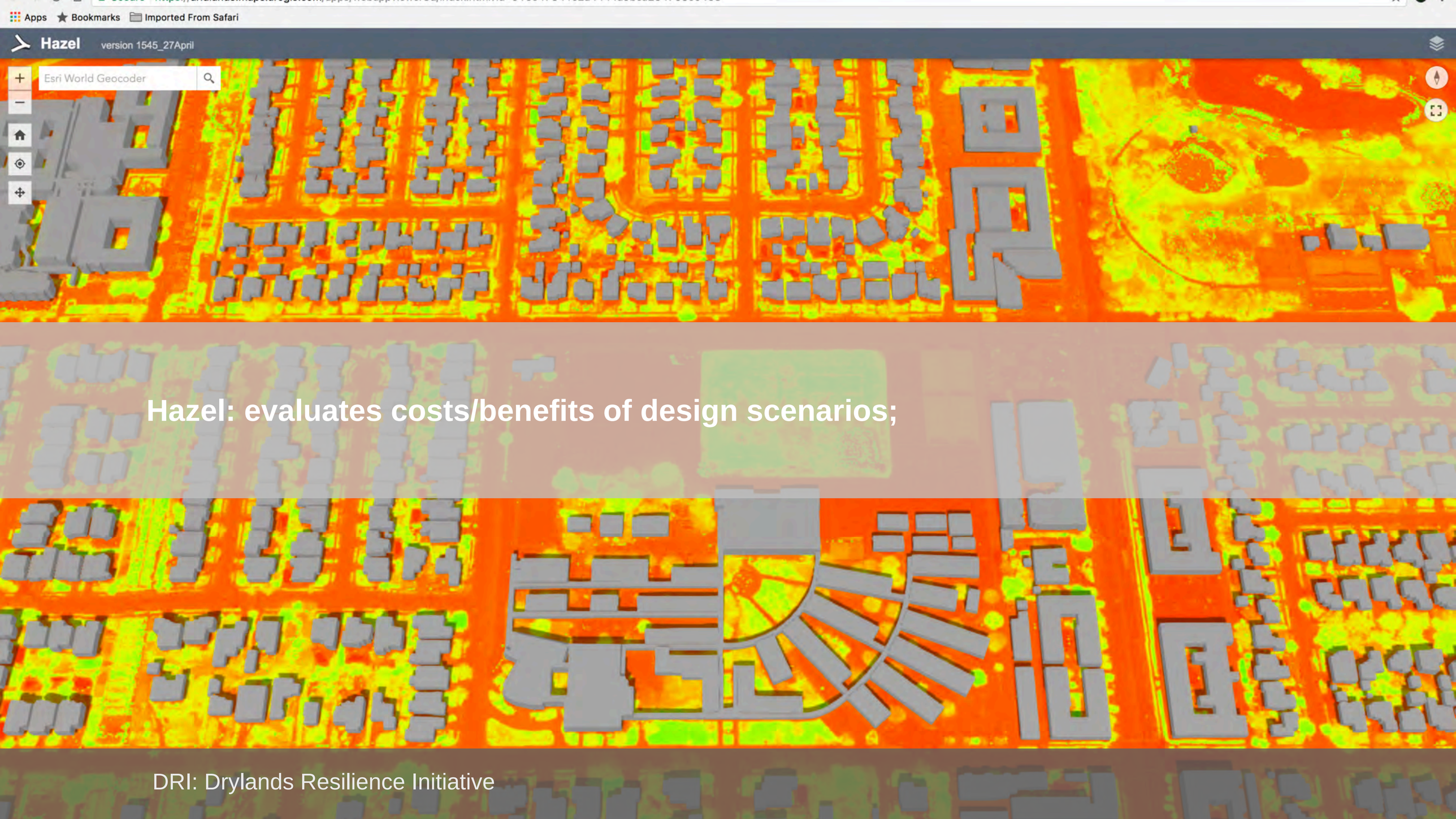




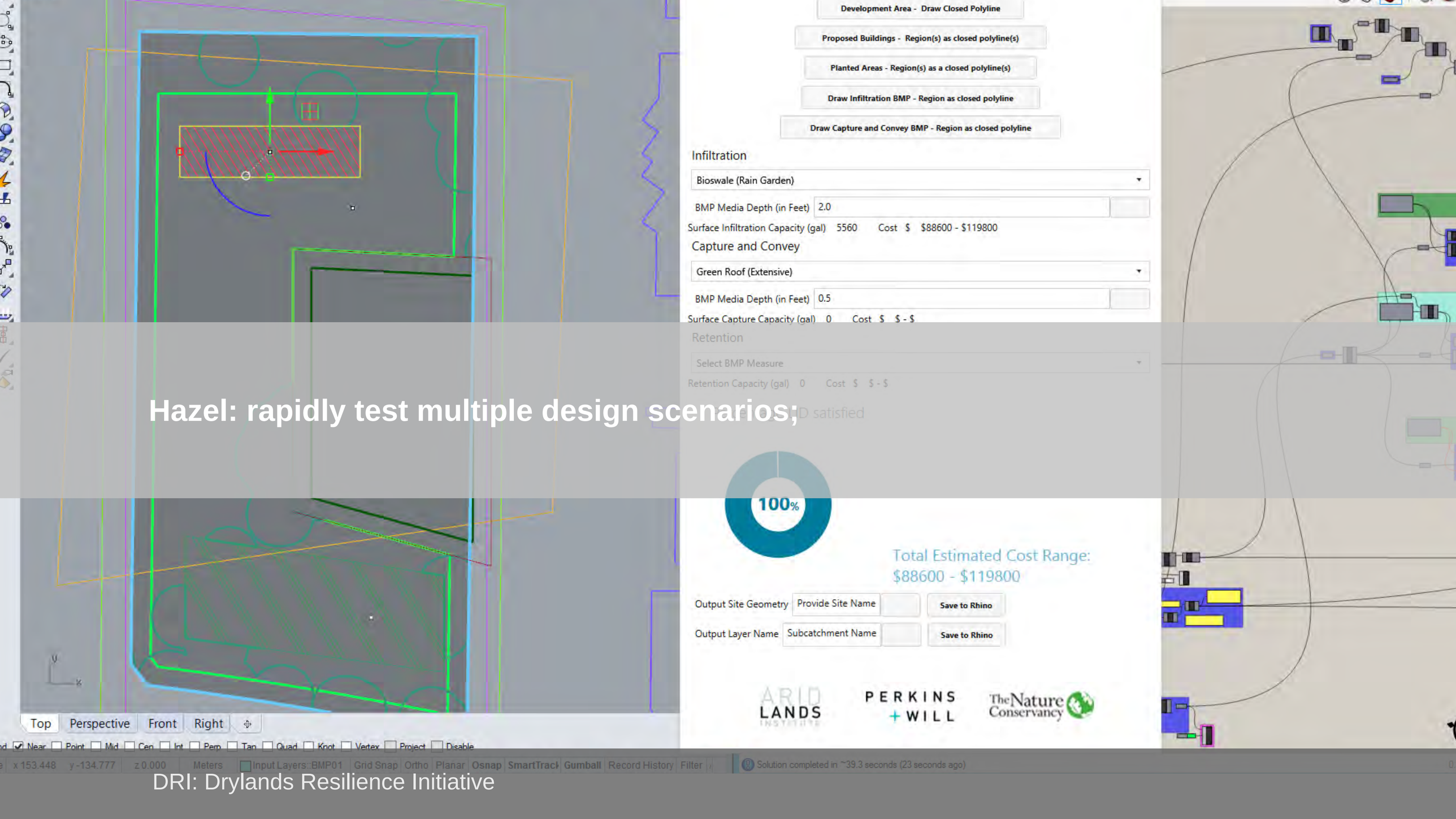
DRI: Drylands Resilience Initiative

Hazel: couples surface and subsurface data at high resolution;

DRI: Drylands Resilience Initiative

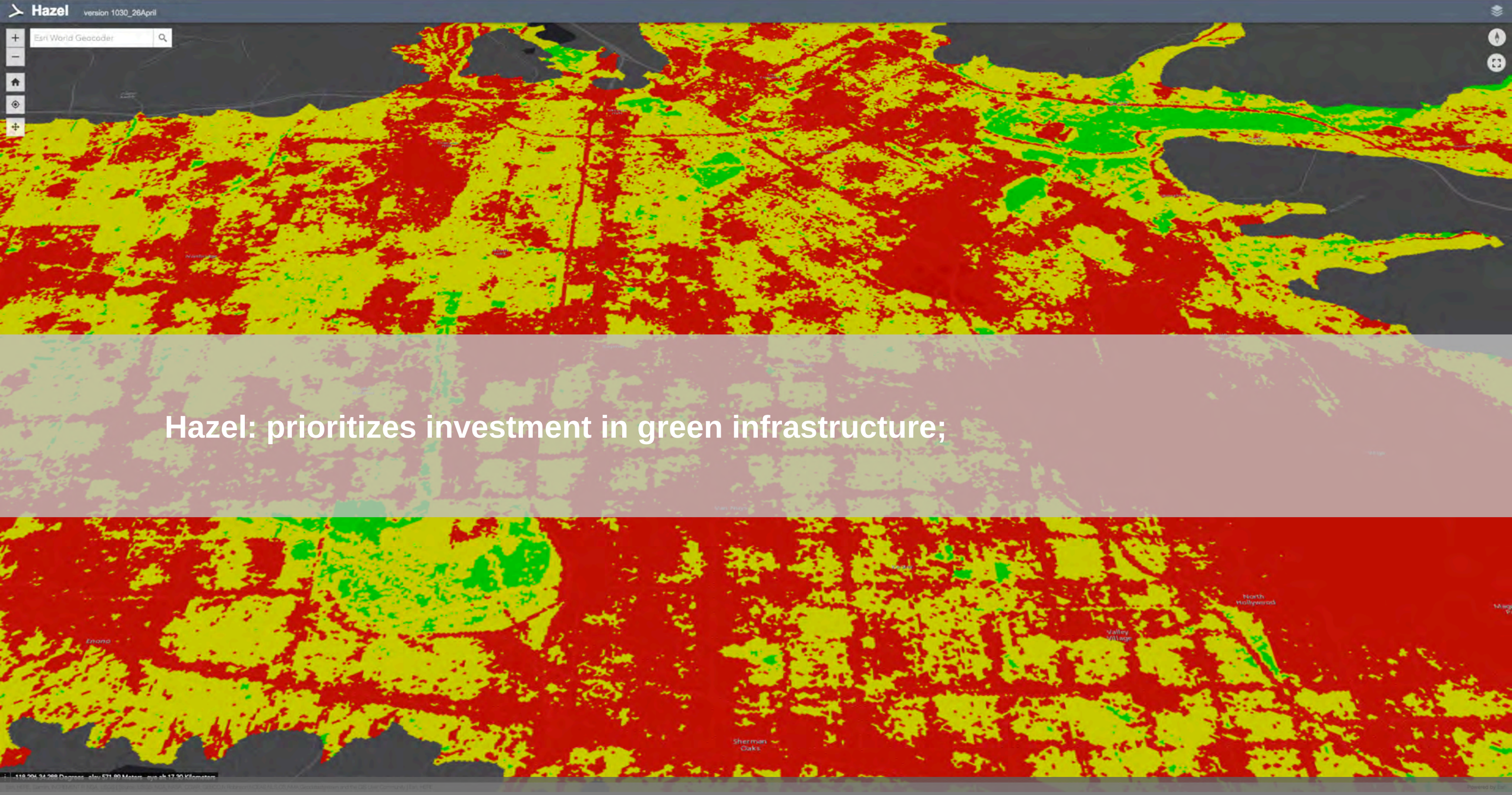

Apps
Bookmarks
Imported From Safari
Hazel
version 1545_27April
Esri World Geocoder
Hazel: evaluates costs/benefits of design scenarios;
DRI: Drylands Resilience Initiative

Hazel enables users to:



Hazel: rapidly test multiple design scenarios;

DRI: Drylands Resilience Initiative



Hazel: prioritizes investment in green infrastructure;

DRI: Drylands Resilience Initiative

Hazel: Reporting Metrics

Hazel: evaluates impacts on water, energy, and carbon conservation objectives;

Hazel: Reporting Metrics

Water Infiltrated

GALLONS (or acre/feet)

GHG Reduced:

TONS of CO_2E

Energy Saved:

kWH OFFSET

Economic Cost/Benefit:

DOLLARS EXPENDED
TREATMENT COSTS AVOIDED
PAYBACK PERIOD
JOBS CREATED

Who will benefit from **Hazel?**

1
Public Sector

Public Agencies and Utilities

METROPOLITAN-SCALE WATER DISTRICTS
MUNICIPAL STORMWATER and SANITATION BUREAUS
MUNICIPAL PUBLIC WORKS and ENGINEERING

2
Private Sector

Design Professionals

ARCHITECTS, URBAN PLANNERS, LANDSCAPE ARCHITECTS

1
Public Sector

Public Agencies and Utilities

METROPOLITAN-SCALE WATER DISTRICTS
MUNICIPAL STORMWATER and SANITATION BUREAUS
MUNICIPAL PUBLIC WORKS and ENGINEERING

NEEDS

Provide basin-scale distributed water infrastructure economic and suitability evaluation;

2
Private Sector

Design Professionals

ARCHITECTS, URBAN PLANNERS, LANDSCAPE ARCHITECTS

NEEDS

Provide property / lot-scale code compliance;
Assess pilot sites for private / public investment.

1
Public Sector

Public Agencies and Utilities
METROPOLITAN-SCALE WATER DISTRICTS
MUNICIPAL STORMWATER and SANITATION BUREAUS
MUNICIPAL PUBLIC WORKS and ENGINEERING

Governmental Water Regulatory Agencies
USEPA, USBoR, USACE
STATE REGULATORY BOARDS, HEALTH and HUMAN SAFETY

NGOs
GREEN-TECH, LAND USE and ENVIRONMENTAL QUALITY,
ENVIRONMENTAL JUSTICE

Elected Officials

2
Private Sector

Design Professionals
ARCHITECTS, URBAN PLANNERS, LANDSCAPE ARCHITECTS

Technical Service Providers
CIVIL and ENVIRONMENTAL ENGINEERS

Insurance Companies
REINSURANCE and RISK ASSESSMENT UNDERWRITING

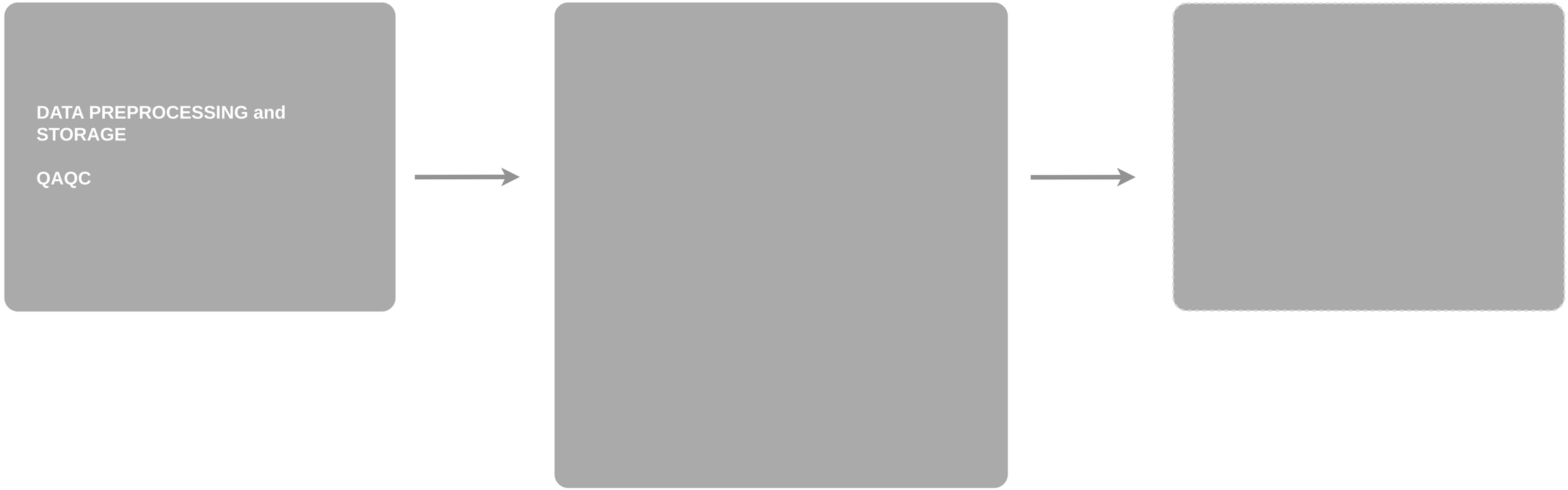
Developers

Educated Citizenry
PRIVATE PROPERTY OWNERS
CONCERNED PUBLIC

How does **Hazel** work?

Conceptual Diagram of **Hazel**

CENTRAL DATABASE



Conceptual Diagram of **Hazel**

CENTRAL DATABASE

COMPUTATION

HYDRO:
LUMPED and 2D PHYSICAL FINITE VOLUME HYDROLOGIC MODELING

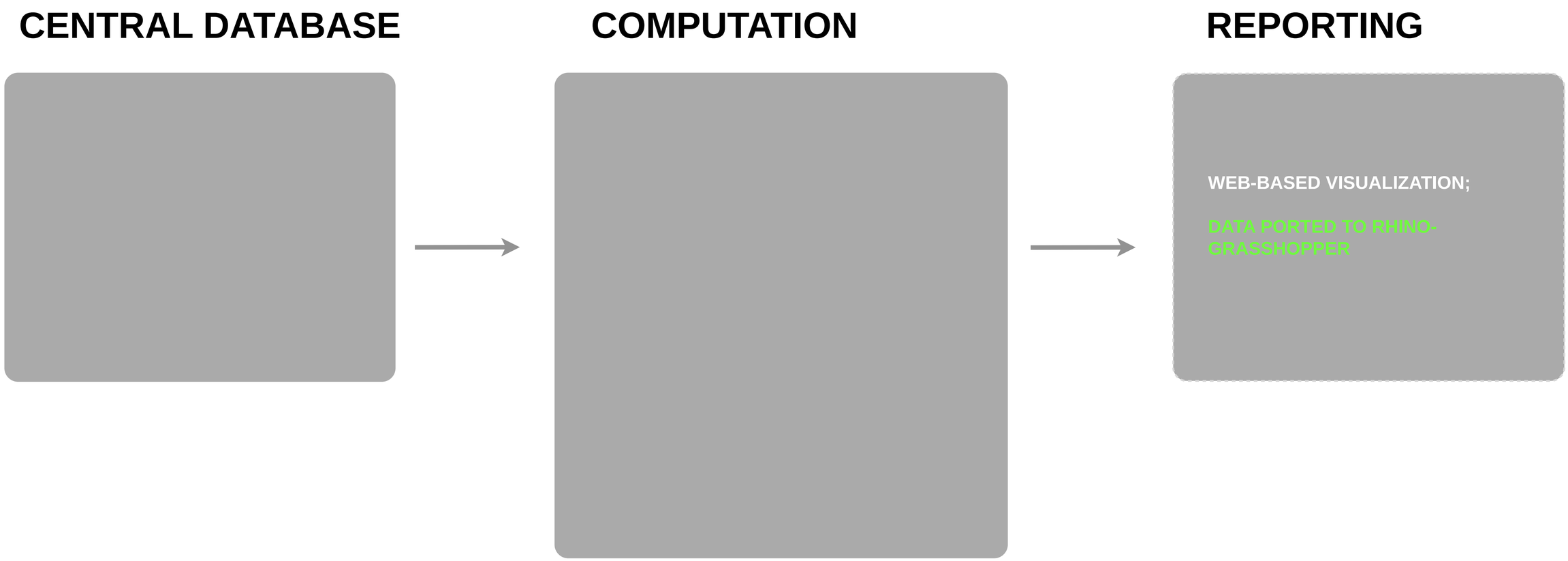
STATISTICAL RIGHT SIZING ANALYSIS

REMOTE SENSING IMAGE PROCESSING

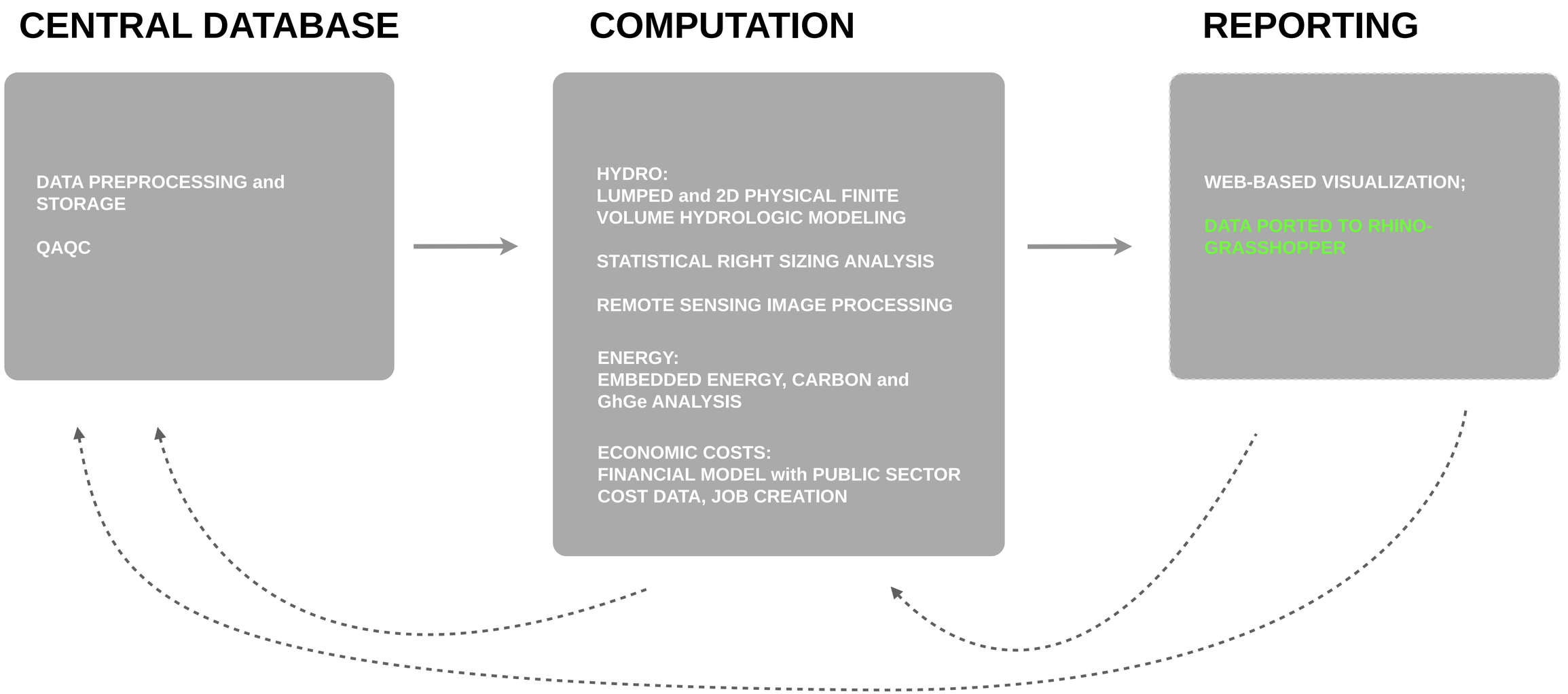
ENERGY:
EMBEDDED ENERGY, CARBON and GhGe ANALYSIS

ECONOMIC COSTS:
FINANCIAL MODEL with PUBLIC SECTOR COST DATA, JOB CREATION

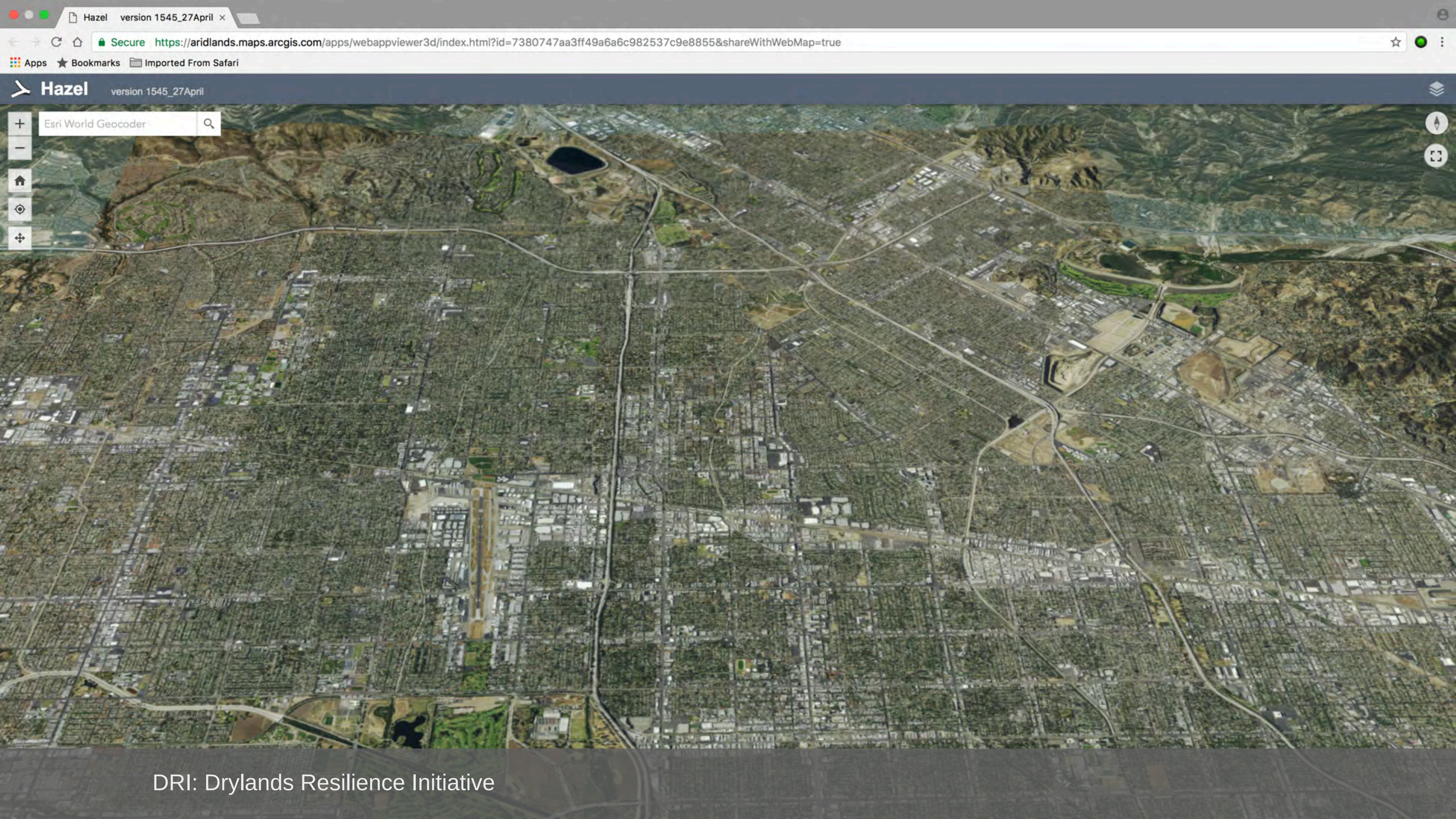
Conceptual Diagram of **Hazel**

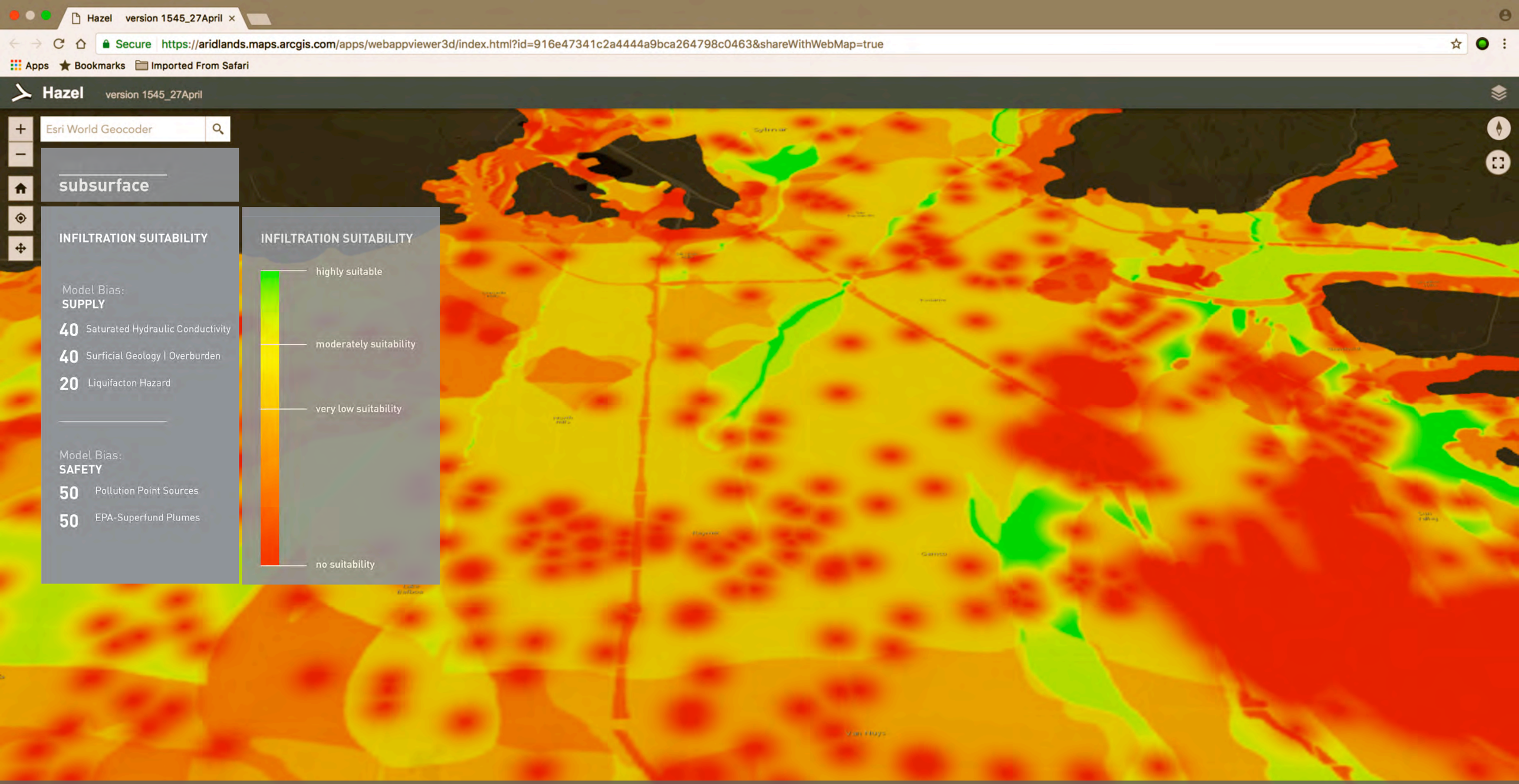


Conceptual Diagram of **Hazel**

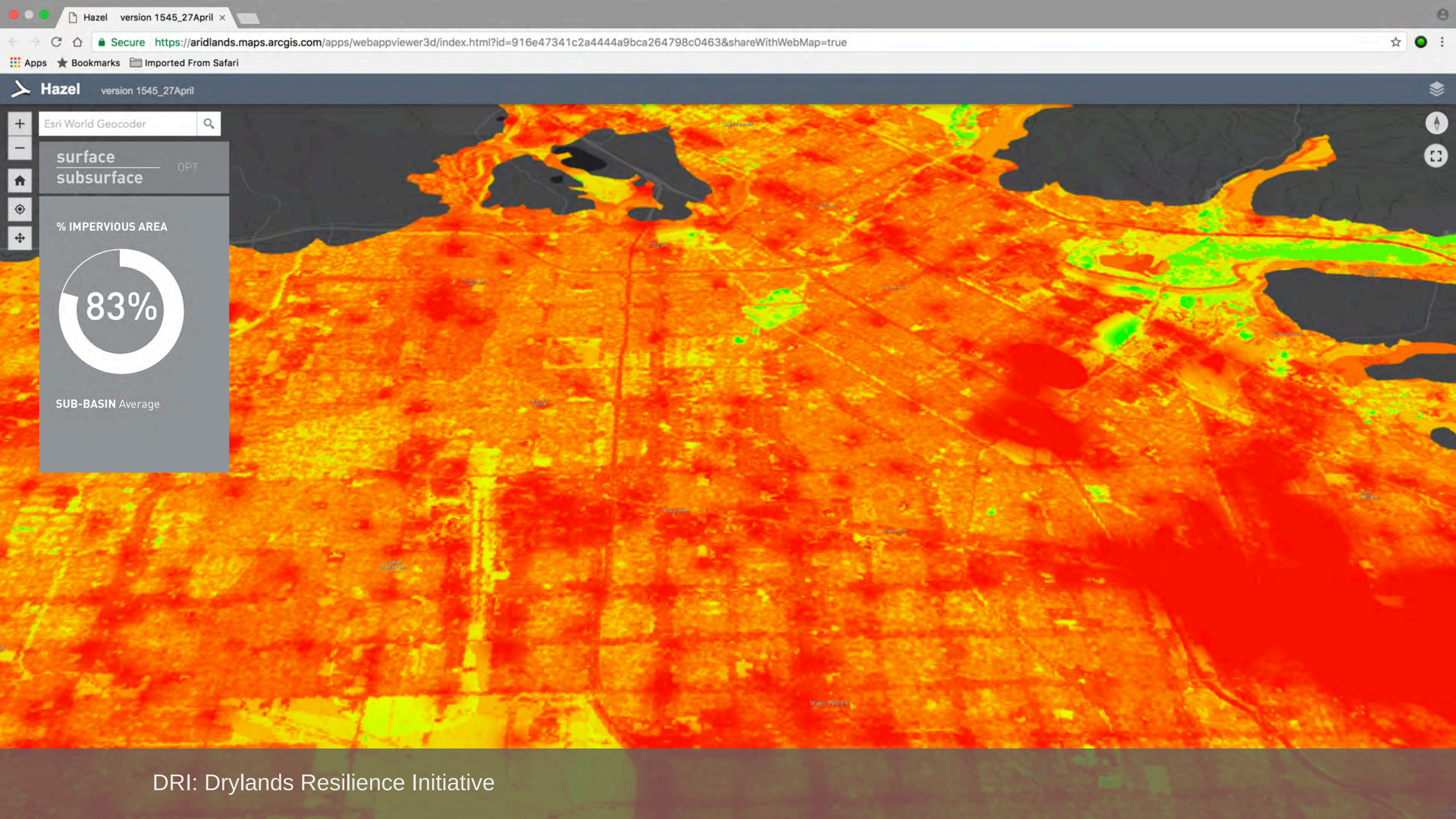


Hazel at work @ **basin-scale**


Hazel version 1545_27April
Secure https://aridlands.maps.arcgis.com/apps/webappviewer3d/index.html?id=7380747aa3ff49a6a6c982537c9e8855&shareWithWebMap=true
Apps Bookmarks Imported From Safari
Hazel version 1545_27April
Esri World Geocoder
DRI: Drylands Resilience Initiative

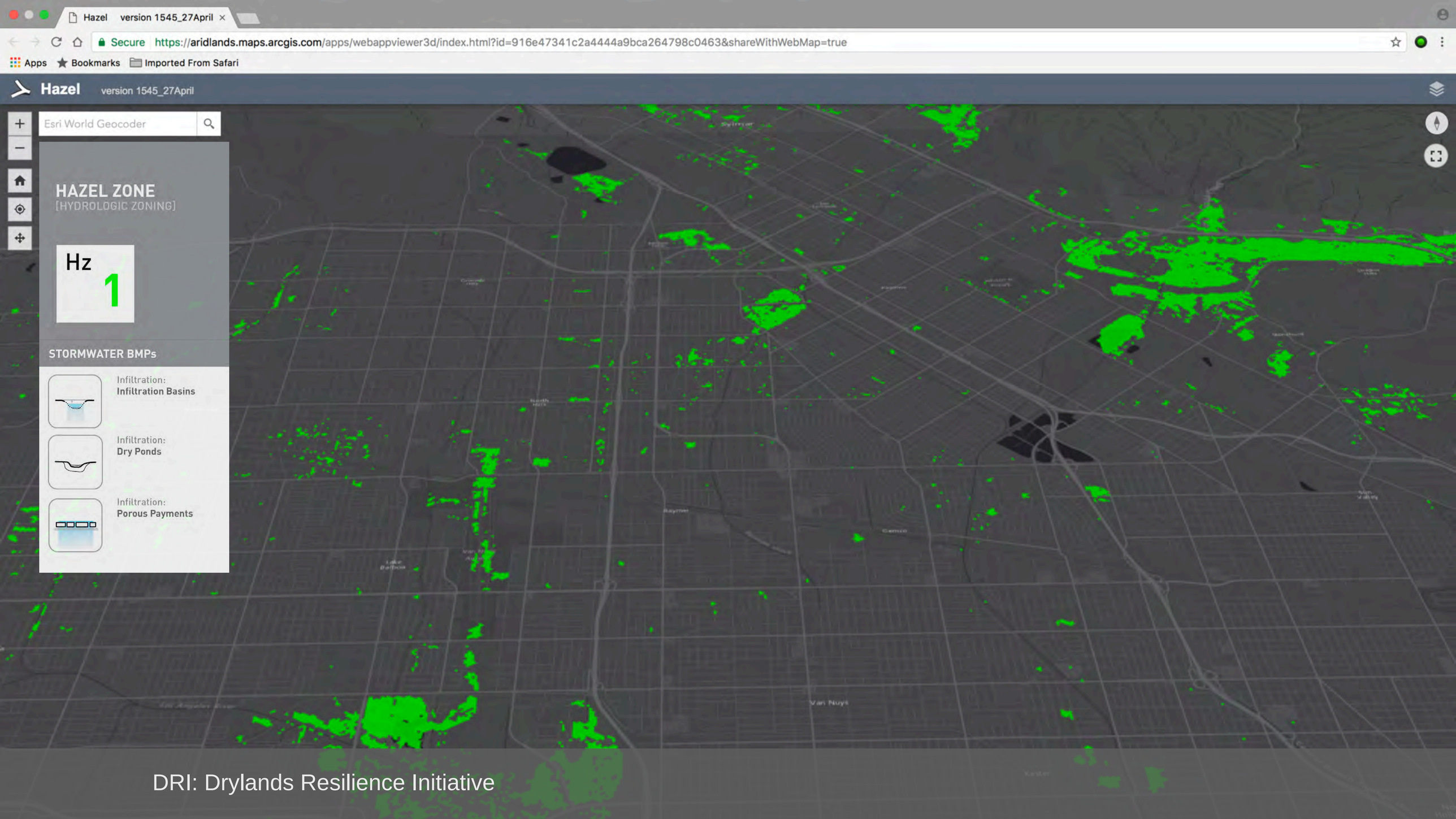


DRI: Drylands Resilience Initiative

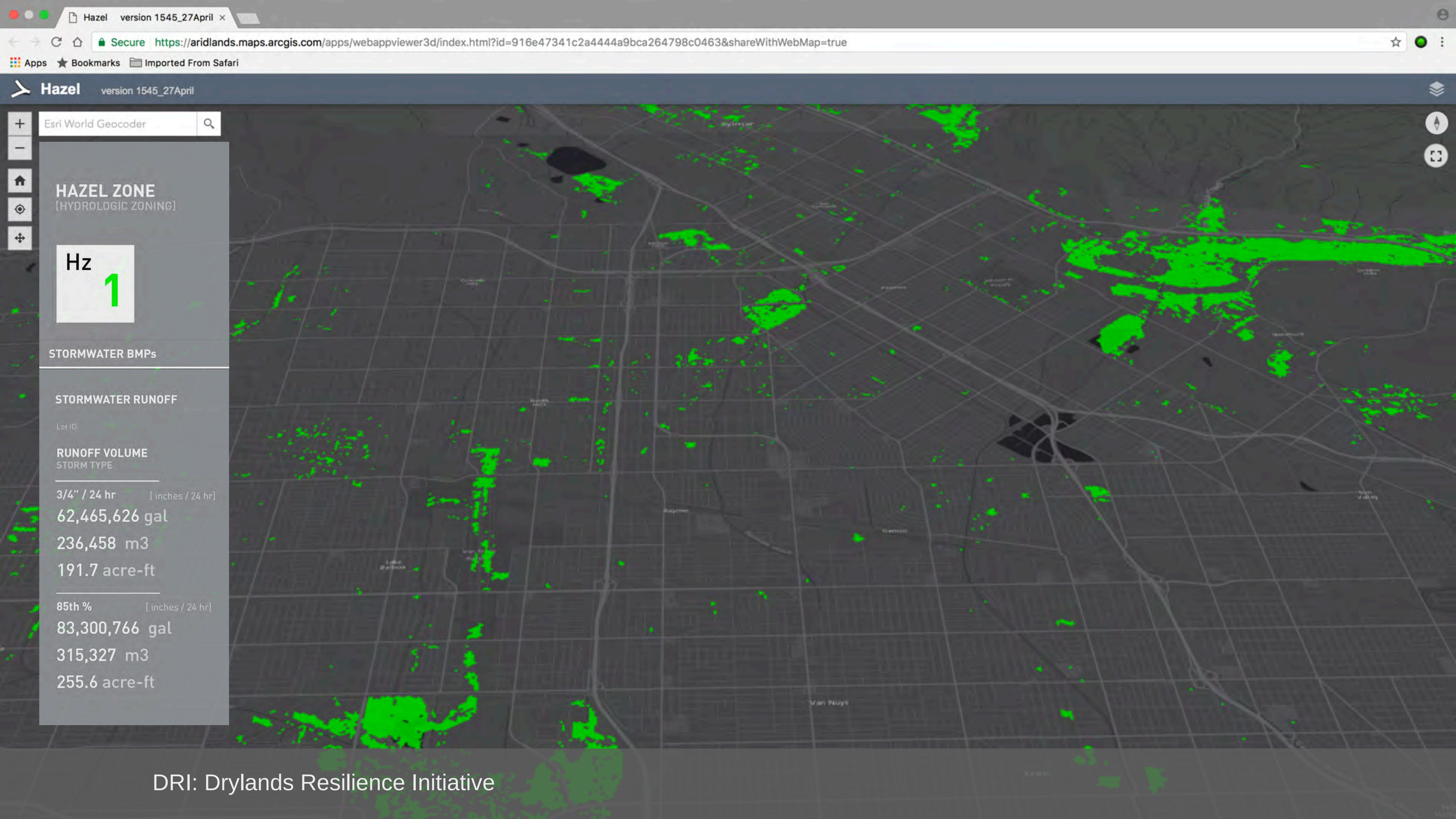


DRI: Drylands Resilience Initiative


Hazel version 1545_27April
Secure https://aridlands.maps.arcgis.com/apps/webappviewer3d/index.html?id=916e47341c2a4444a9bca264798c0463&shareWithWebMap=true
Apps Bookmarks Imported From Safari
Hazel version 1545_27April
Esri World Geocoder
HAZEL ZONE
[HYDROLOGIC ZONING]
Hz 1
HAZEL ZONE
[HYDROLOGIC ZONING]
Hz 2
HAZEL ZONE
[HYDROLOGIC ZONING]
Hz 3
DRI: Drylands Resilience Initiative

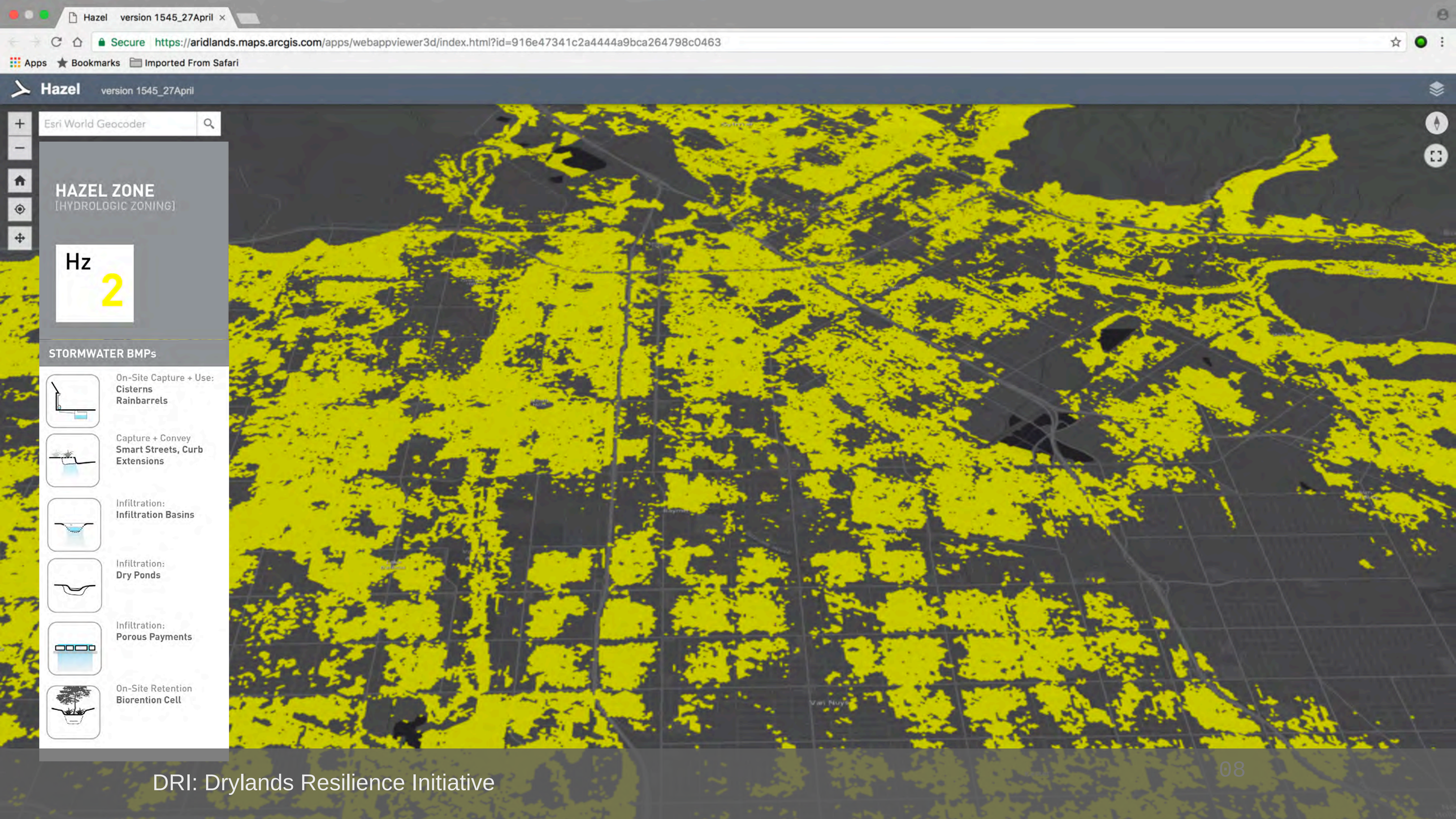


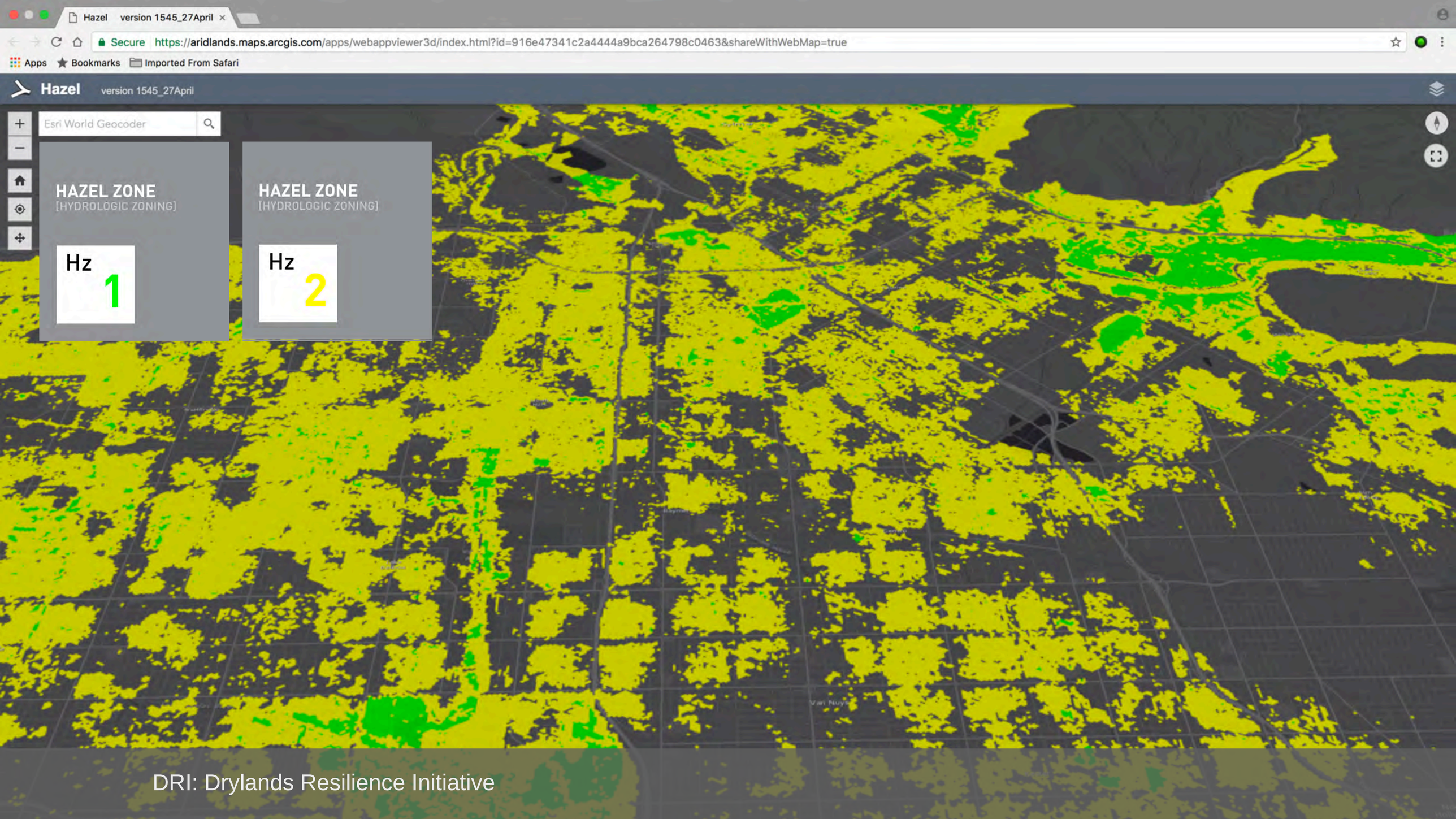
DRI: Drylands Resilience Initiative



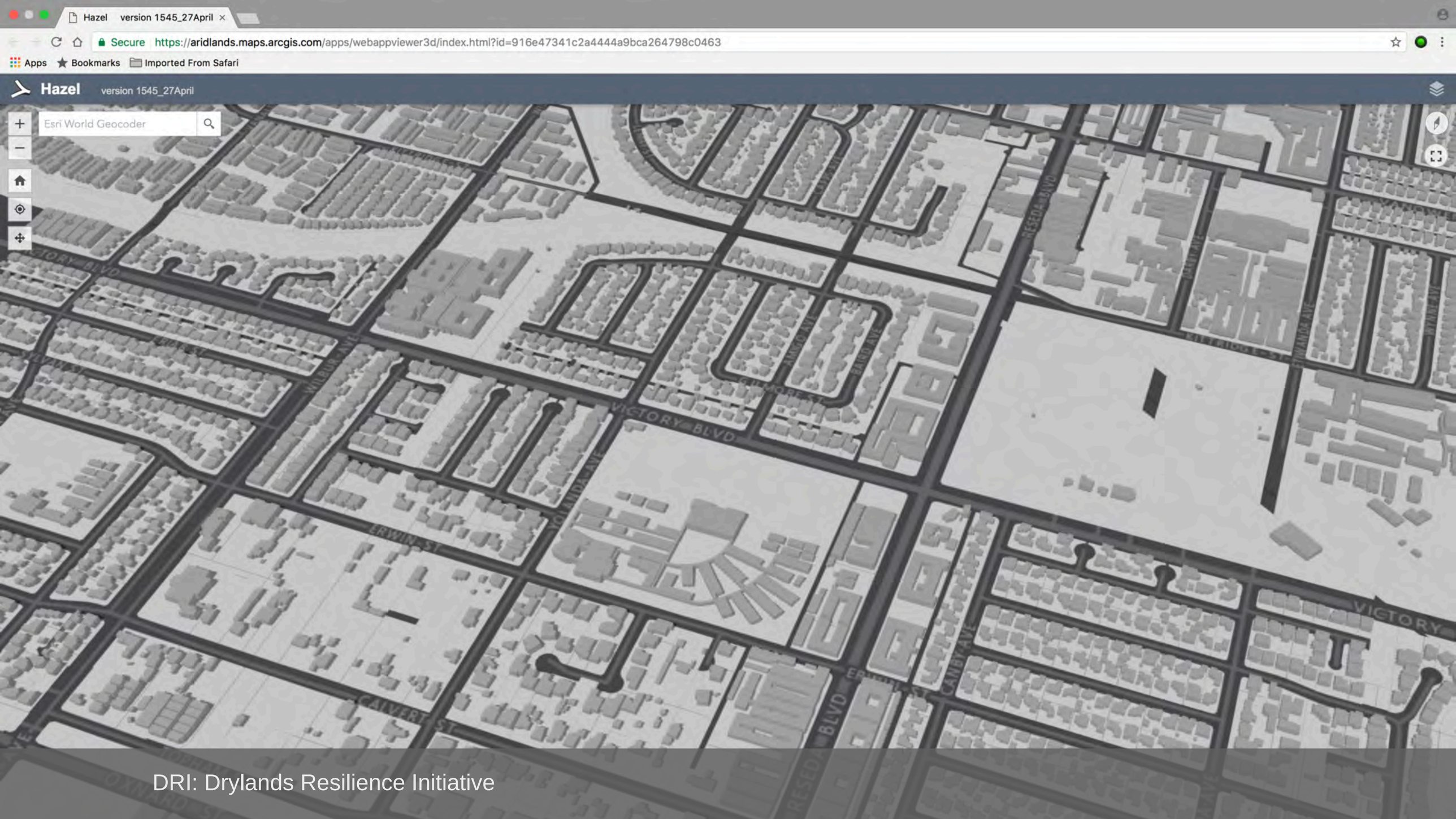
DRI: Drylands Resilience Initiative

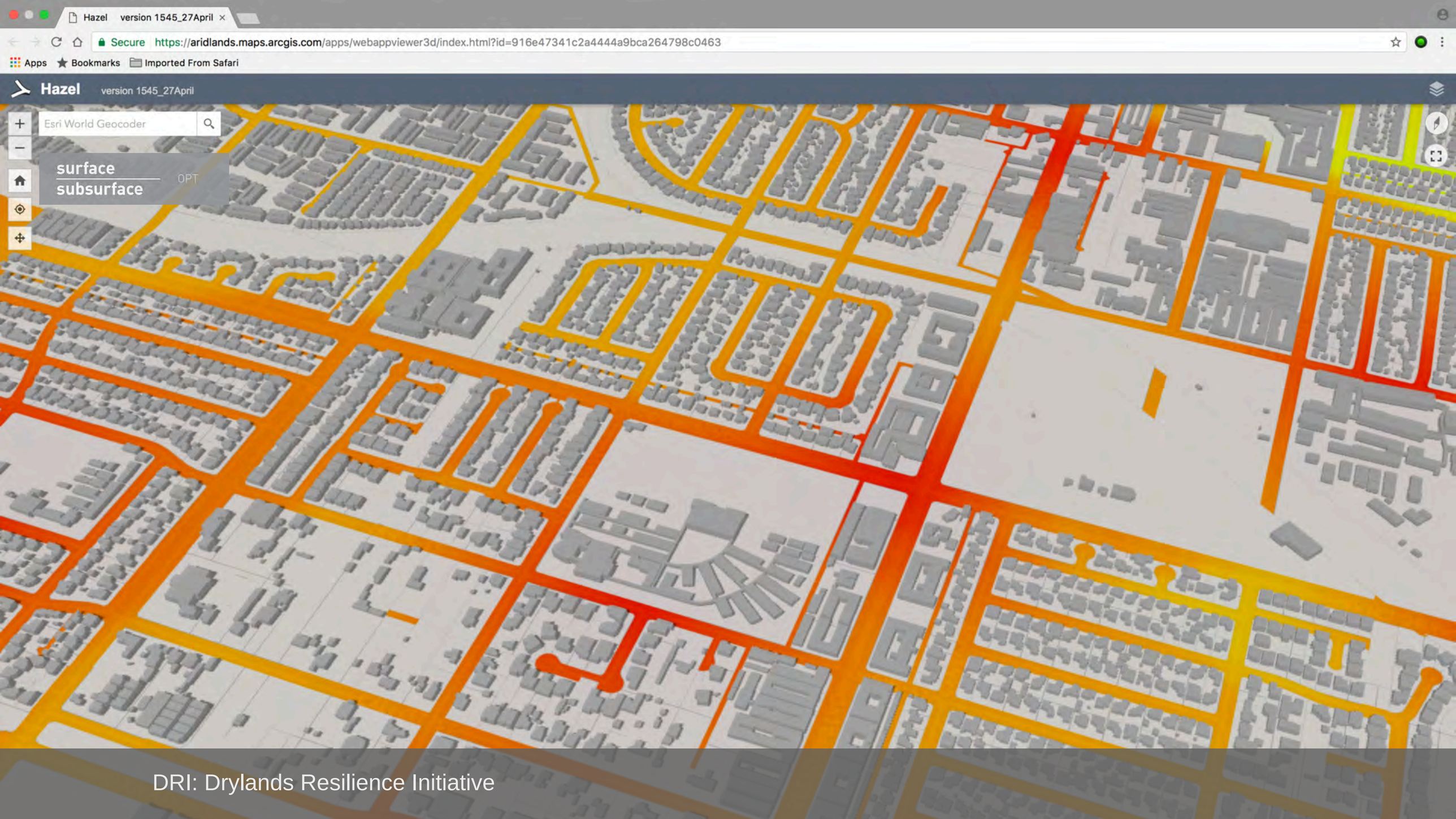
DRI: Drylands Resilience Initiative


Hazel version 1545_27April
Secure https://aridlands.maps.arcgis.com/apps/webappviewer3d/index.html?id=916e47341c2a4444a9bca264798c0463
Apps Bookmarks Imported From Safari
Hazel version 1545_27April
Esri World Geocoder
HAZEL ZONE
[HYDROLOGIC ZONING]
Hz 2
STORMWATER BMPs
On-Site Capture + Use:
Cisterns
Rainbarrels
Capture + Convey
Smart Streets, Curb Extensions
Infiltration:
Infiltration Basins
Infiltration:
Dry Ponds
Infiltration:
Porous Payments
On-Site Retention
Biorention Cell

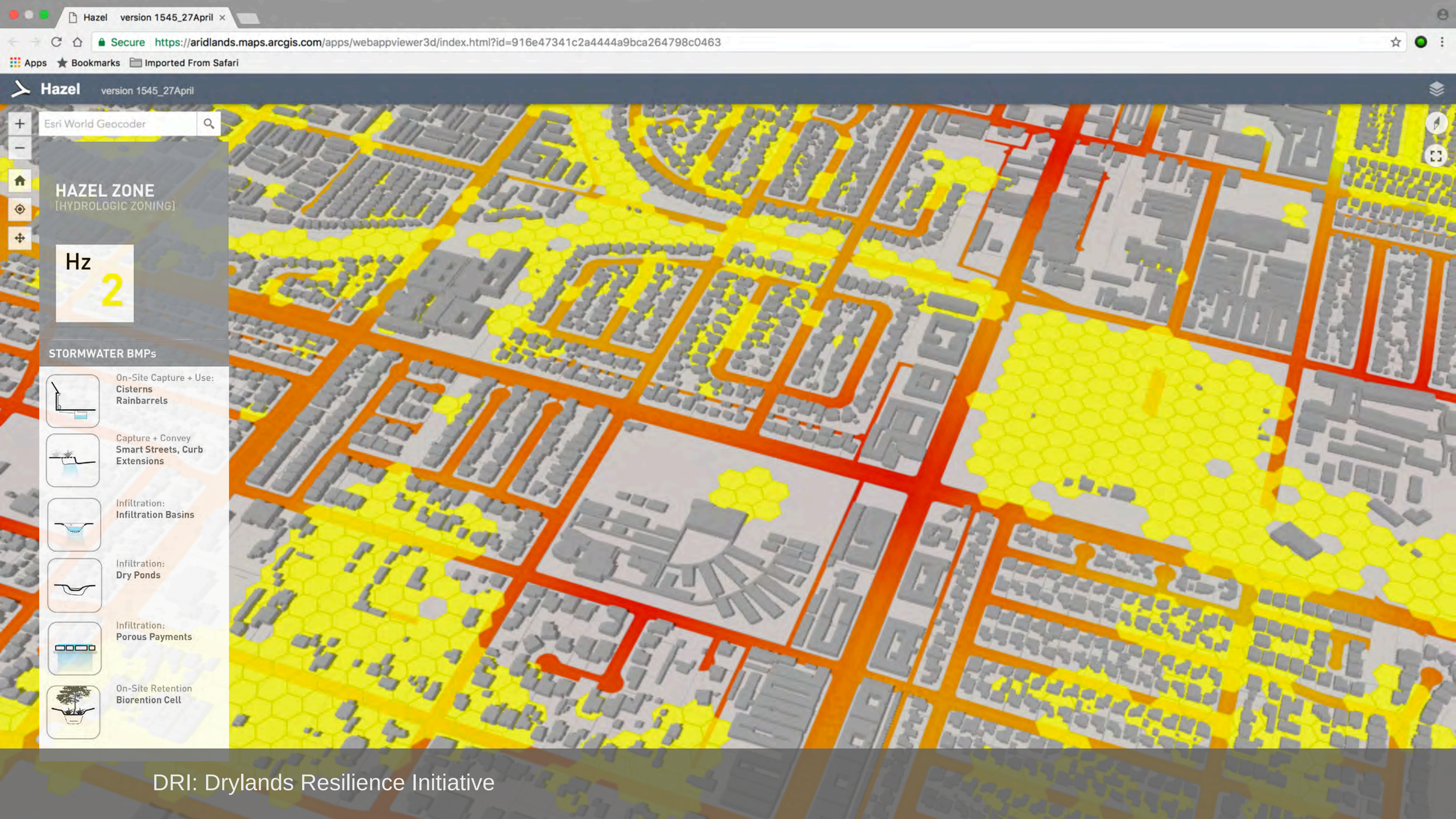

Hazel version 1545_27April
Secure https://aridlands.maps.arcgis.com/apps/webappviewer3d/index.html?id=916e47341c2a4444a9bca264798c0463&shareWithWebMap=true
Apps Bookmarks Imported From Safari
Hazel version 1545_27April
Esri World Geocoder
HAZEL ZONE
[HYDROLOGIC ZONING]
Hz 1
HAZEL ZONE
[HYDROLOGIC ZONING]
Hz 2
DRI: Drylands Resilience Initiative

Hazel at work @ **lot-scale**


Hazel version 1545_27April
Secure https://aridlands.maps.arcgis.com/apps/webappviewer3d/index.html?id=916e47341c2a4444a9bca264798c0463
Apps Bookmarks Imported From Safari
Hazel version 1545_27April
Esri World Geocoder
VICTORY BLVD
ERWIN ST
CALVERT ST
DRI: Drylands Resilience Initiative



DRI: Drylands Resilience Initiative



DRI: Drylands Resilience Initiative

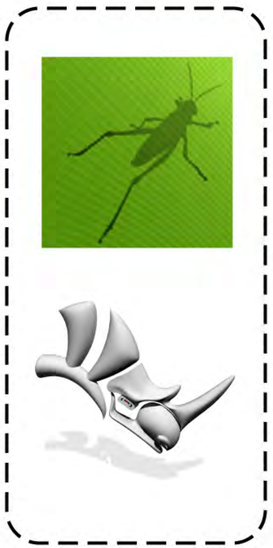
DRI: Drylands Resilience Initiative

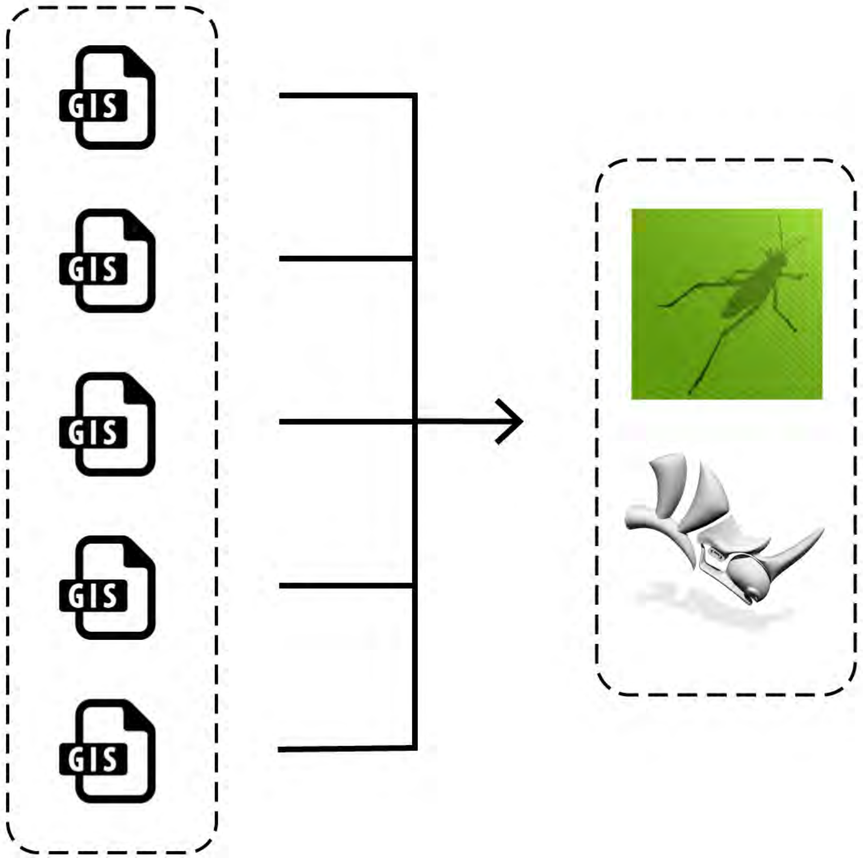

Hazel version 1545_27April
https://aridlands.maps.arcgis.com/apps/webappviewer3d/index.html?id=916e47341c2a4444a9bca264798c0463
Apps
Bookmarks
Imported From Safari
Hazel
version 1545_27April
Esri World Geocoder
surface
STORMWATER RUNOFF
Lot ID:
RUNOFF VOLUME
STORM TYPE
3/4" / 24 hr
[inches / 24 hr]
465,596 gal
1,762.4 m3
1.43 acre-ft
85th %
[inches / 24 hr]
580,014 gal
2,195.6 m3
1.78 acre-ft
DRI: Drylands Resilience Initiative

3

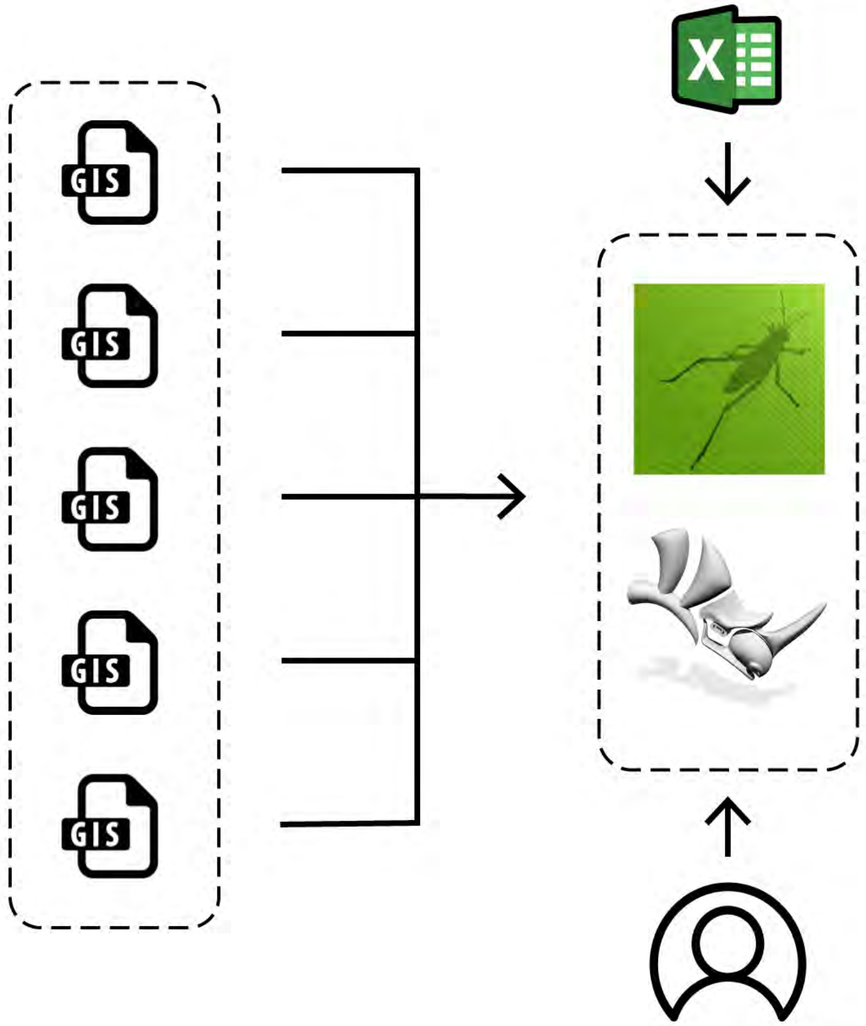
How to Hazel?

Elevating Design Process

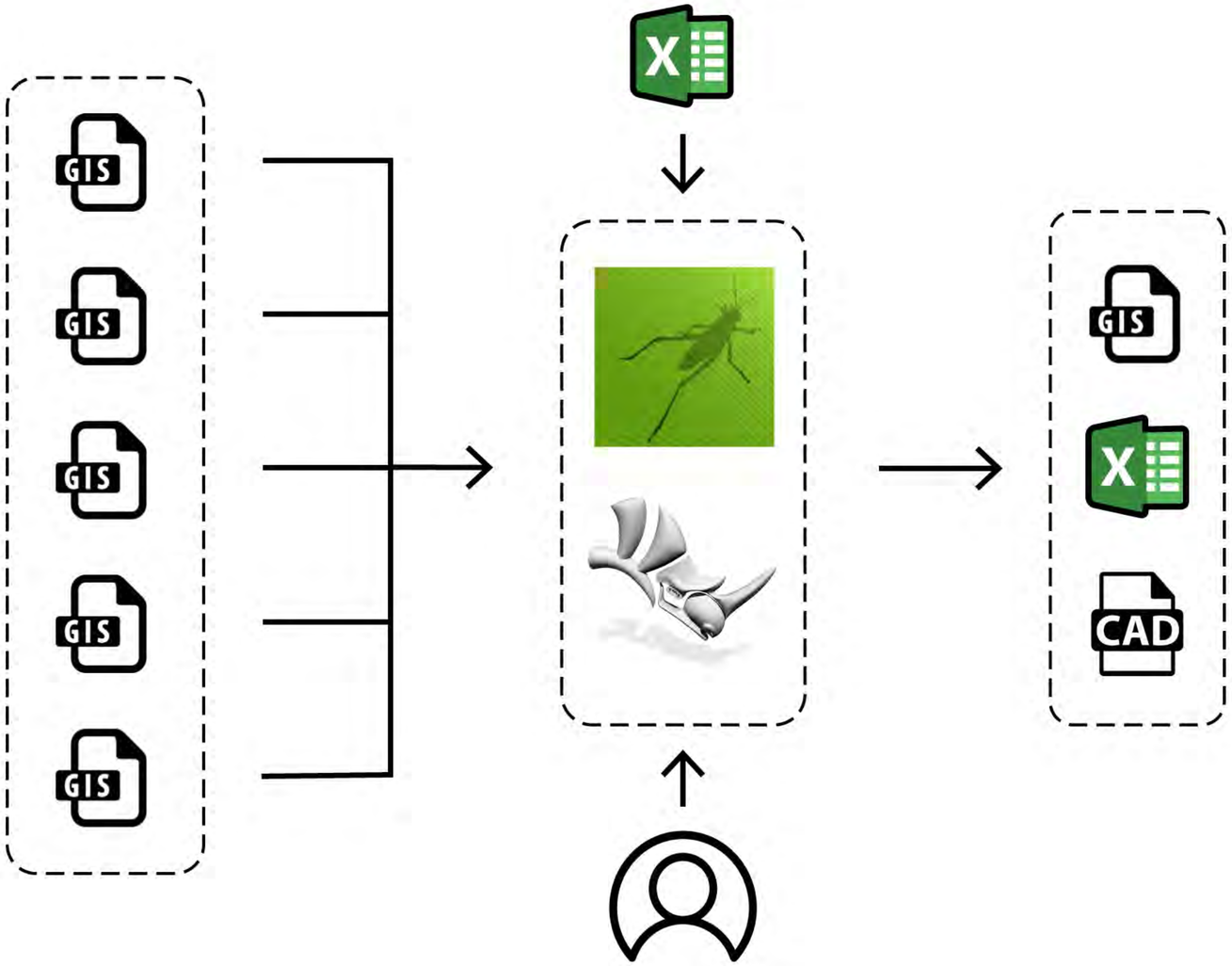




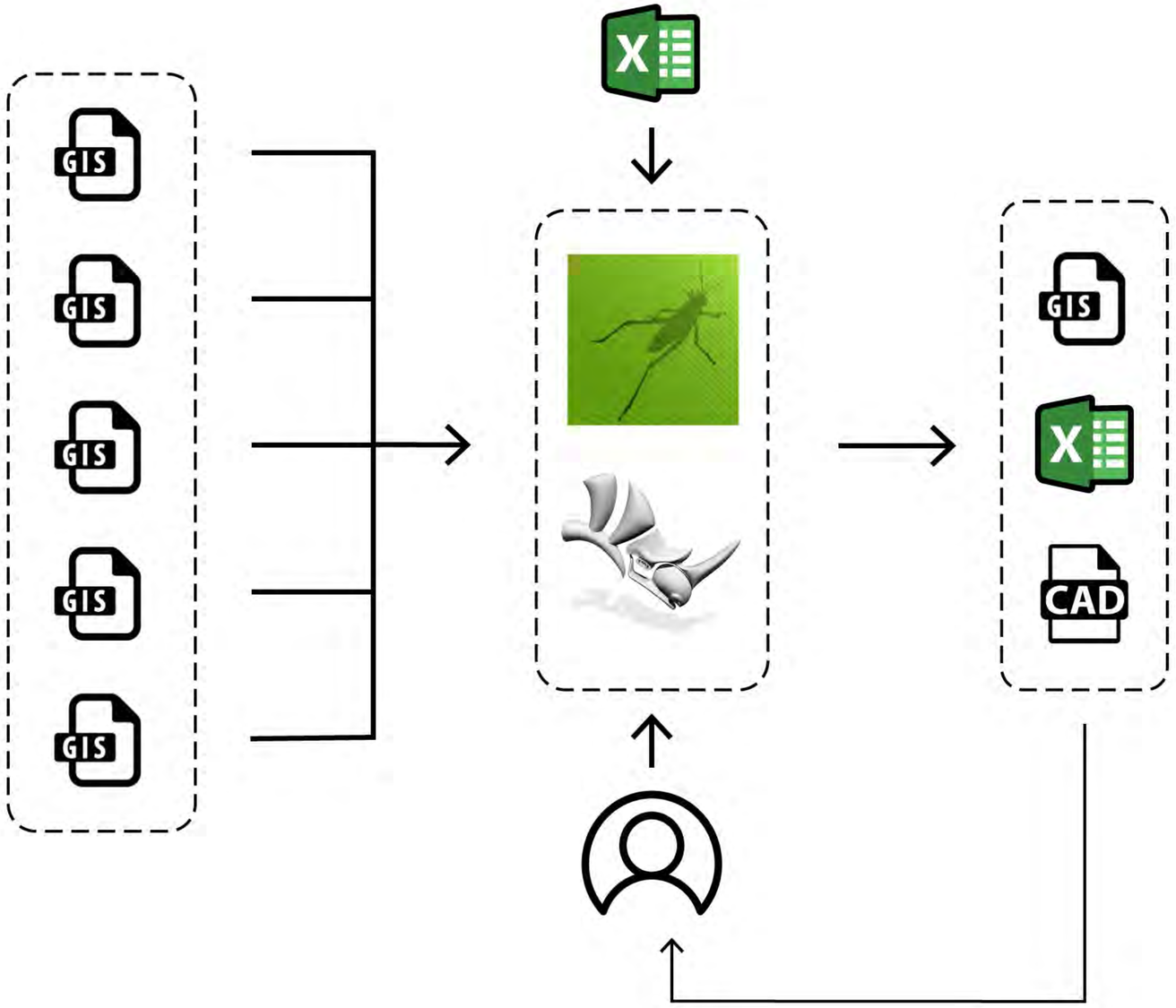
HAZEL WORKFLOW



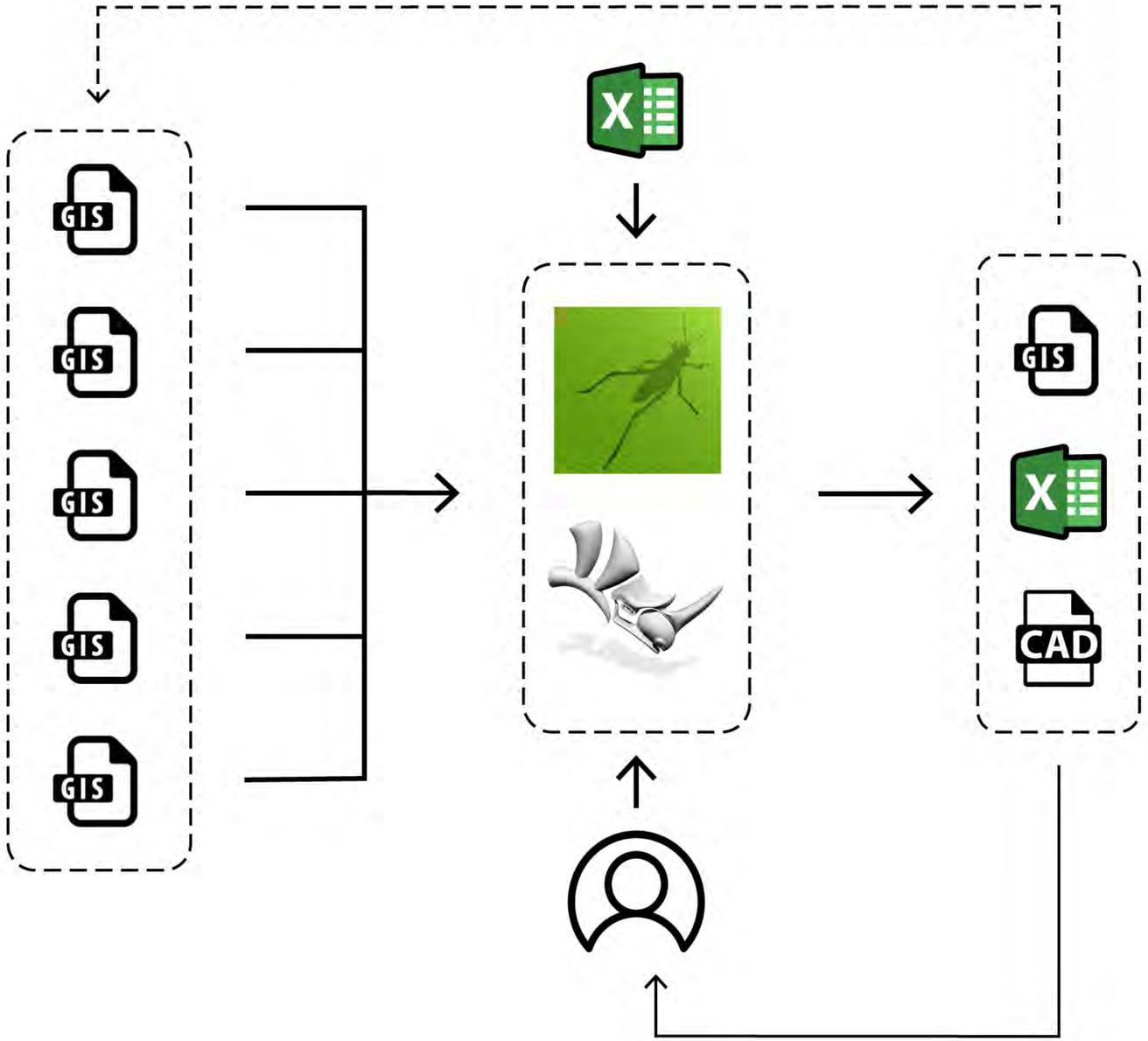
HAZEL WORKFLOW



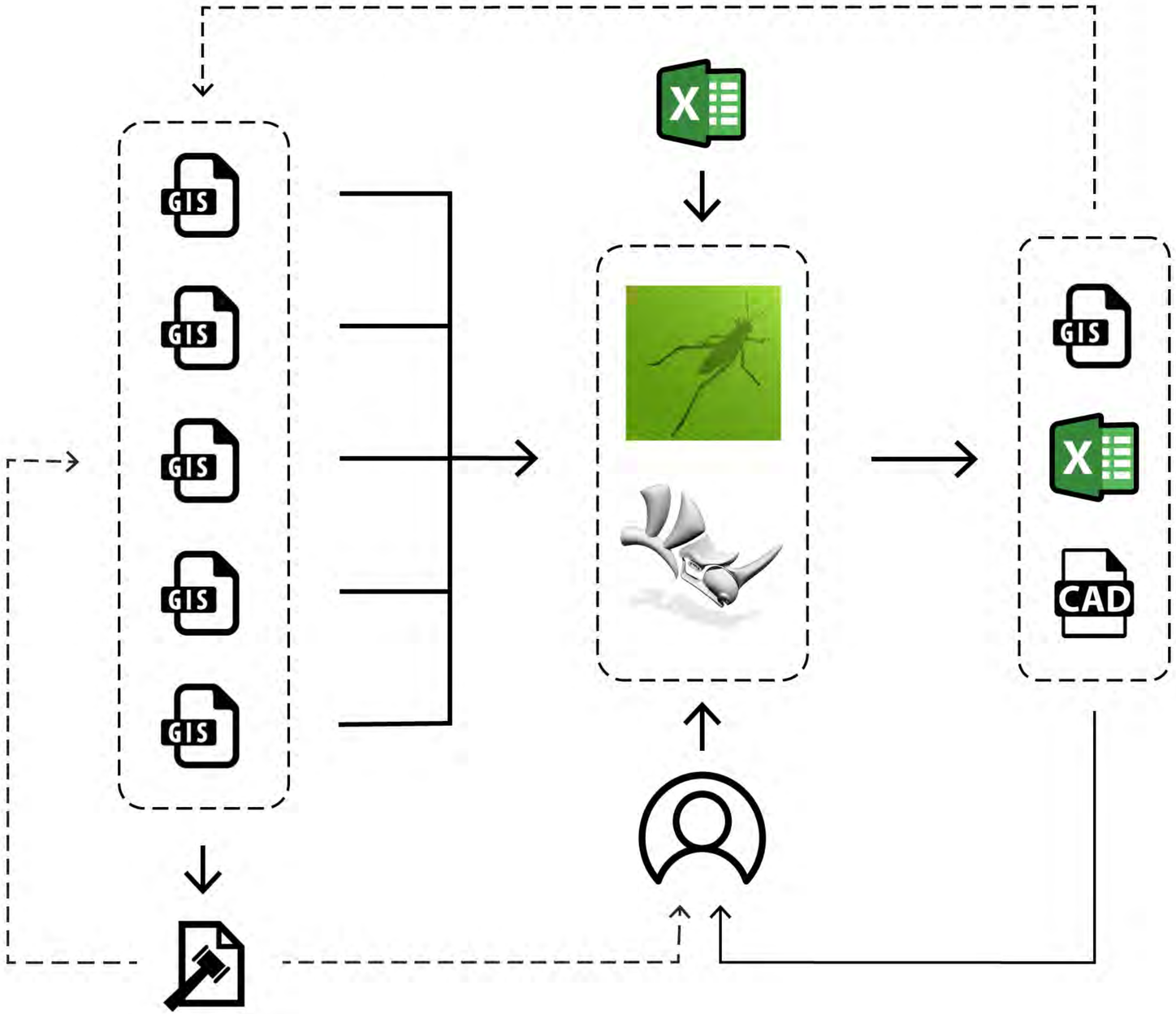
HAZEL WORKFLOW



HAZEL WORKFLOW

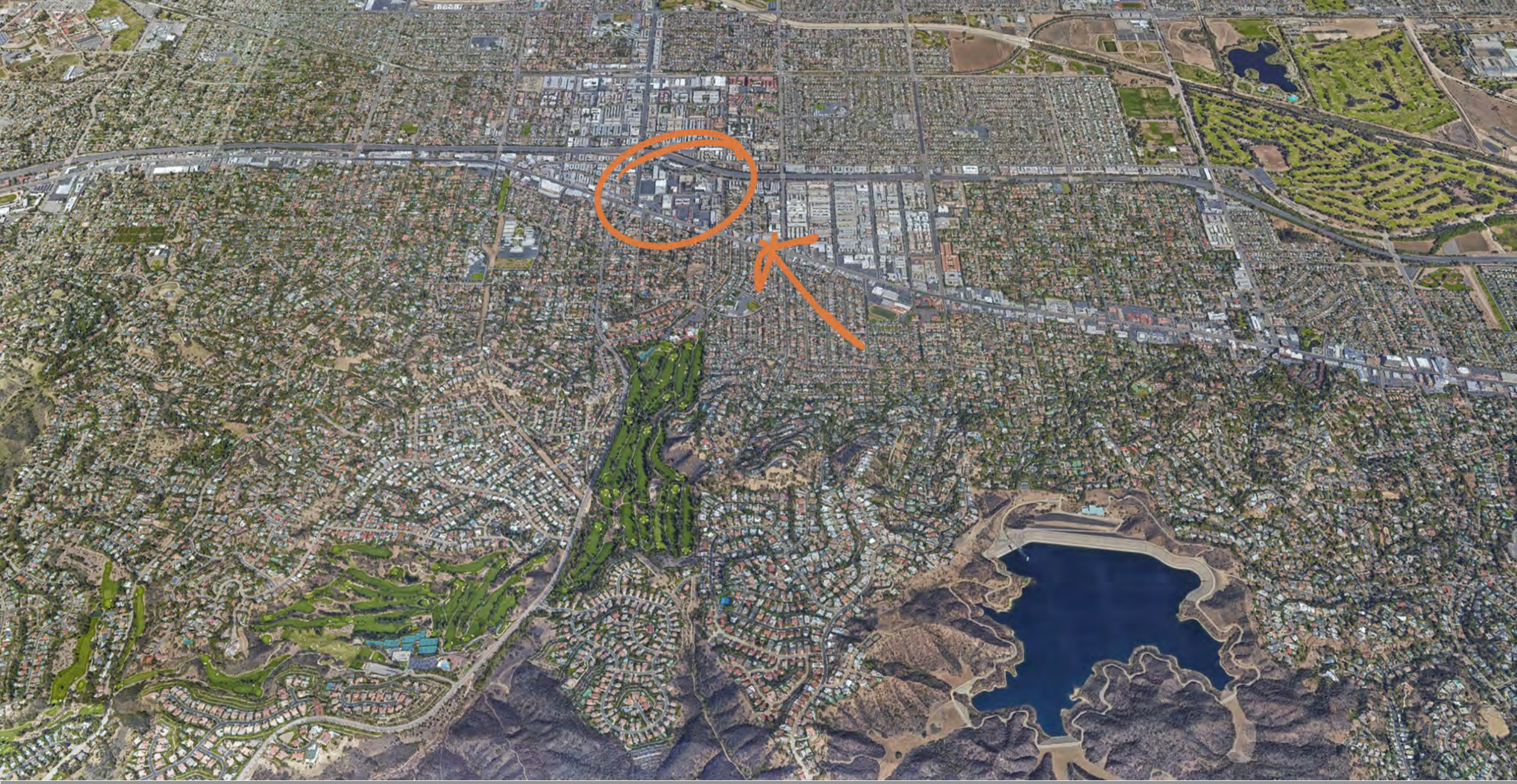


HAZEL WORKFLOW



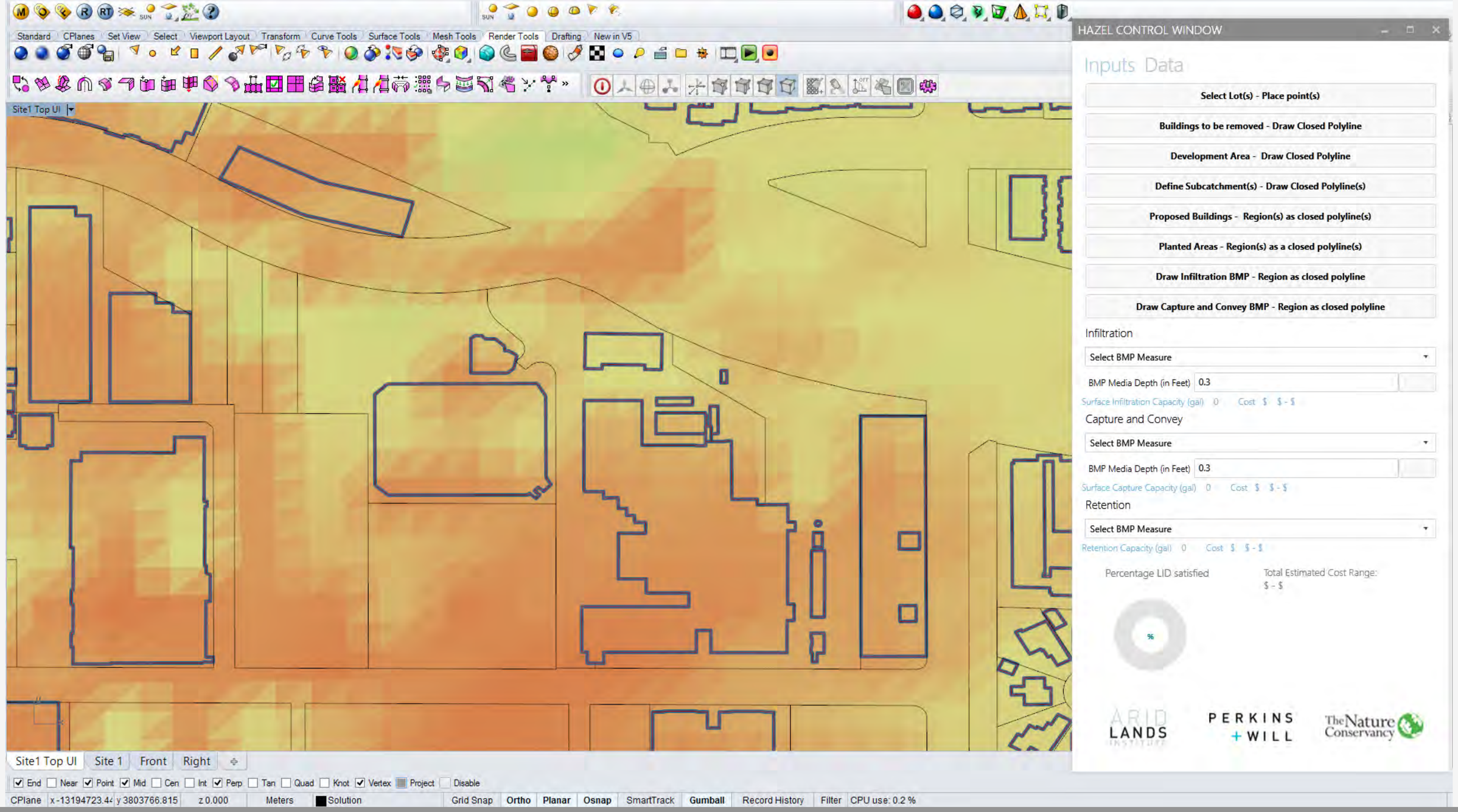
HAZEL WORKFLOW

CASE STUDY:
PROTOTYPE SITE

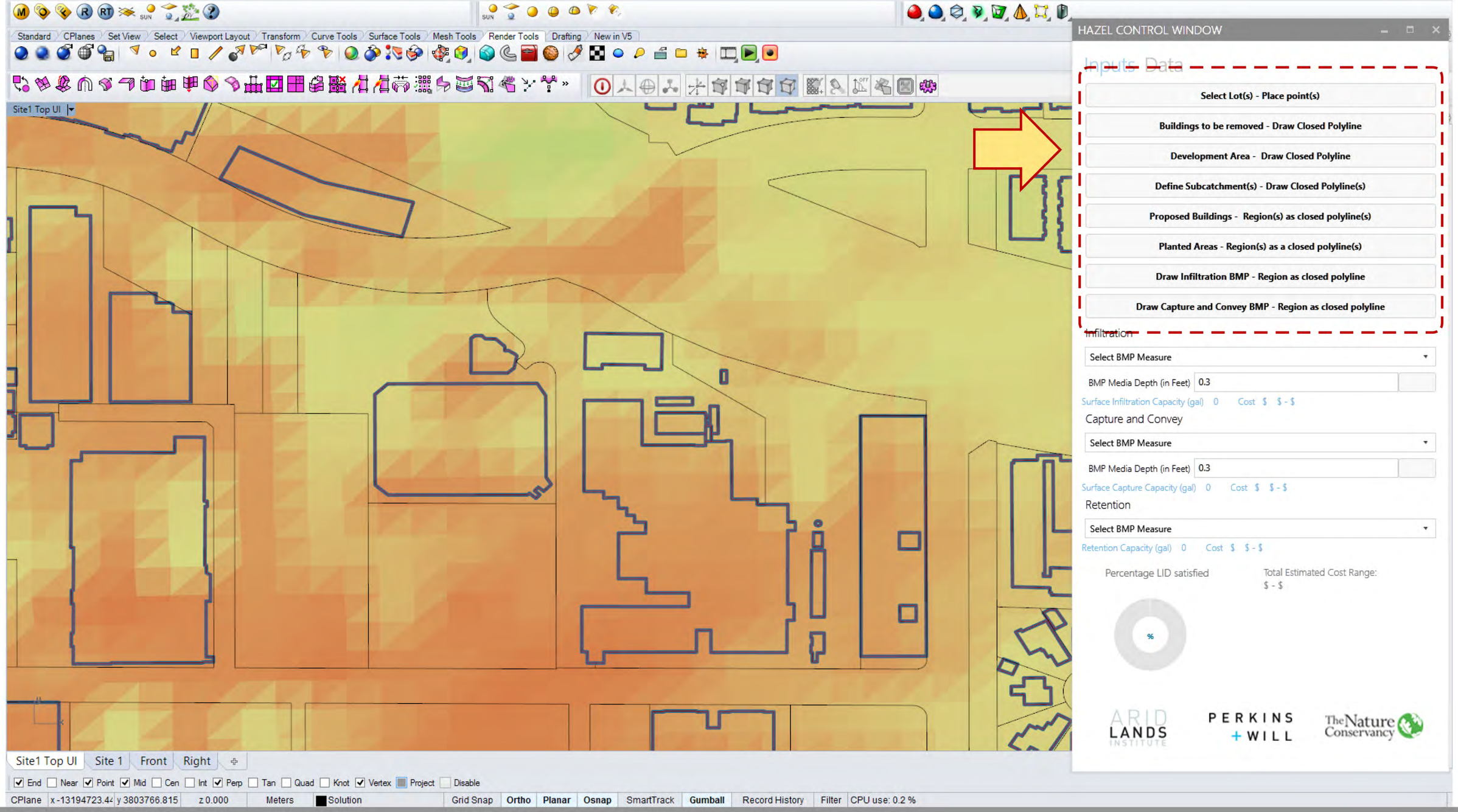


CASE STUDY: PROTOTYPE CAMPUS SITE

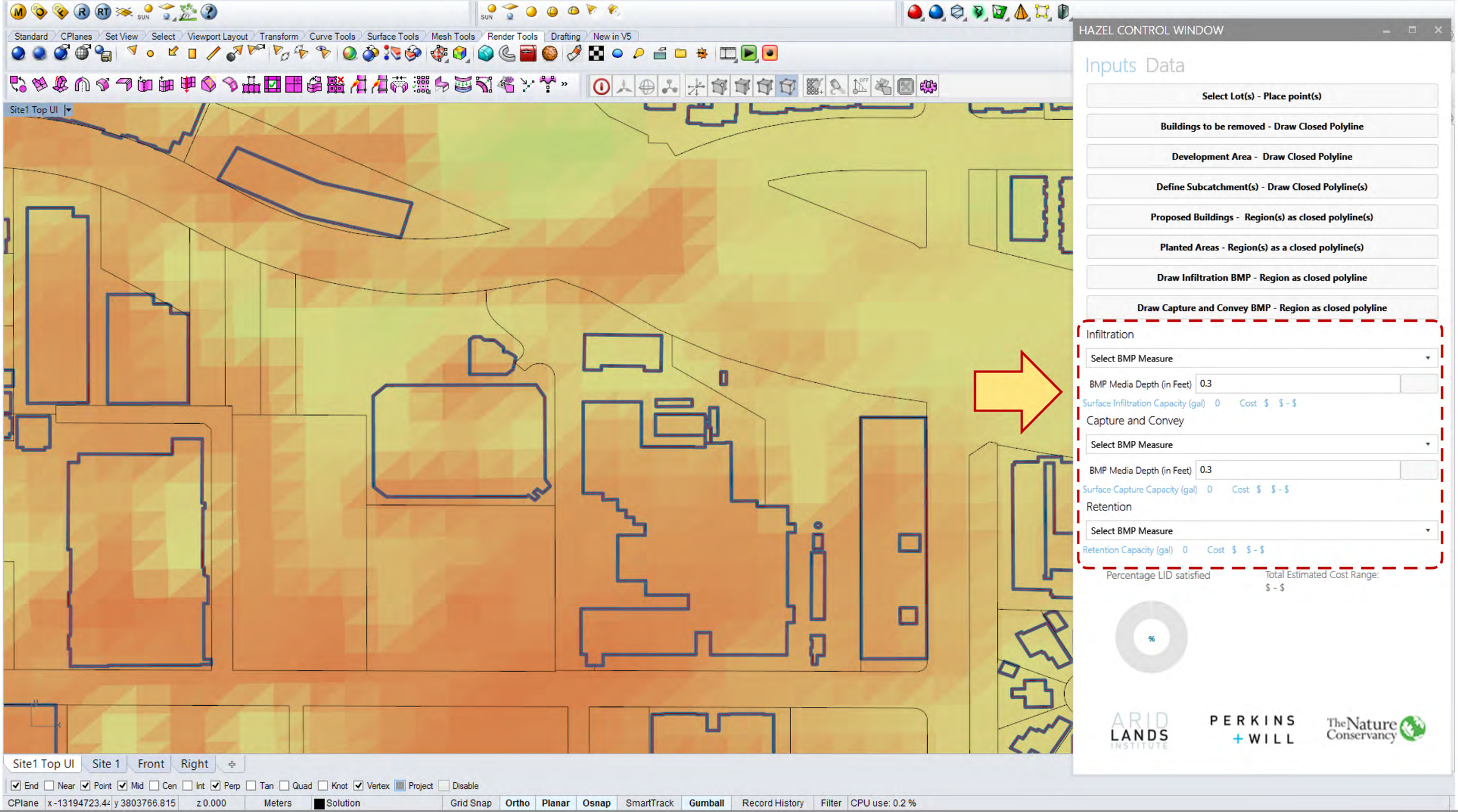
CAMPUS SITE : GIS EXTRACT


Standard
CPlanes
Set View
Select
Viewport Layout
Transform
Curve Tools
Surface Tools
Mesh Tools
Render Tools
Drafting
New in V5
Site1 Top UI
HAZEL CONTROL WINDOW
Inputs Data
Select Lot(s) - Place point(s)
Buildings to be removed - Draw Closed Polyline
Development Area - Draw Closed Polyline
Define Subcatchment(s) - Draw Closed Polyline(s)
Proposed Buildings - Region(s) as closed polyline(s)
Planted Areas - Region(s) as a closed polyline(s)
Draw Infiltration BMP - Region as closed polyline
Draw Capture and Convey BMP - Region as closed polyline
Infiltration
Select BMP Measure
BMP Media Depth (in Feet) 0.3
Surface Infiltration Capacity (gal) 0 Cost $ $ - $
Capture and Convey
Select BMP Measure
BMP Media Depth (in Feet) 0.3
Surface Capture Capacity (gal) 0 Cost $ $ - $
Retention
Select BMP Measure
Retention Capacity (gal) 0 Cost $ $ - $
Percentage LID satisfied
Total Estimated Cost Range:
$ - $
%
ARID LANDS
PERKINS + WILL
The Nature Conservancy
Site1 Top UI
Site 1
Front
Right
End Near Point Mid Cen Int Perp Tan Quad Knot Vertex Project Disable
CPlane x -13194723.44 y 3803766.815 z 0.000 Meters Solution Grid Snap Ortho Planar Osnap SmartTrack Gumball Record History Filter CPU use: 0.2 %

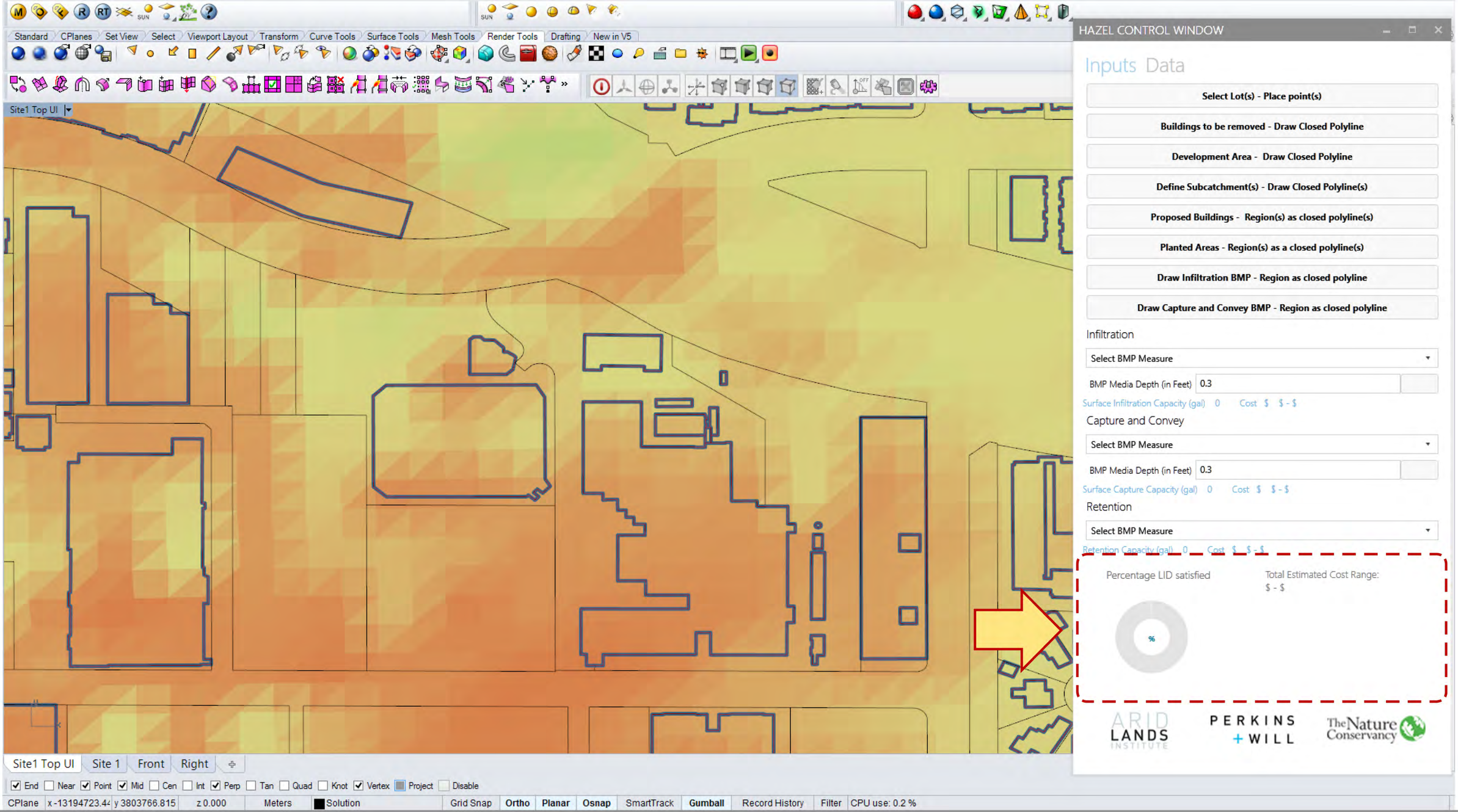
USING HAZEL


HAZEL CONTROL WINDOW
Inputs Data
Select Lot(s) - Place point(s)
Buildings to be removed - Draw Closed Polyline
Development Area - Draw Closed Polyline
Define Subcatchment(s) - Draw Closed Polyline(s)
Proposed Buildings - Region(s) as closed polyline(s)
Planted Areas - Region(s) as a closed polyline(s)
Draw Infiltration BMP - Region as closed polyline
Draw Capture and Convey BMP - Region as closed polyline
Infiltration
Select BMP Measure
BMP Media Depth (in Feet) 0.3
Surface Infiltration Capacity (gal) 0 Cost $ $ - $
Capture and Convey
Select BMP Measure
BMP Media Depth (in Feet) 0.3
Surface Capture Capacity (gal) 0 Cost $ $ - $
Retention
Select BMP Measure
Retention Capacity (gal) 0 Cost $ $ - $
Percentage LID satisfied
Total Estimated Cost Range:
$ - $
%
ARID LANDS INSTITUTE
PERKINS + WILL
The Nature Conservancy
Site1 Top UI
Site 1
Front
Right
End Near Point Mid Cen Int Perp Tan Quad Knot Vertex Project Disable
CPlane x -13194723.44 y 3803766.815 z 0.000 Meters Solution Grid Snap Ortho Planar Osnap SmartTrack Gumball Record History Filter CPU use: 0.2 %

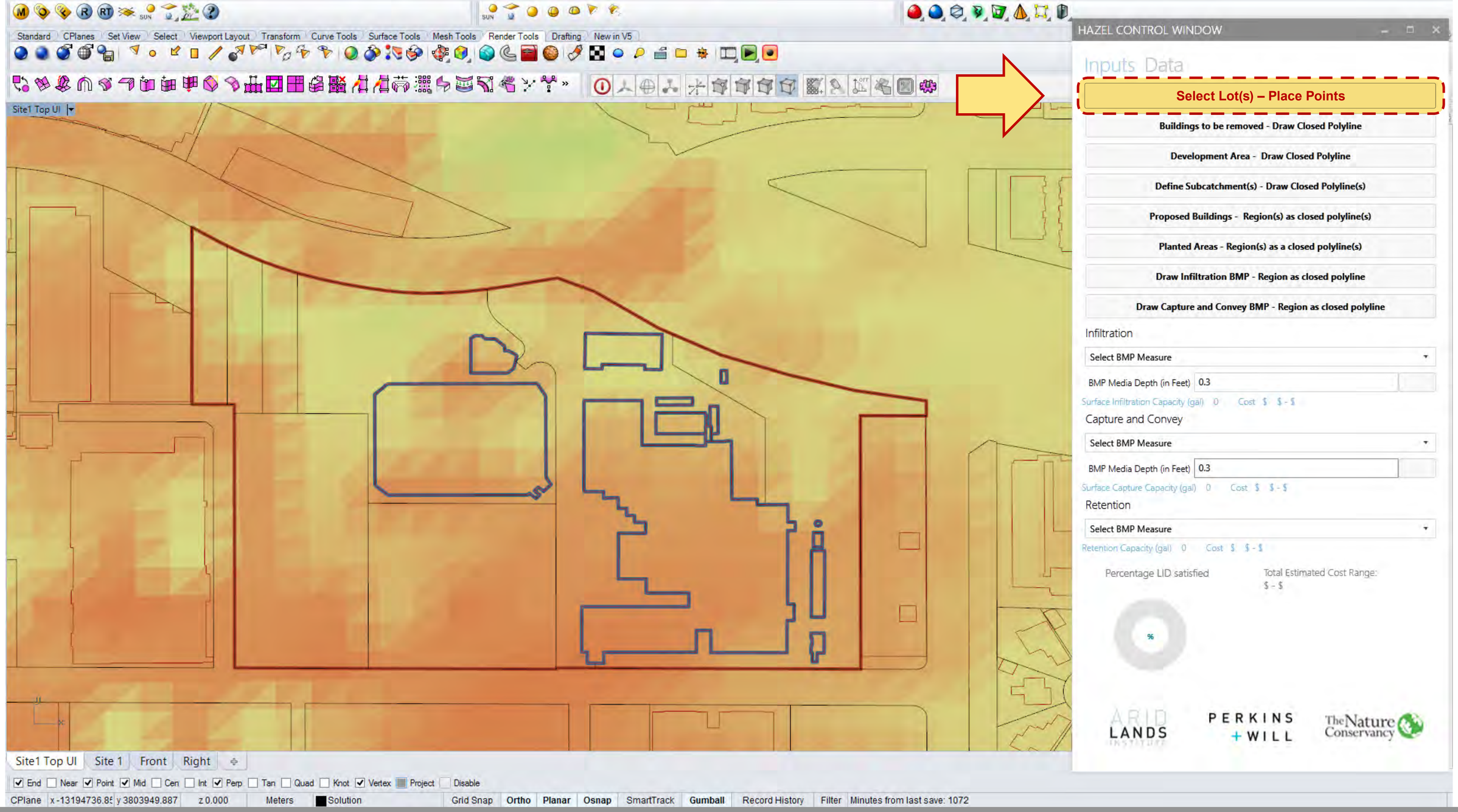
USING HAZEL


HAZEL CONTROL WINDOW
Inputs Data
Select Lot(s) - Place point(s)
Buildings to be removed - Draw Closed Polyline
Development Area - Draw Closed Polyline
Define Subcatchment(s) - Draw Closed Polyline(s)
Proposed Buildings - Region(s) as closed polyline(s)
Planted Areas - Region(s) as a closed polyline(s)
Draw Infiltration BMP - Region as closed polyline
Draw Capture and Convey BMP - Region as closed polyline
Infiltration
Select BMP Measure
BMP Media Depth (in Feet) 0.3
Surface Infiltration Capacity (gal) 0 Cost $ $ - $
Capture and Convey
Select BMP Measure
BMP Media Depth (in Feet) 0.3
Surface Capture Capacity (gal) 0 Cost $ $ - $
Retention
Select BMP Measure
Retention Capacity (gal) 0 Cost $ $ - $
Percentage LID satisfied
Total Estimated Cost Range:
$ - $
%
ARID LANDS INSTITUTE
PERKINS + WILL
The Nature Conservancy
Site1 Top UI
Site 1
Front
Right
End Near Point Mid Cen Int Perp Tan Quad Knot Vertex Project Disable
CPlane x -13194723.44 y 3803766.815 z 0.000 Meters Solution Grid Snap Ortho Planar Osnap SmartTrack Gumball Record History Filter CPU use: 0.2 %

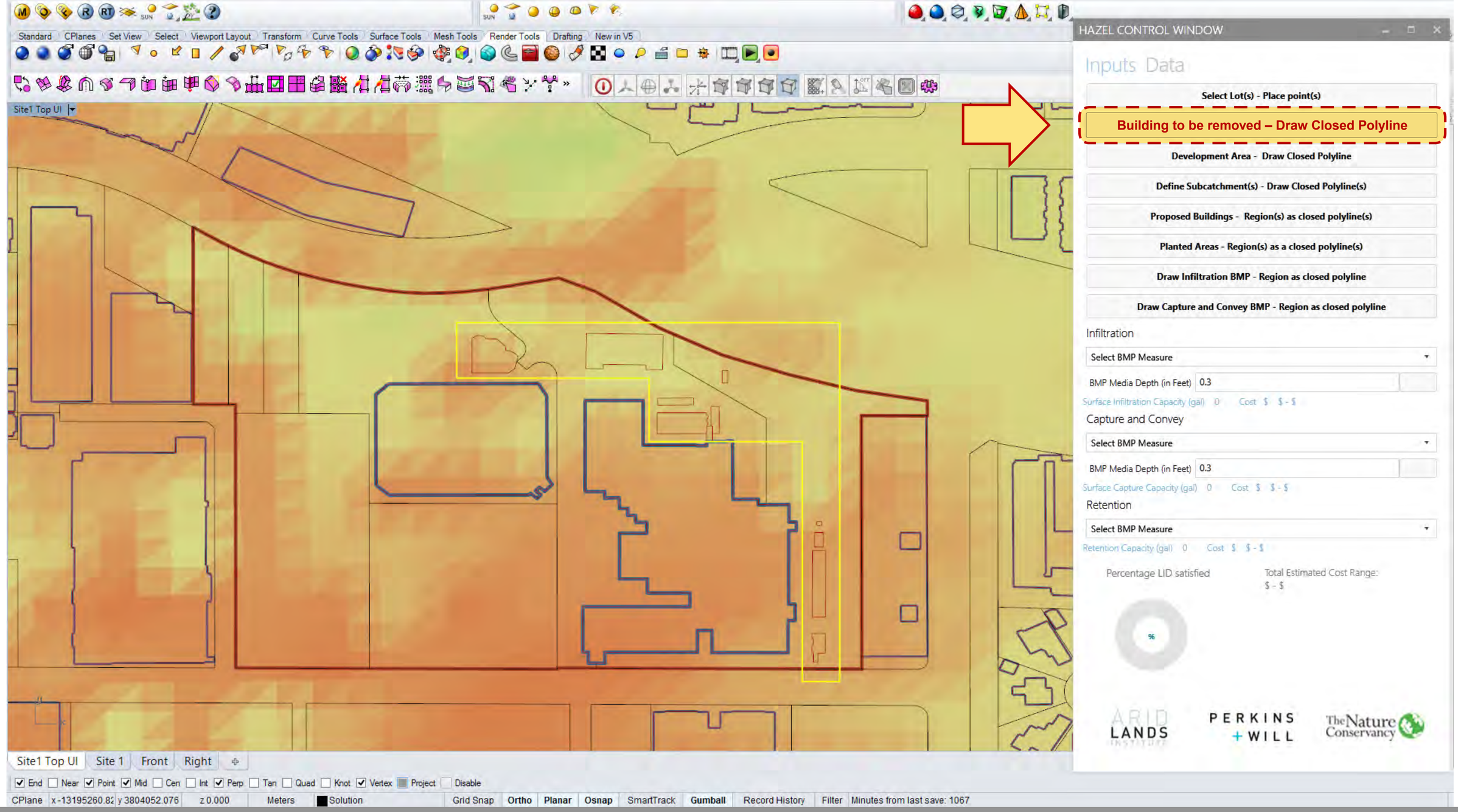
USING HAZEL


HAZEL CONTROL WINDOW
Inputs Data
Select Lot(s) - Place point(s)
Buildings to be removed - Draw Closed Polyline
Development Area - Draw Closed Polyline
Define Subcatchment(s) - Draw Closed Polyline(s)
Proposed Buildings - Region(s) as closed polyline(s)
Planted Areas - Region(s) as a closed polyline(s)
Draw Infiltration BMP - Region as closed polyline
Draw Capture and Convey BMP - Region as closed polyline
Infiltration
Select BMP Measure
BMP Media Depth (in Feet) 0.3
Surface Infiltration Capacity (gal) 0 Cost $ $ - $
Capture and Convey
Select BMP Measure
BMP Media Depth (in Feet) 0.3
Surface Capture Capacity (gal) 0 Cost $ $ - $
Retention
Select BMP Measure
Retention Capacity (gal) 0 Cost $ $ - $
Percentage LID satisfied
Total Estimated Cost Range:
$ - $
%
ARID LANDS INSTITUTE
PERKINS + WILL
The Nature Conservancy
Site1 Top UI
Site 1
Front
Right
End Near Point Mid Cen Int Perp Tan Quad Knot Vertex Project Disable
CPlane x -13194723.44 y 3803766.815 z 0.000 Meters Solution Grid Snap Ortho Planar Osnap SmartTrack Gumball Record History Filter CPU use: 0.2 %

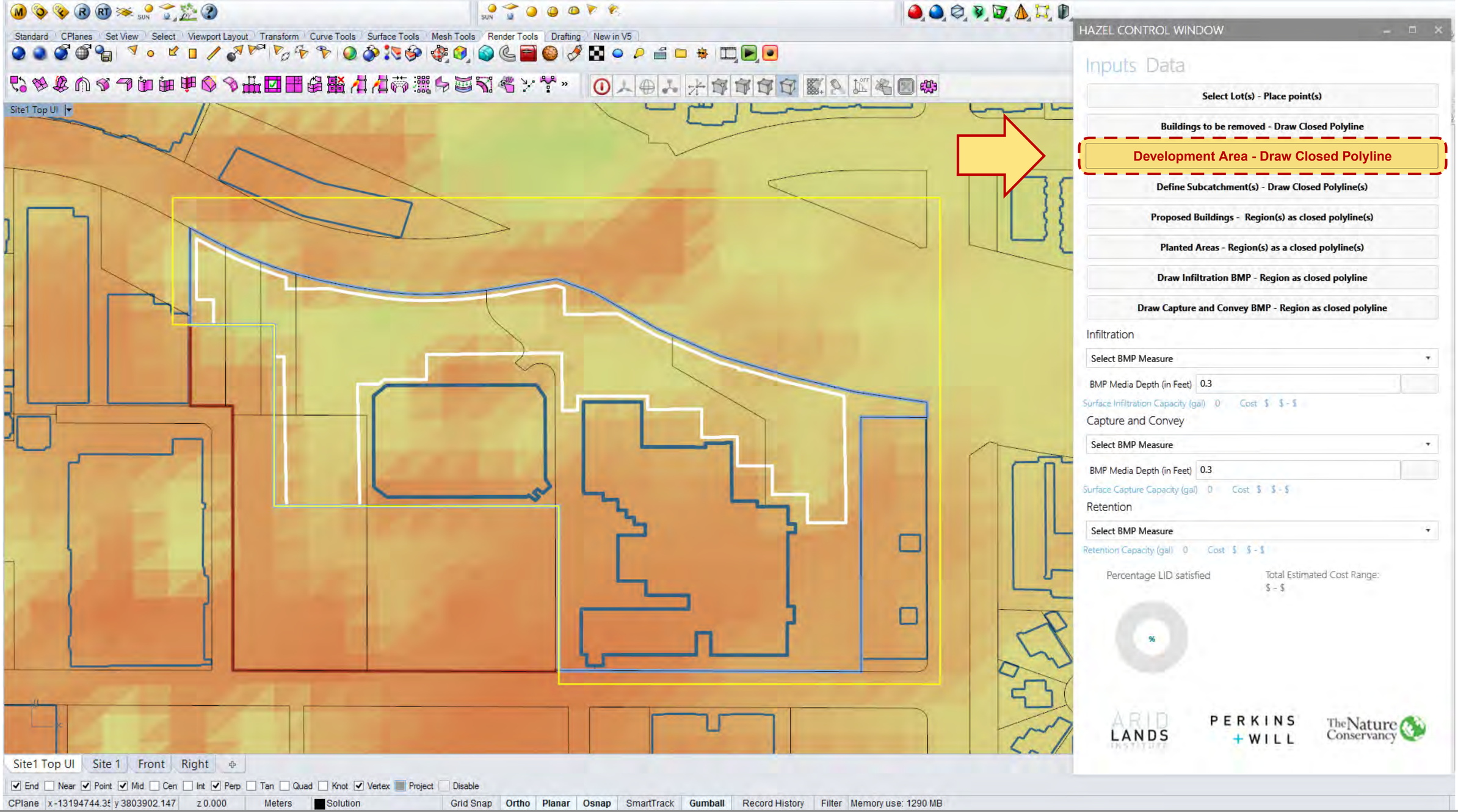
USING HAZEL



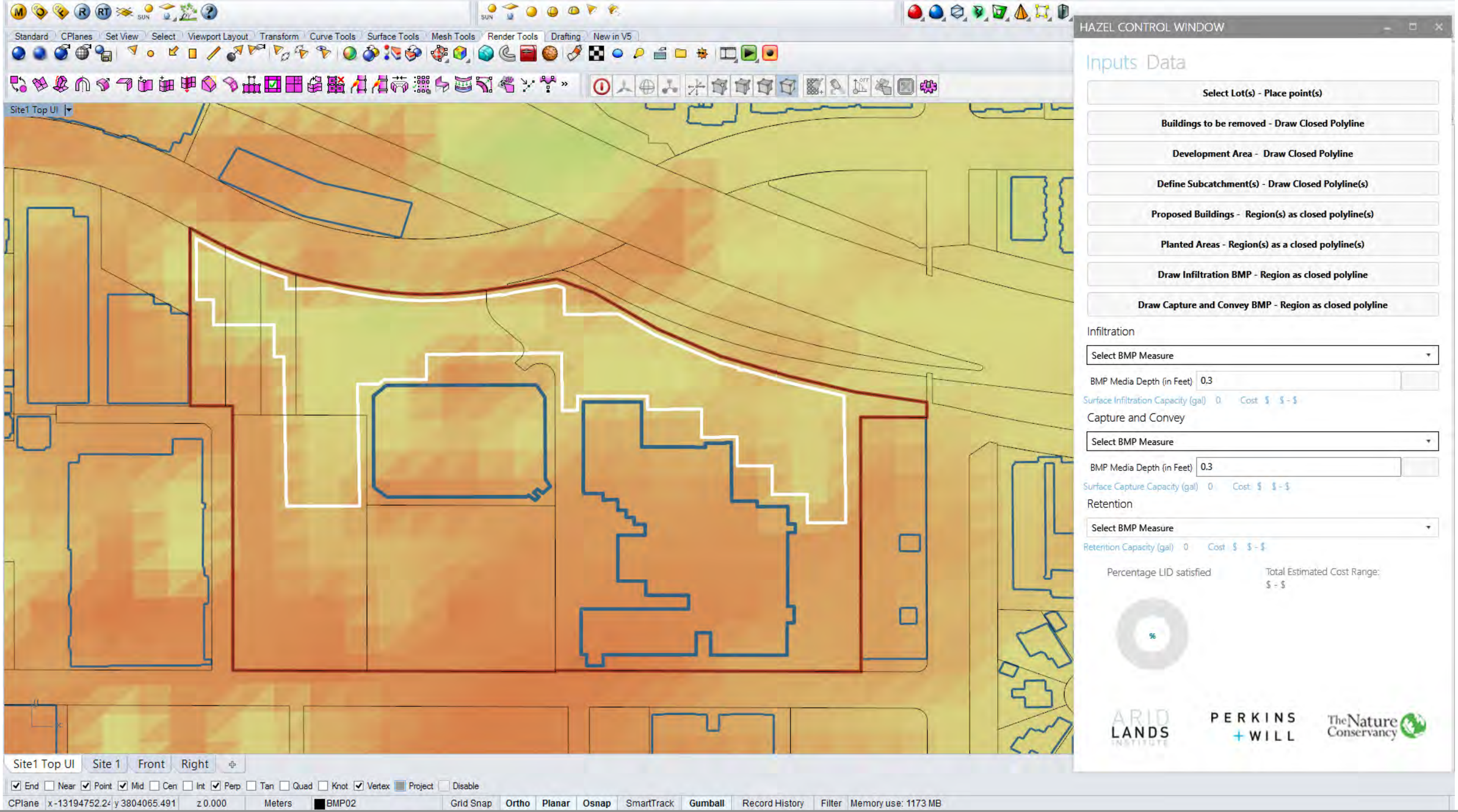
USING HAZEL : SELECT LOTS



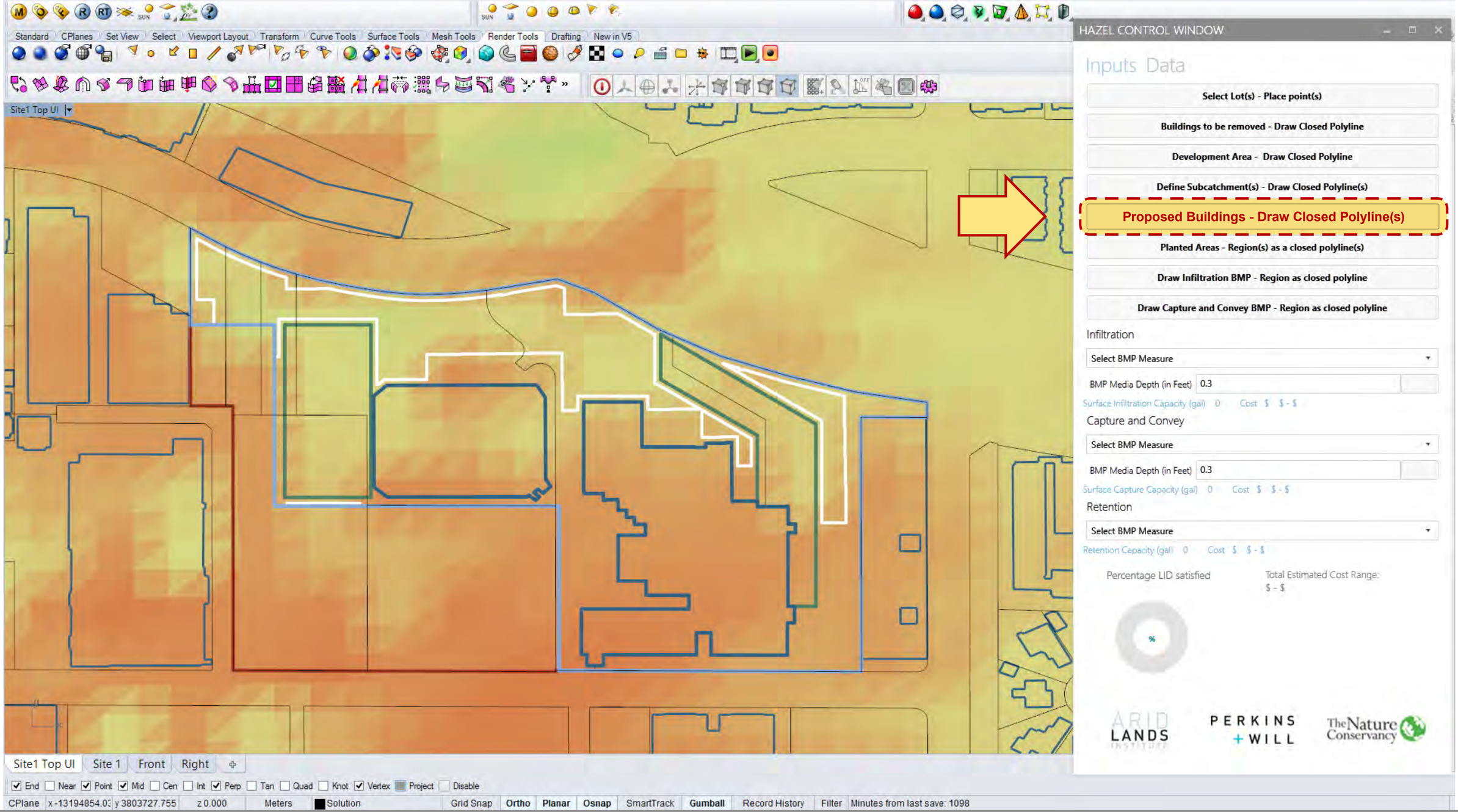
USING HAZEL : BUILDINGS TO BE REMOVED



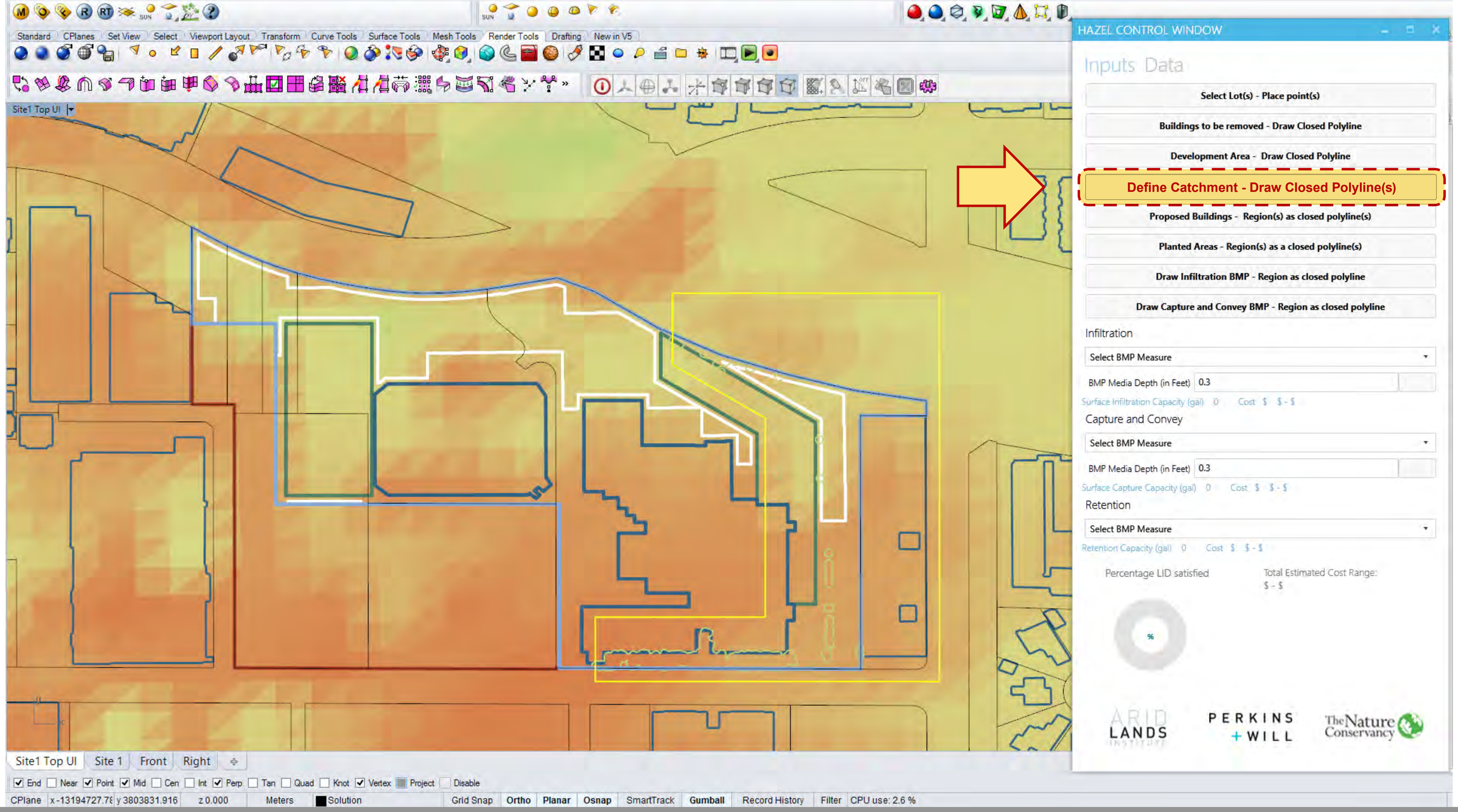
USING HAZEL : DEVELOPMENT AREA



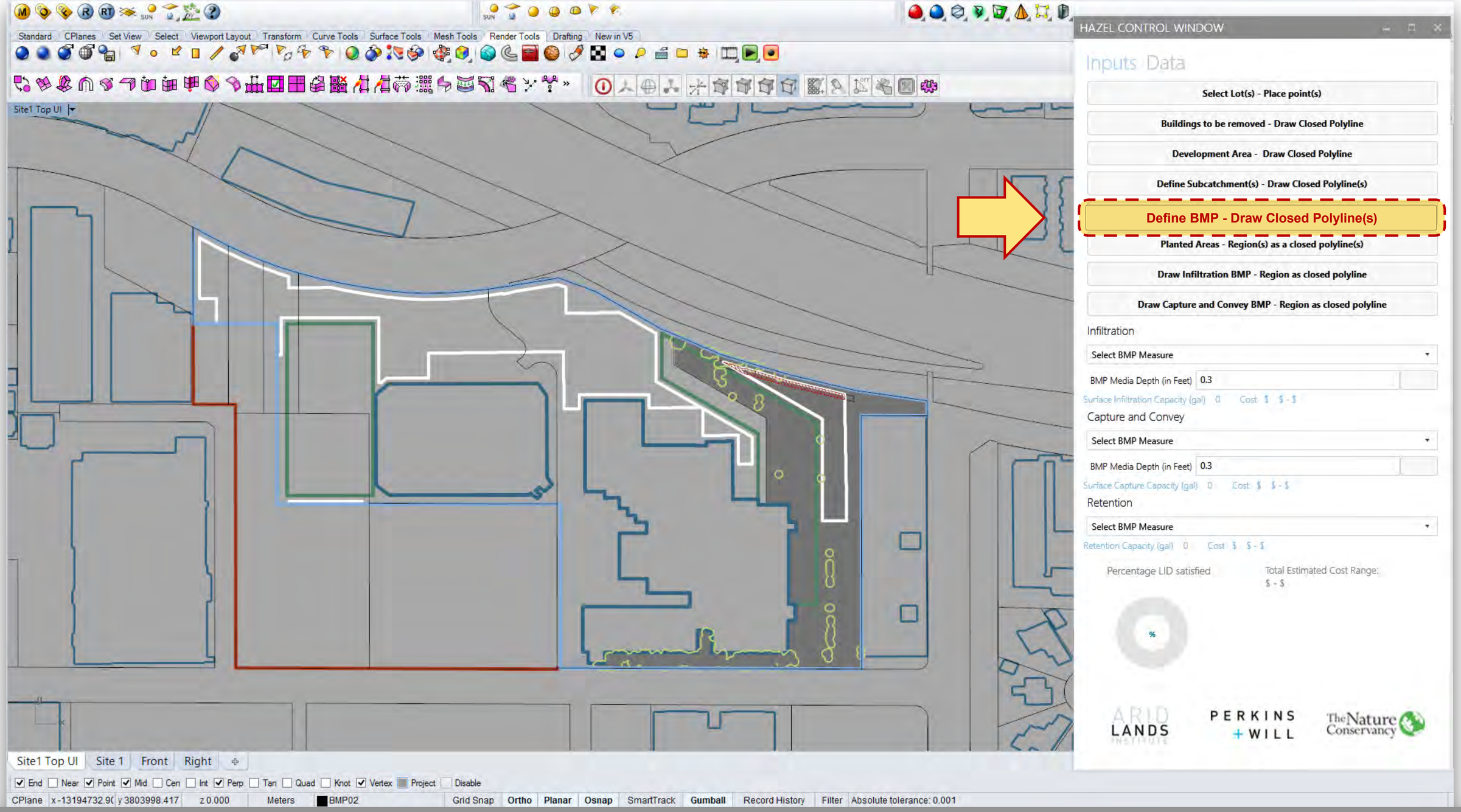
USING HAZEL : RECOMMENDED INFILTRATION ZONE



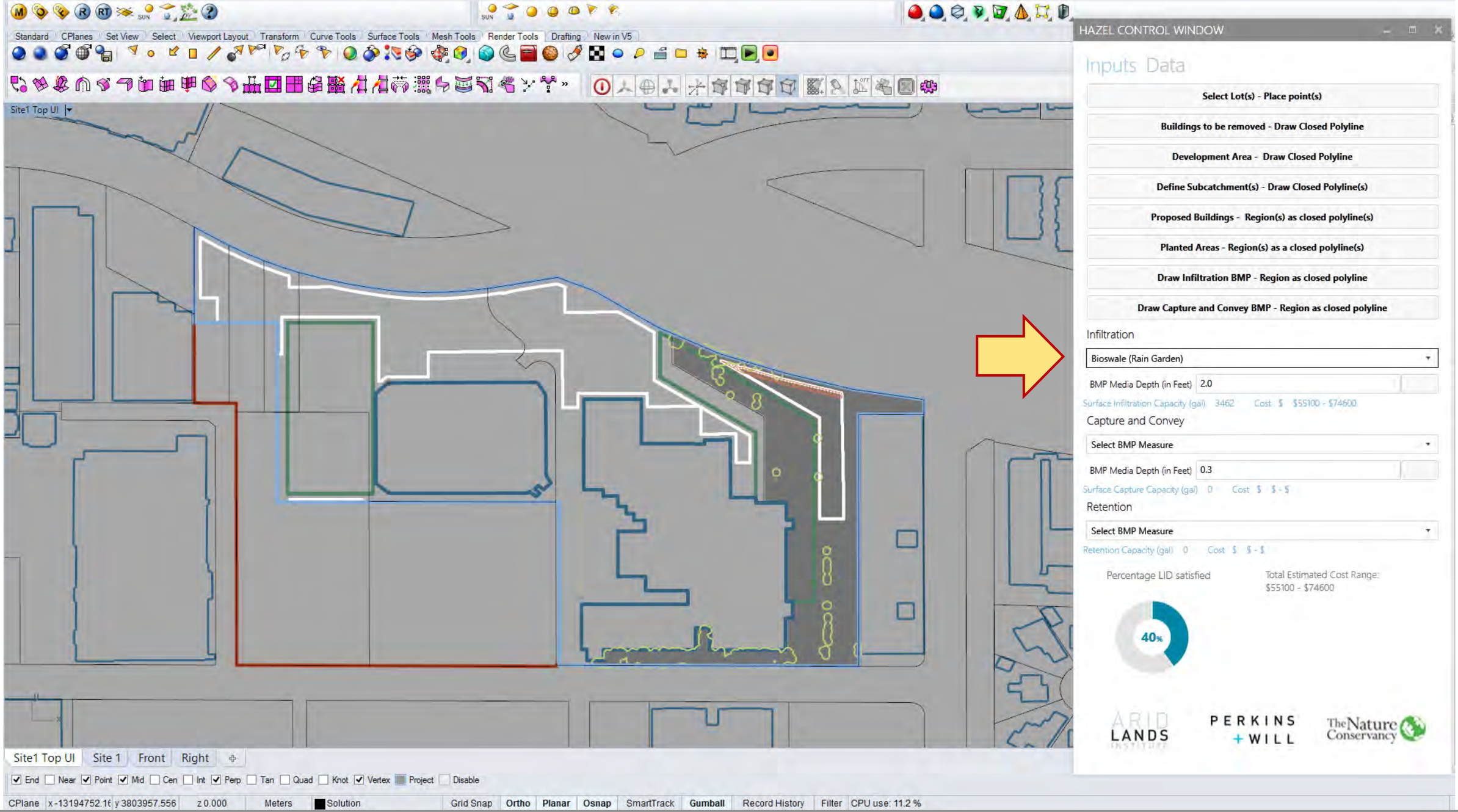
USING HAZEL : DEVELOPMENT AREA



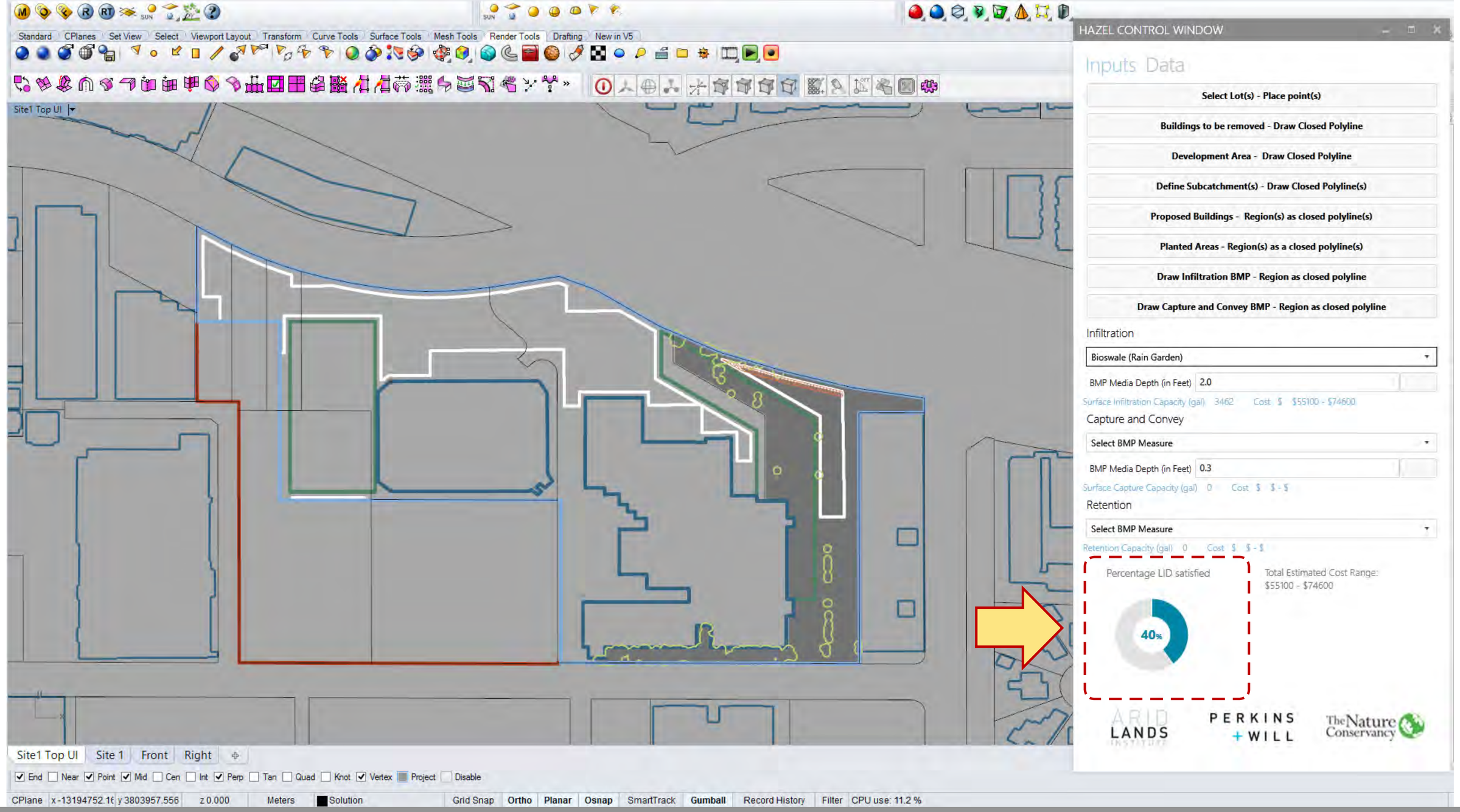
USING HAZEL : SUBCATCHMENT AREA



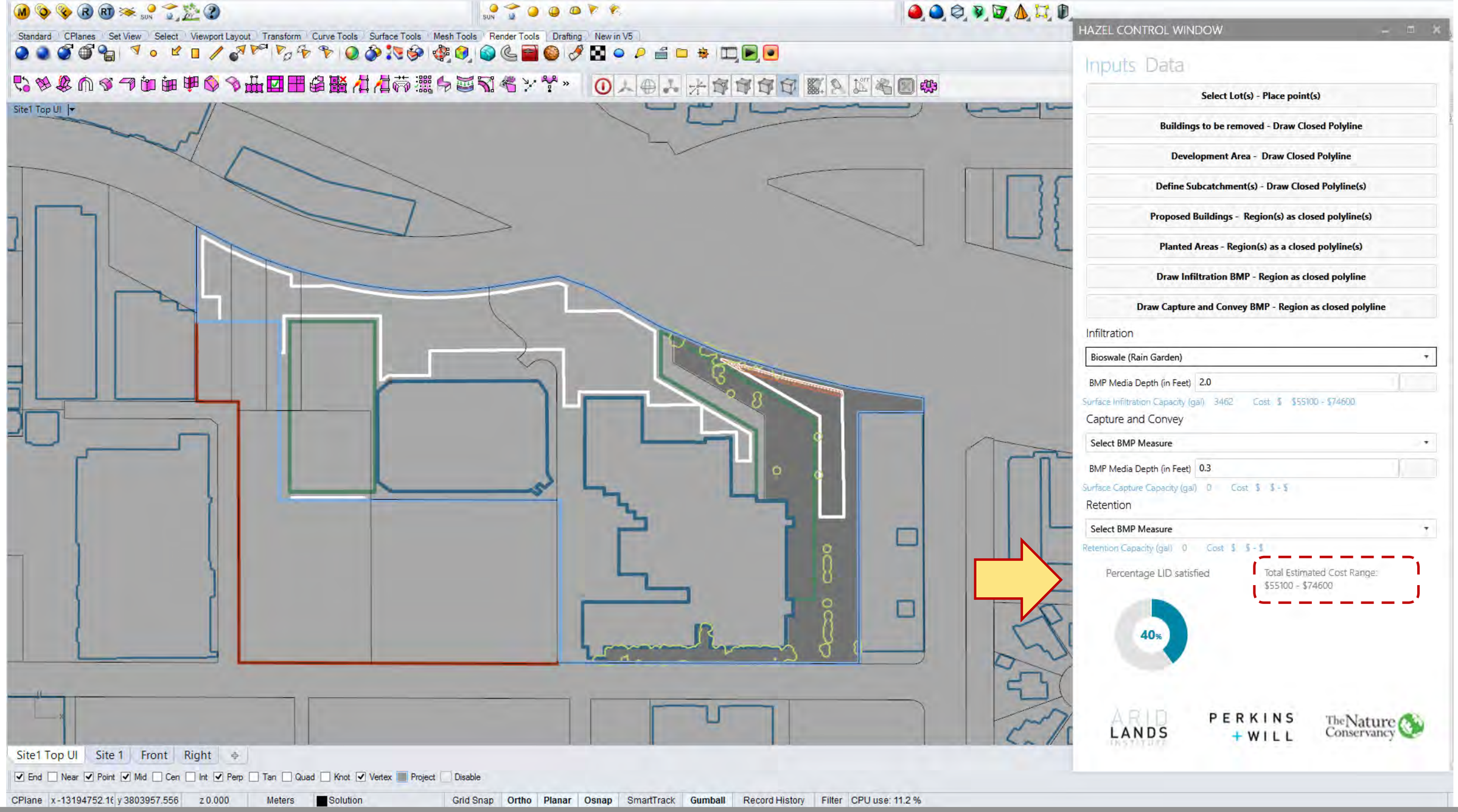
USING HAZEL : DEFINE BMP REGION



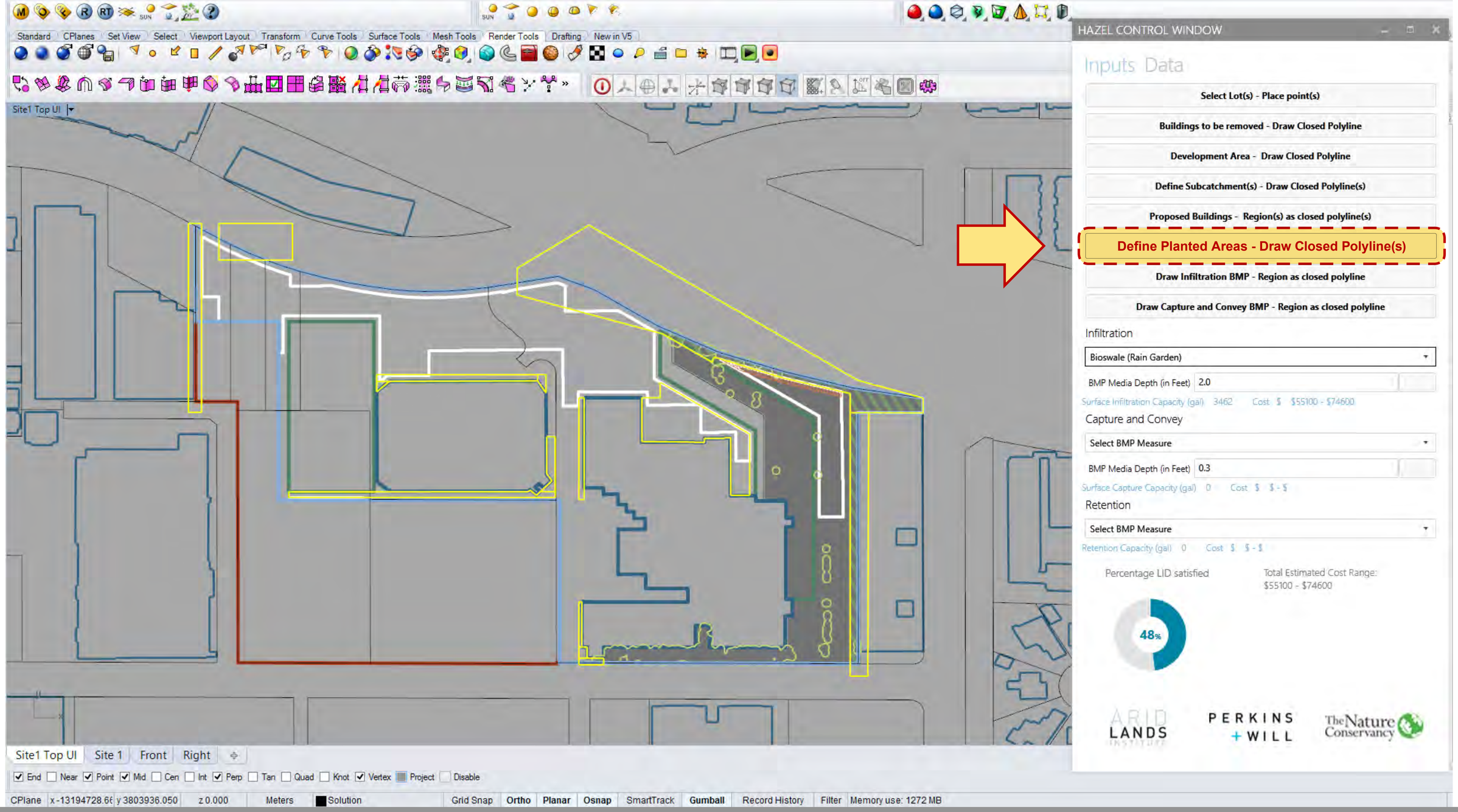
USING HAZEL : SELECT BMP TYPE



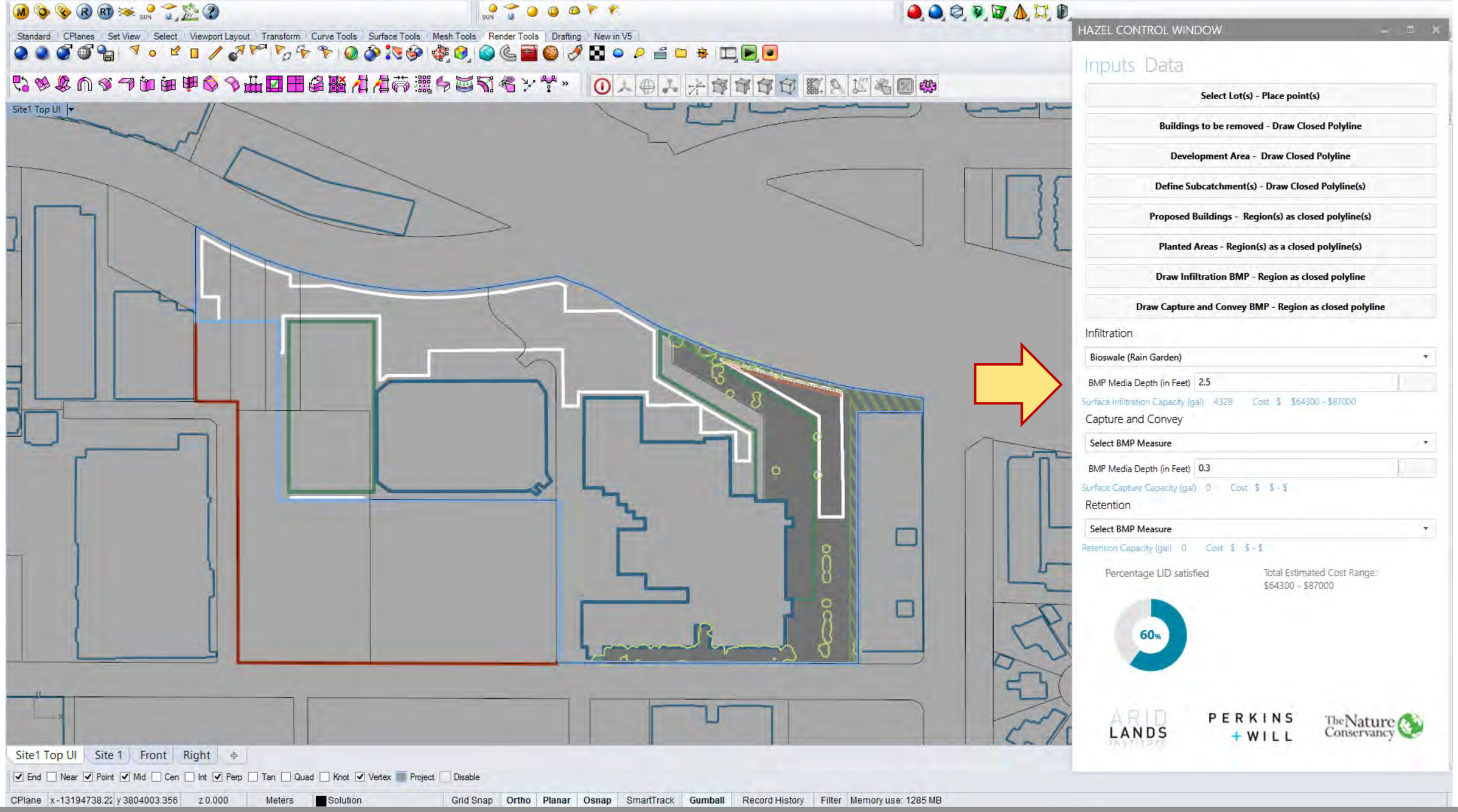
USING HAZEL : PERCENTAGE IN COMPLIANCE



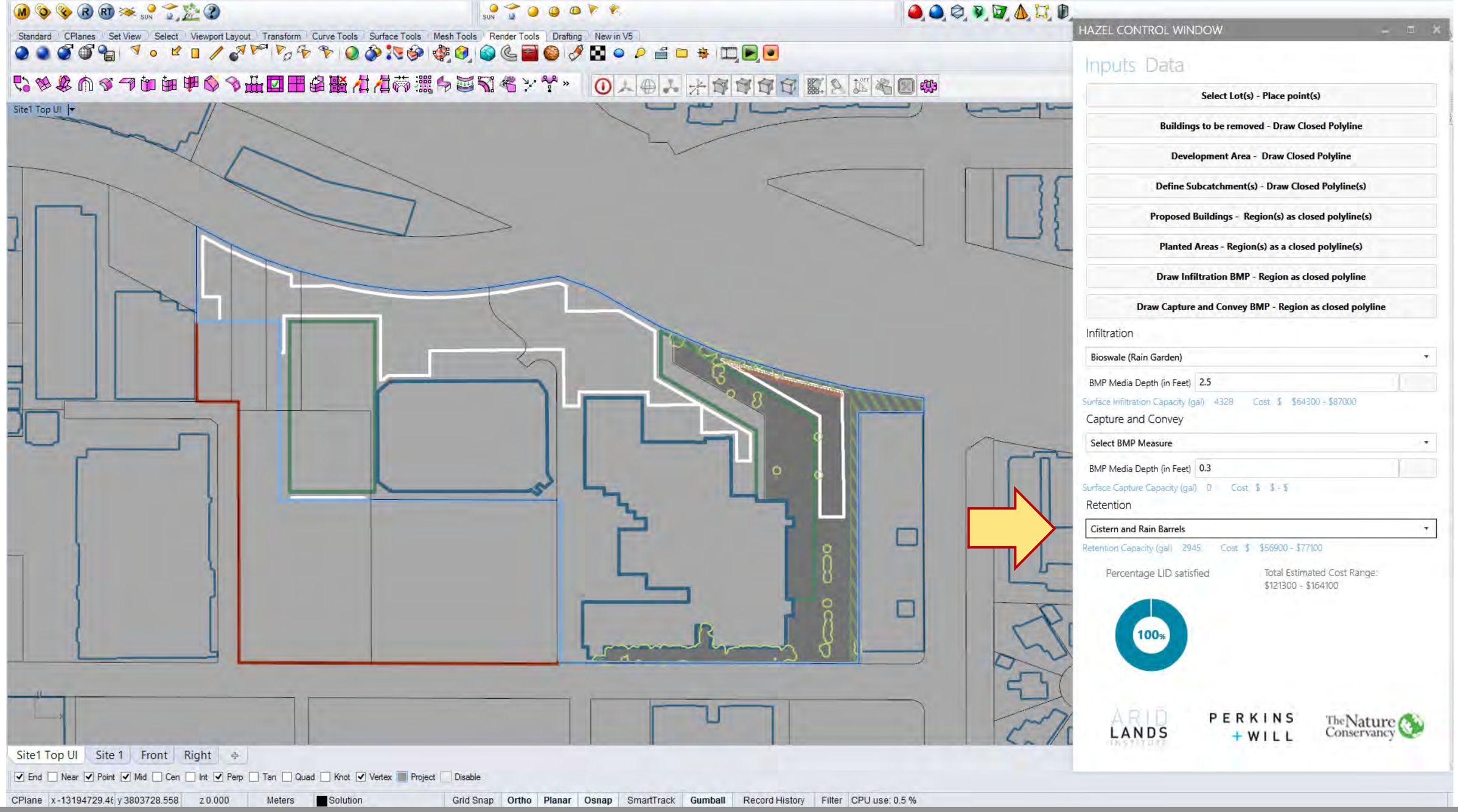
USING HAZEL : ESTIMATED COST RANGE



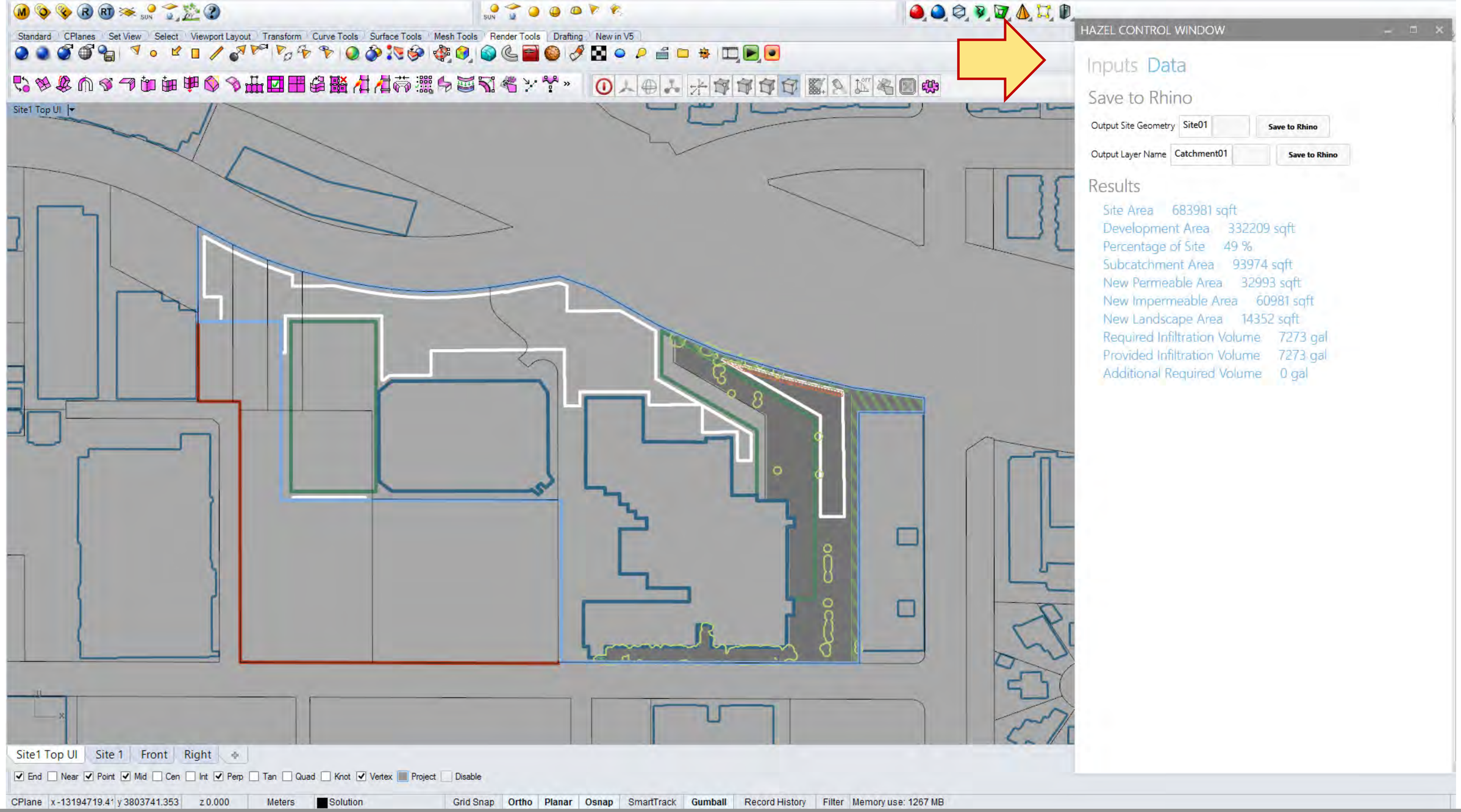
USING HAZEL : DEFINE LANDSCAPE AREAS



USING HAZEL : ADJUST BMP DEPTH



USING HAZEL : SELECT RETENTION BMP



USING HAZEL : RESULTING DATA

Workshops: Testing the Tool + User Interface

USING HAZEL : WORKSHOP 1

“Give Ability to check Civil Engineer”

“Explore scenarios, options, alternatives”

“Scope of magnitude of challenge and problem definition up front”

“Cost data very valuable”

“Power of data - lots of it in one place - FAST”

USING HAZEL : WORKSHOP 2

Infiltration

Bioswale (Rain Garden)

BMP Media Depth (in Feet) 2.0

Surface Infiltration Capacity (gal) 7680 Cost $ $122400 - $165500

Capture and Convey

Select BMP Measure

BMP Media Depth (in Feet) 0.3

Surface Capture Capacity (gal) 0 Cost $ $ - $

Retention

Select BMP Measure

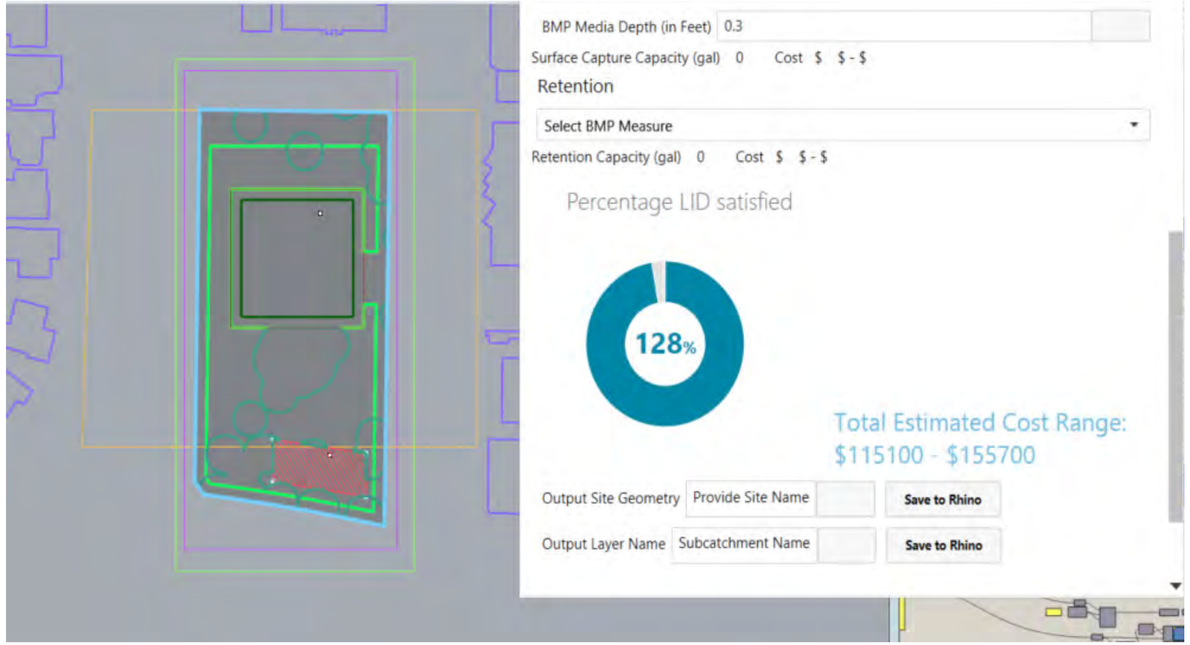
Retention Capacity (gal) 0 Cost $ $ - $

Percentage LID satisfied

125%

Total Estimated Cost Range:
$122400 - $165500

Output Site Geometry Provide Site Name Save to Rhino



BMP Media Depth (in Feet) 0.3

Surface Capture Capacity (gal) 0 Cost $ $ - $

Retention

Select BMP Measure

Retention Capacity (gal) 0 Cost $ $ - $

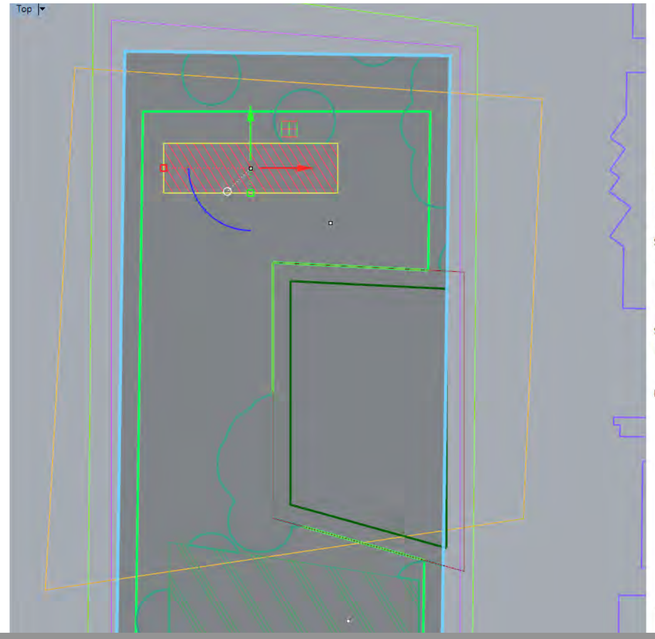
Percentage LID satisfied

128%

Total Estimated Cost Range:
$115100 - $155700

Output Site Geometry Provide Site Name Save to Rhino

Output Layer Name Subcatchment Name Save to Rhino



Development Area - Draw Closed Polyline

Proposed Buildings - Region(s) as a closed polyline(s)

Planted Areas - Region(s) as a closed polyline(s)

Draw Infiltration BMP - Region as closed polyline

Draw Capture and Convey BMP - Region as closed polyline

Infiltration

Bioswale (Rain Garden)

BMP Media Depth (in Feet) 2.0

Surface Infiltration Capacity (gal) 5560 Cost $ $88600 - $119800

Capture and Convey

Green Roof (Extensive)

BMP Media Depth (in Feet) 0.5

Surface Capture Capacity (gal) 0 Cost $ $ - $

Retention

Select BMP Measure

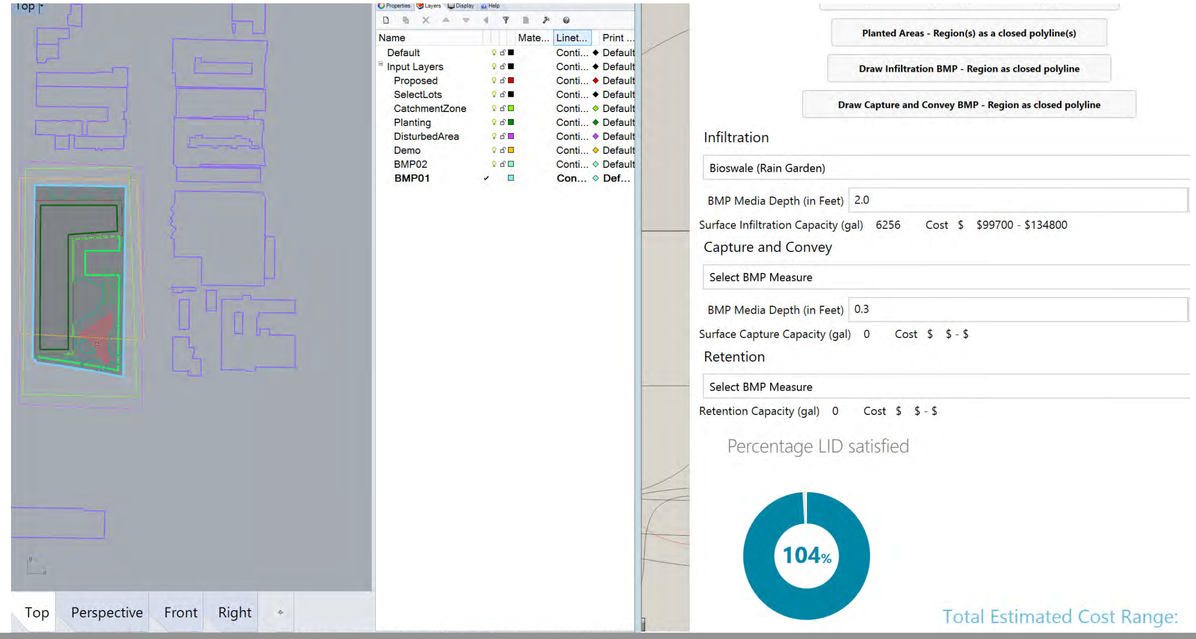
Retention Capacity (gal) 0 Cost $ $ - $

Percentage LID satisfied

100%

Total Estimated Cost Range:
$88600 - $119800

Output Site Geometry Provide Site Name Save to Rhino



Planted Areas - Region(s) as a closed polyline(s)

Draw Infiltration BMP - Region as closed polyline

Draw Capture and Convey BMP - Region as closed polyline

Infiltration

Bioswale (Rain Garden)

BMP Media Depth (in Feet) 2.0

Surface Infiltration Capacity (gal) 6256 Cost $ $99700 - $134800

Capture and Convey

Select BMP Measure

BMP Media Depth (in Feet) 0.3

Surface Capture Capacity (gal) 0 Cost $ $ - $

Retention

Select BMP Measure

Retention Capacity (gal) 0 Cost $ $ - $

Percentage LID satisfied

104%

Total Estimated Cost Range:

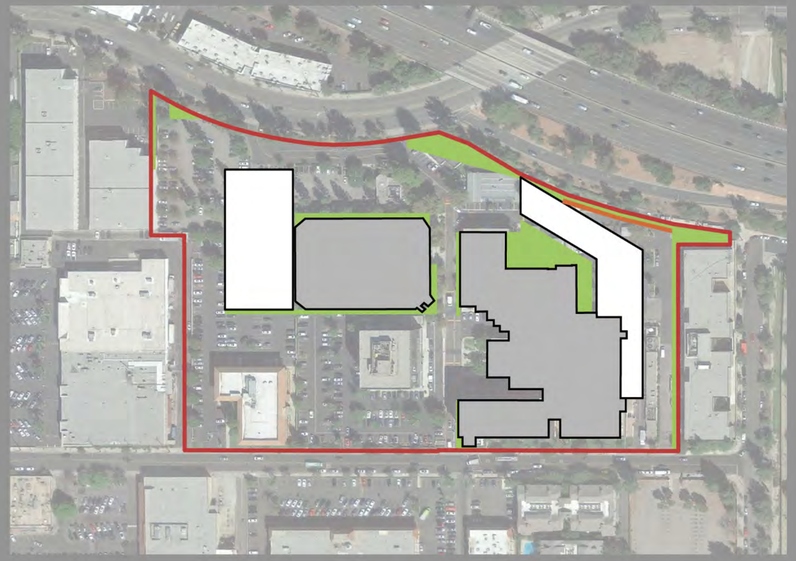
USING HAZEL : WORKSHOP 2

“Likely to accelerate significantly more exploration in much shorter time”

“Good tool for decision-making at planning stage”

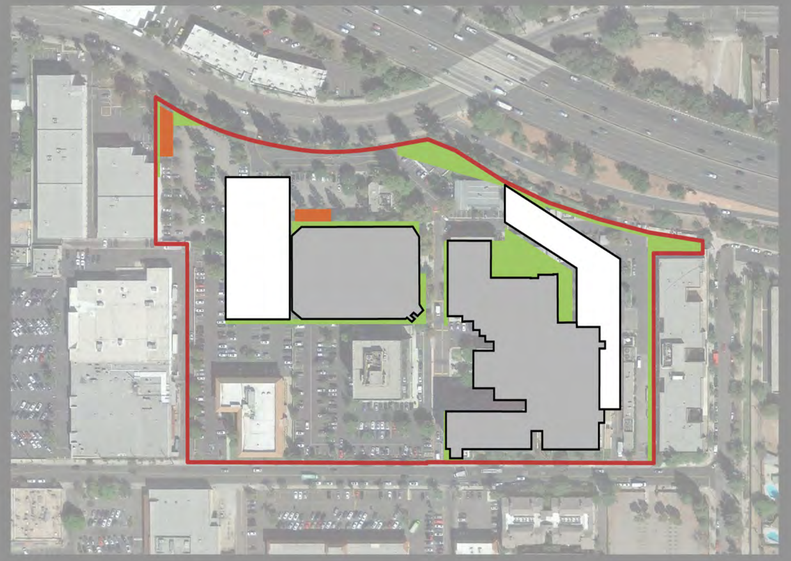
“More time could be spend exploring design option rather than spent on calculations and research”

“Hazel allows for quick analysis of a site early on without needing extensive background on the subject”



BIORETENTION BASIN

2.0	STORMWATER INFILTRATED (Acre-ft/year)	5.7 homes
9.5	ENERGY SAVED (MWh/year)	
7.9	GHG / CARBON AVOIDED (Tonnes CO2e/year)	1.9 cars
0.04	HABITAT CREATED (Acres)	
0.2	HEAT ISLAND REDUCED (Acres)	



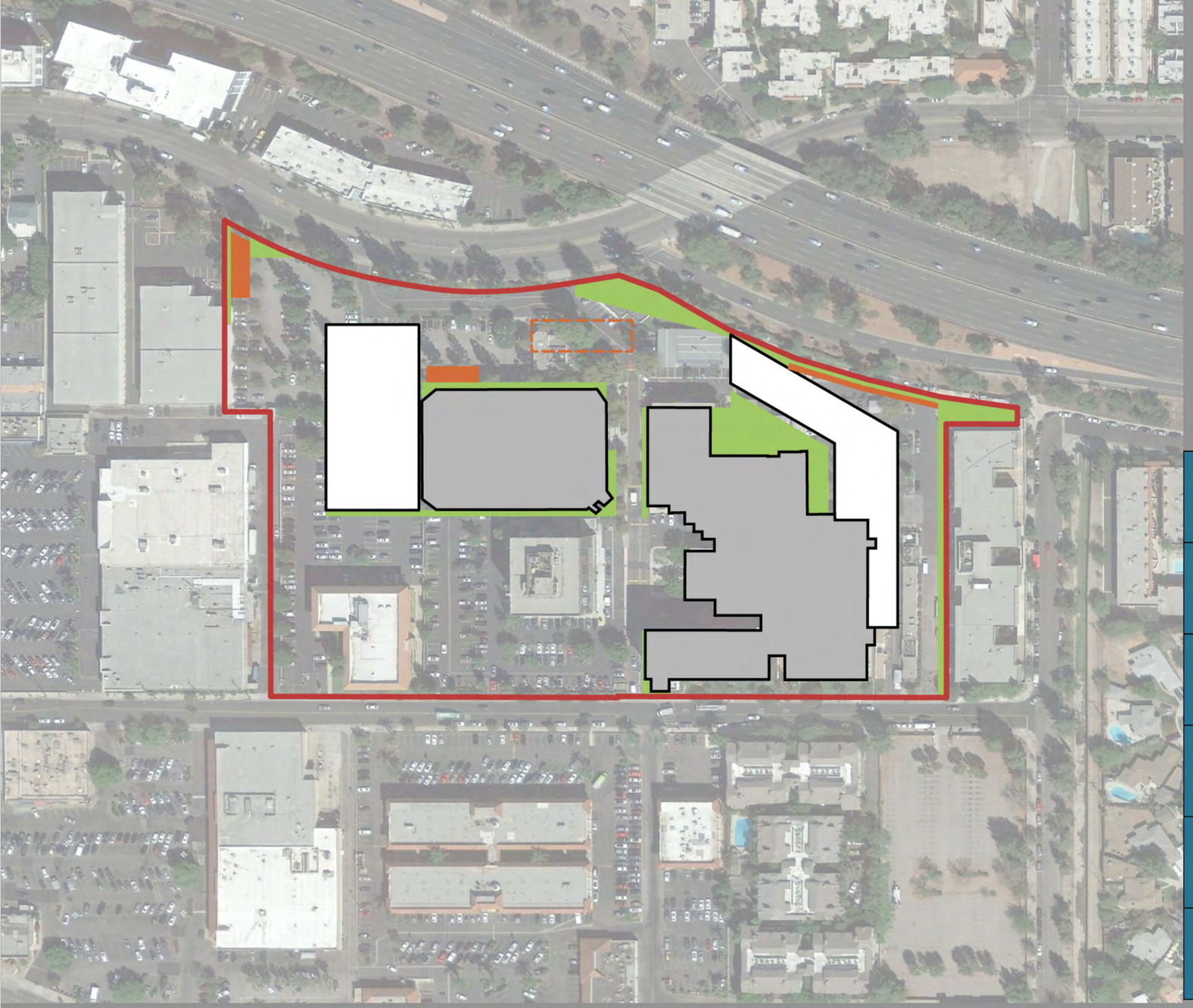
PERVIOUS PAVING

3.9	STORMWATER INFILTRATED (Acre-ft/year)	10.9 homes
18.1	ENERGY SAVED (MWh/year)	
15	GHG / CARBON AVOIDED (Tonnes CO2e/year)	3.6 cars
0	HABITAT CREATED (Acres)	
0	HEAT ISLAND REDUCED (Acres)	

CISTERN

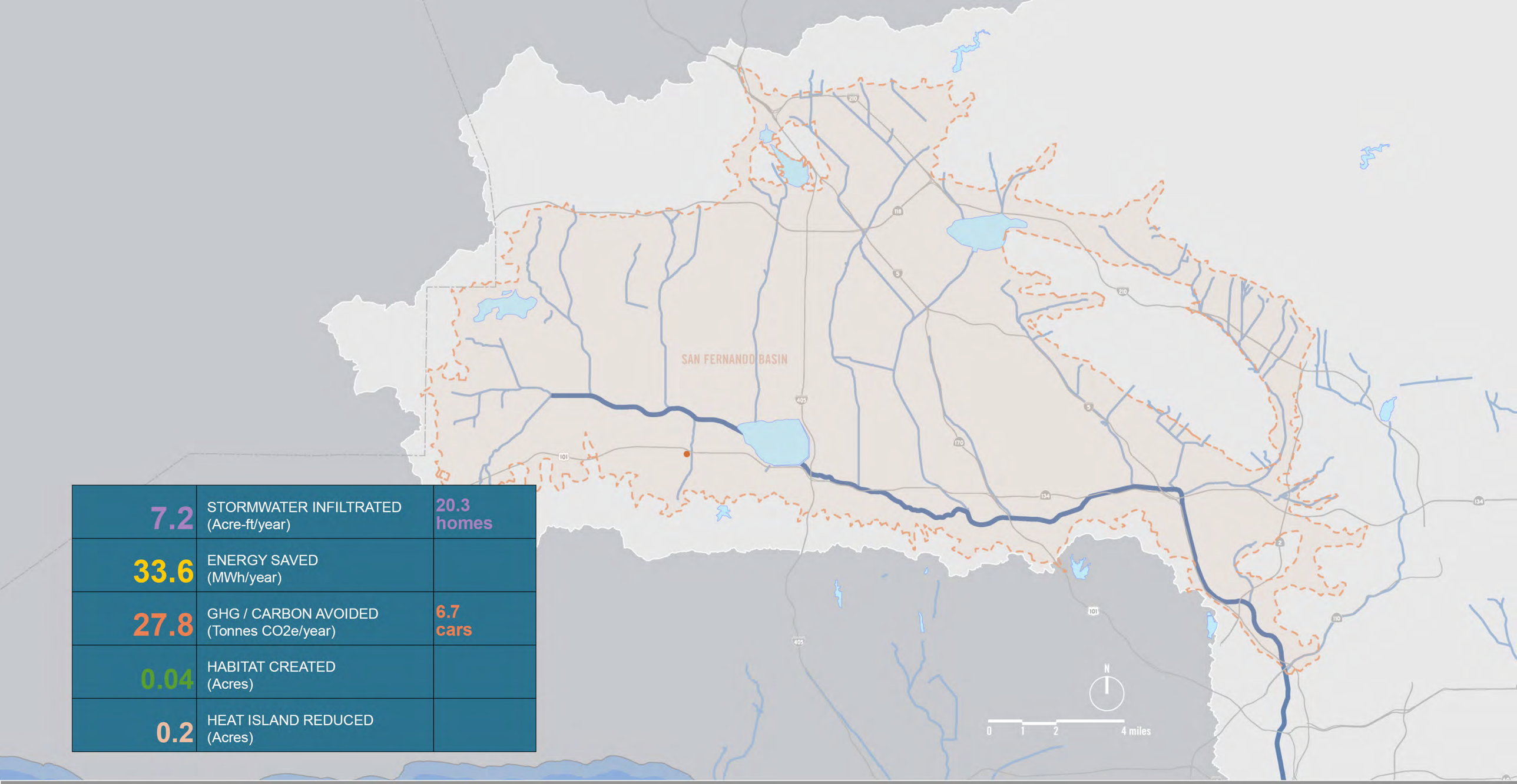
1.3	STORMWATER INFILTRATED (Acre-ft/year)	3.7 homes
6.0	ENERGY SAVED (MWh/year)	
5.0	GHG / CARBON AVOIDED (Tonnes CO2e/year)	1.2 cars
0	HABITAT CREATED (Acres)	
0	HEAT ISLAND REDUCED (Acres)	

IMPLICATIONS



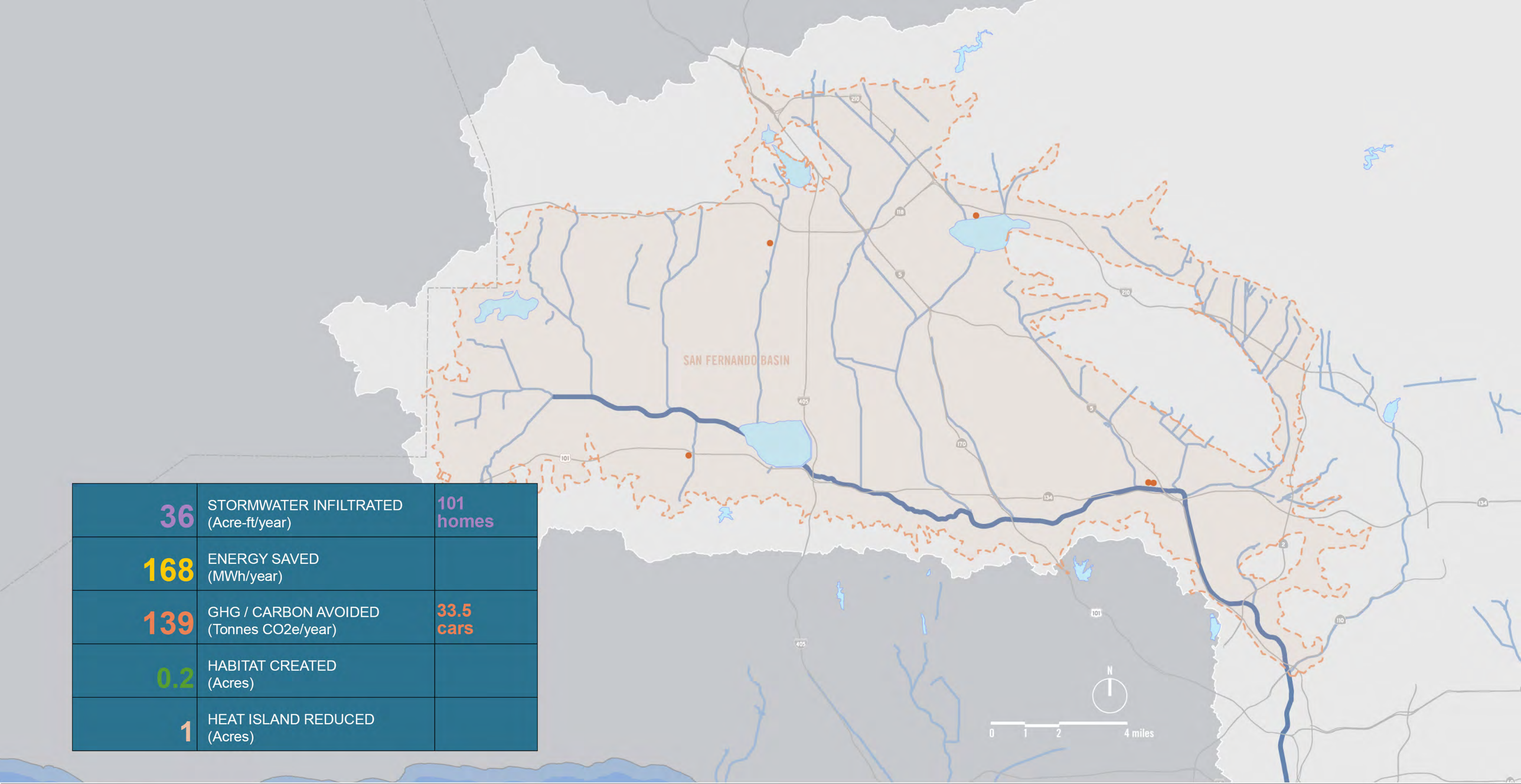
$513,800-$696,000	ESTIMATED CONSTRUCTION COST RANGE	
7.2	STORMWATER INFILTRATED (Acre-ft/year)	20.3 homes
33.6	ENERGY SAVED (MWh/year)	
27.8	GHG / CARBON AVOIDED (Tonnes CO2e/year)	6.7 cars
0.04	HABITAT CREATED (Acres)	
0.2	HEAT ISLAND REDUCED (Acres)	

COMPLETE SOLUTION



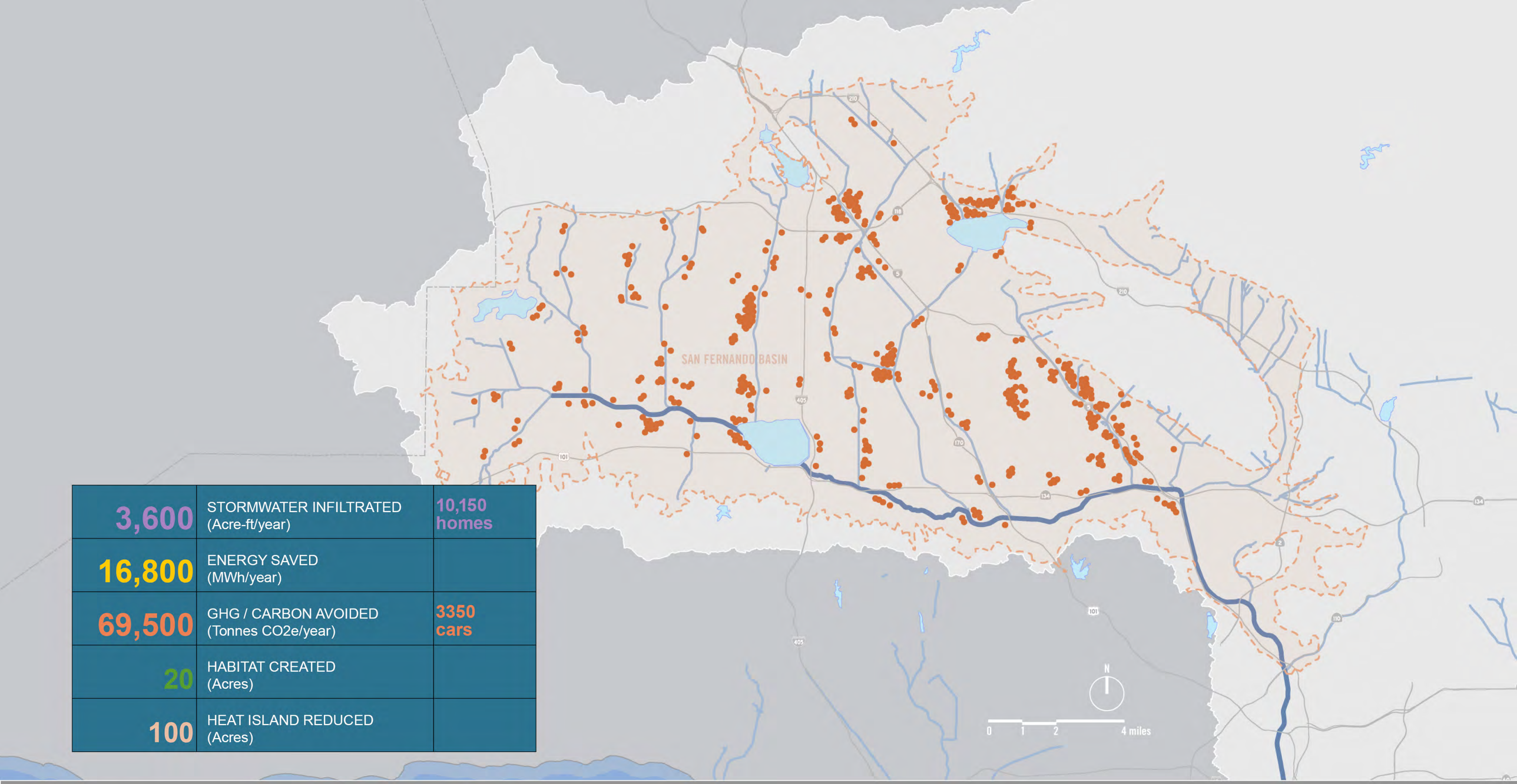
7.2	STORMWATER INFILTRATED (Acre-ft/year)	20.3 homes
33.6	ENERGY SAVED (MWh/year)	
27.8	GHG / CARBON AVOIDED (Tonnes CO2e/year)	6.7 cars
0.04	HABITAT CREATED (Acres)	
0.2	HEAT ISLAND REDUCED (Acres)	

REGIONAL IMPLICATION: 1 BMP



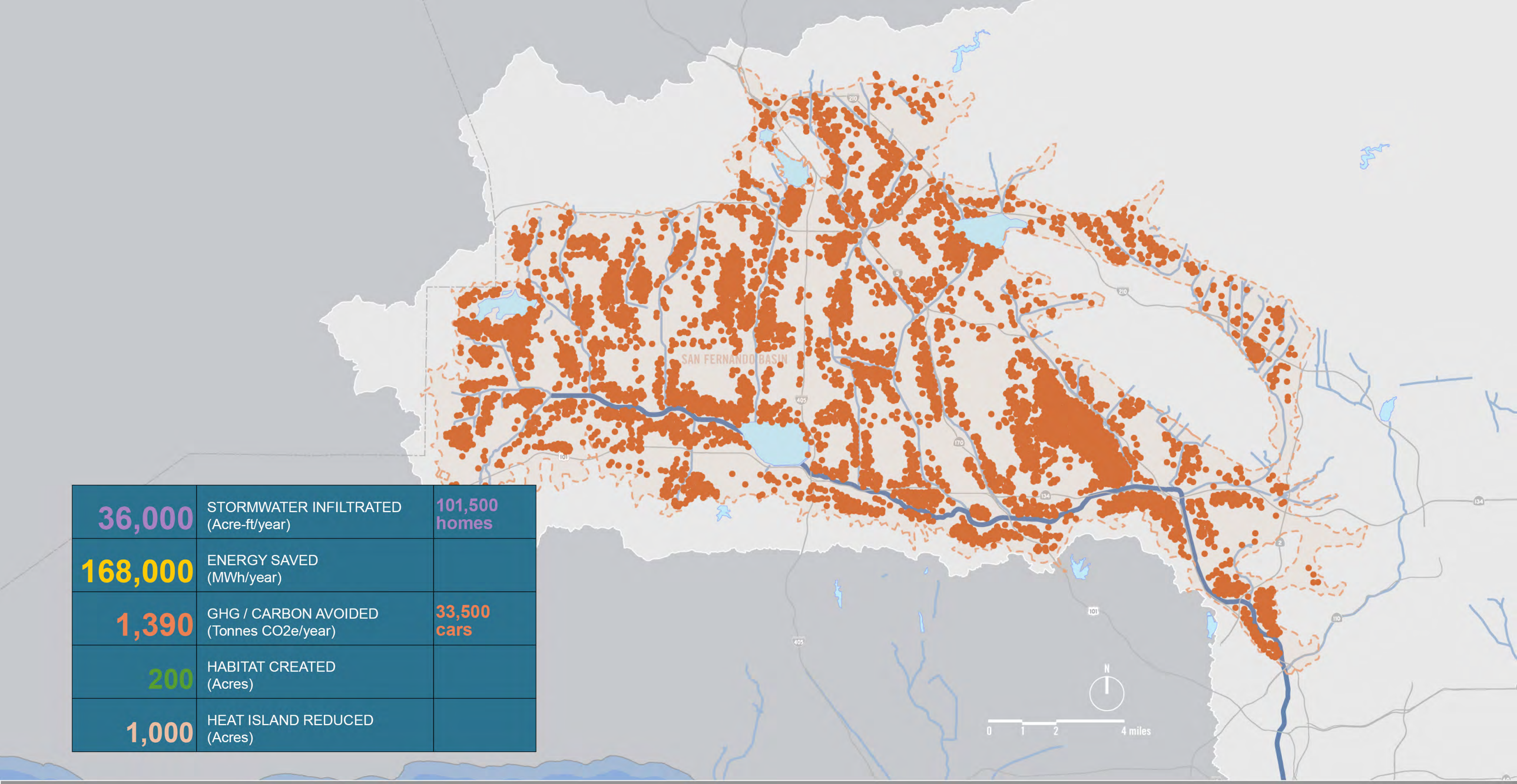
36	STORMWATER INFILTRATED (Acre-ft/year)	101 homes
168	ENERGY SAVED (MWh/year)	
139	GHG / CARBON AVOIDED (Tonnes CO2e/year)	33.5 cars
0.2	HABITAT CREATED (Acres)	
1	HEAT ISLAND REDUCED (Acres)	

REGIONAL IMPLICATION: 5 BMPs



3,600	STORMWATER INFILTRATED (Acre-ft/year)	10,150 homes
16,800	ENERGY SAVED (MWh/year)	
69,500	GHG / CARBON AVOIDED (Tonnes CO2e/year)	3350 cars
20	HABITAT CREATED (Acres)	
100	HEAT ISLAND REDUCED (Acres)	

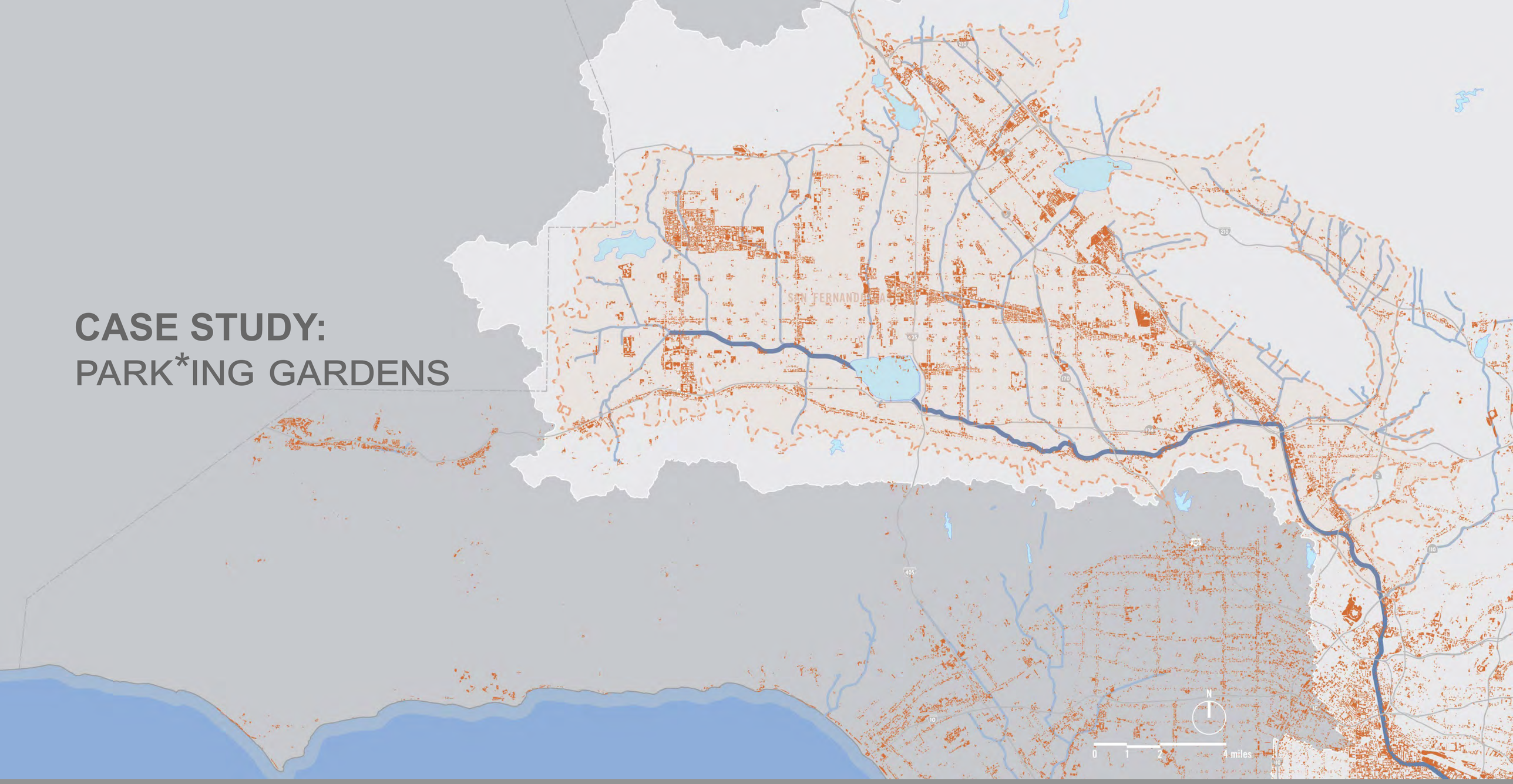
REGIONAL IMPLICATION: 500 BMPs



36,000	STORMWATER INFILTRATED (Acre-ft/year)	101,500 homes
168,000	ENERGY SAVED (MWh/year)	
1,390	GHG / CARBON AVOIDED (Tonnes CO2e/year)	33,500 cars
200	HABITAT CREATED (Acres)	
1,000	HEAT ISLAND REDUCED (Acres)	

REGIONAL IMPLICATION: 5000 BMPs

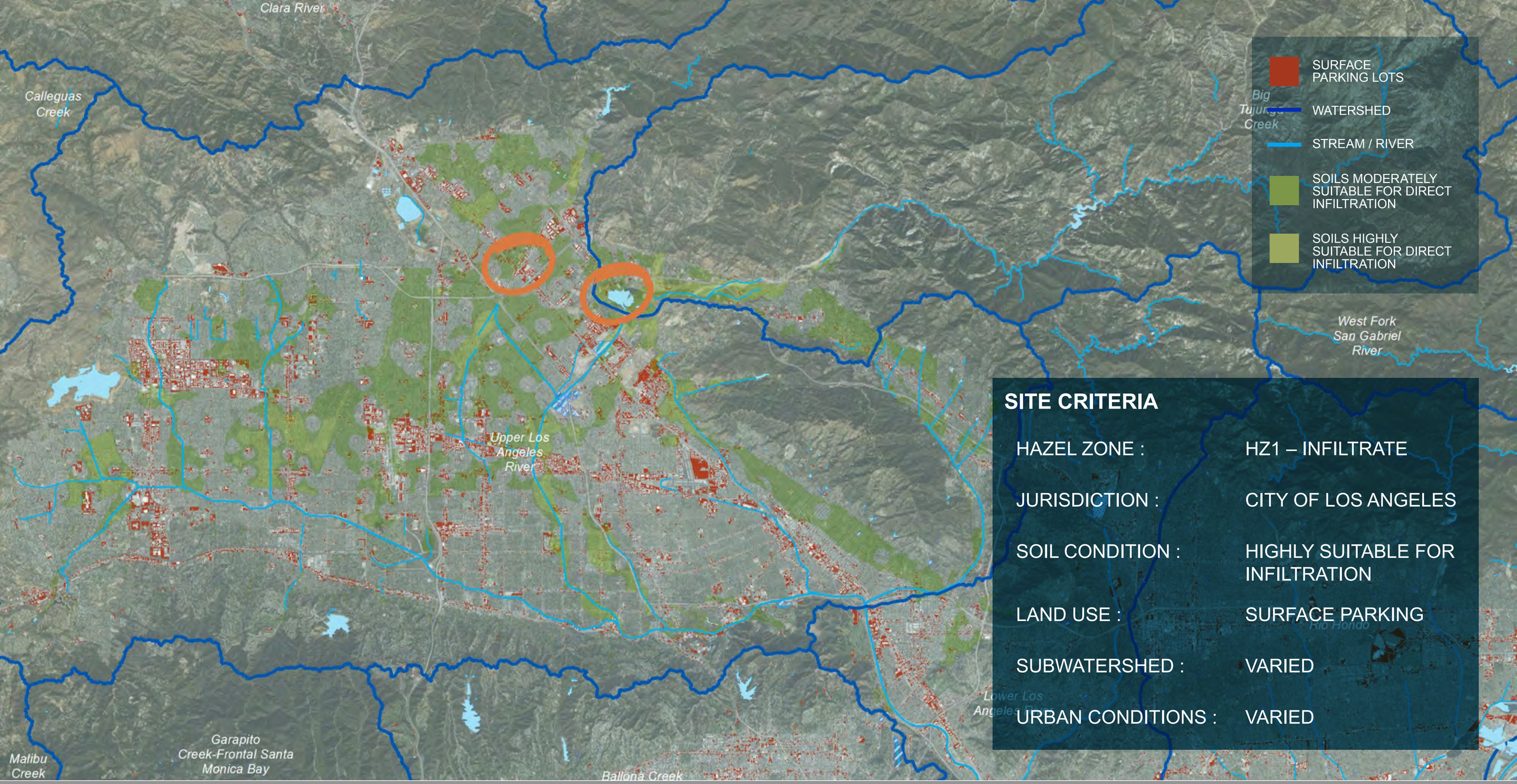
CASE STUDY:
PARK*ING GARDENS



Cultural Institute of Tampico
Tampico, Mexico

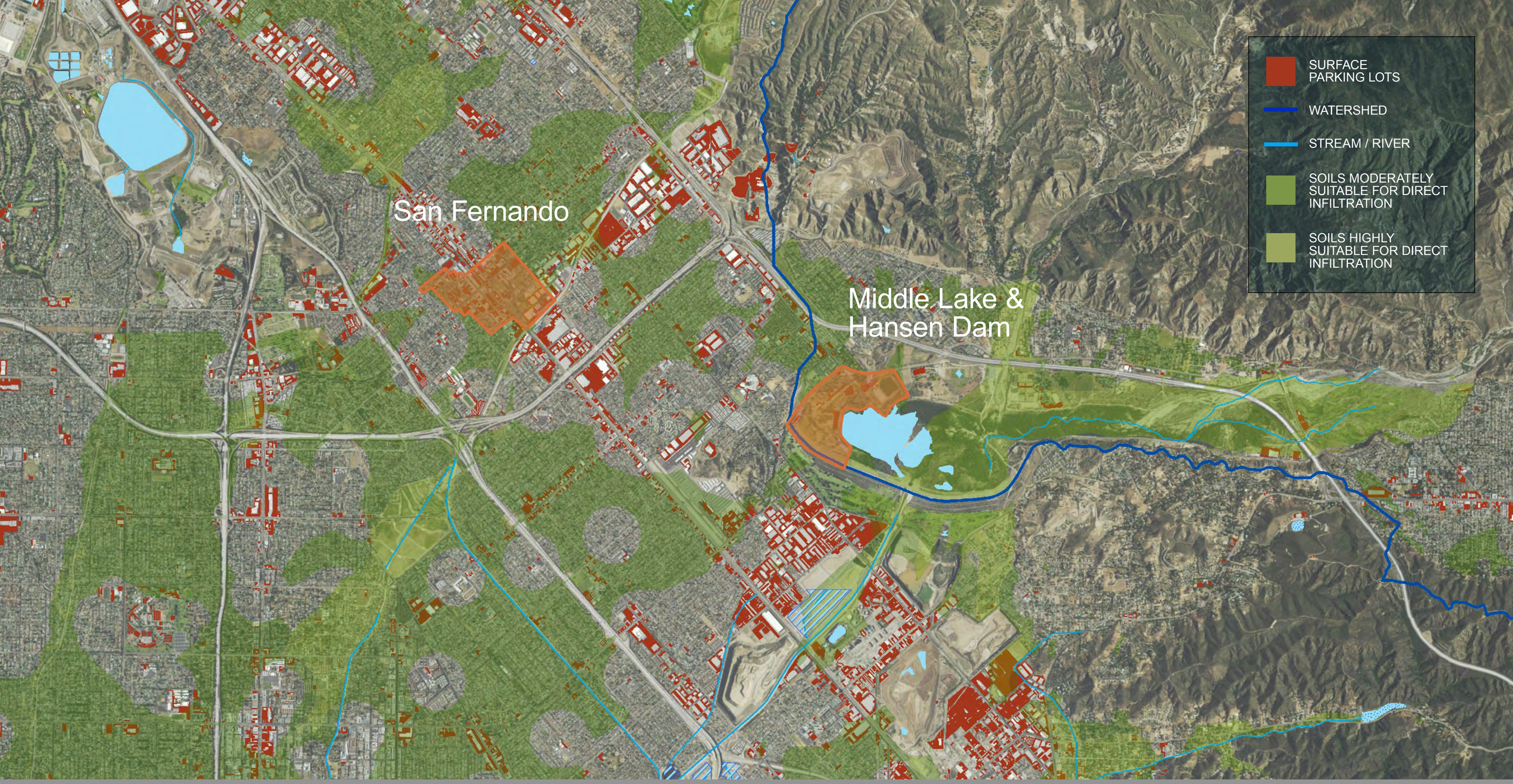
Beiqijia Technology Business District 1
Beijing, China

PARK*ING GARDENS: PRECEDENTS



SITE CRITERIA

HAZEL ZONE :	HZ1 – INFILTRATE
JURISDICTION :	CITY OF LOS ANGELES
SOIL CONDITION :	HIGHLY SUITABLE FOR INFILTRATION
LAND USE :	SURFACE PARKING
SUBWATERSHED :	VARIED
URBAN CONDITIONS :	VARIED



PARK*ING GARDENS: SAN FERNANDO VALLEY

1: Gleditsia triacanthos

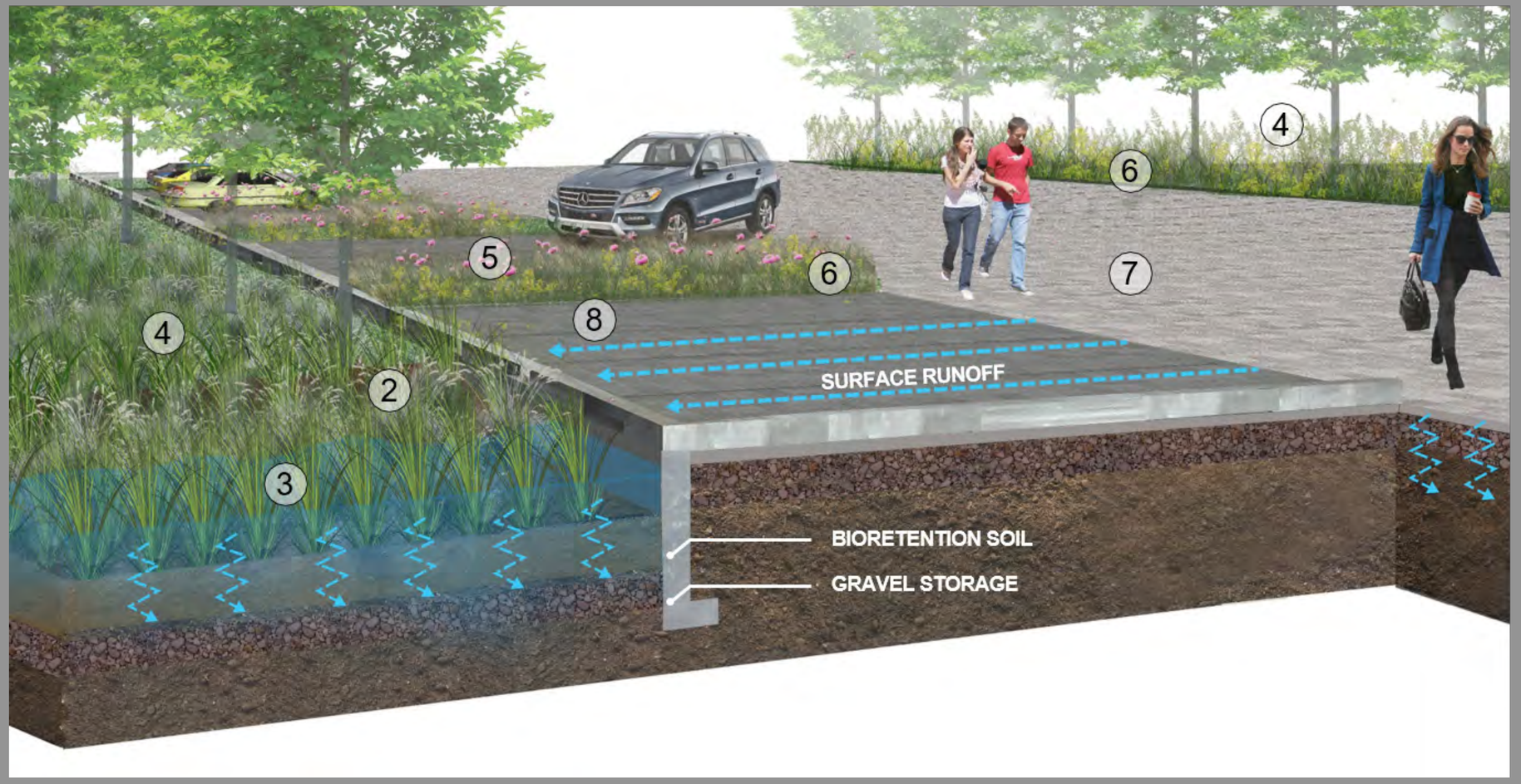
2: Festuca rubra

3: Triglochin striata

4: Stipa austroitalica

5: Silybum marianum

6: Sinapis arvensis



PETROCHEMICALS

LEAD (Pb)

7: PERVIOUS PAVERS

8: IMPERVIOUS PAVERS

PARK*ING GARDENS: SAN FERNANDO VALLEY

4

Hazel in Policy Context:

How Cities are Making Stormwater Work

772

CITIES FACING LEGAL ACTION BY EPA

$100B

NEEDED TO FIX U.S. STORMWATER INFRASTRUCTURE

42%

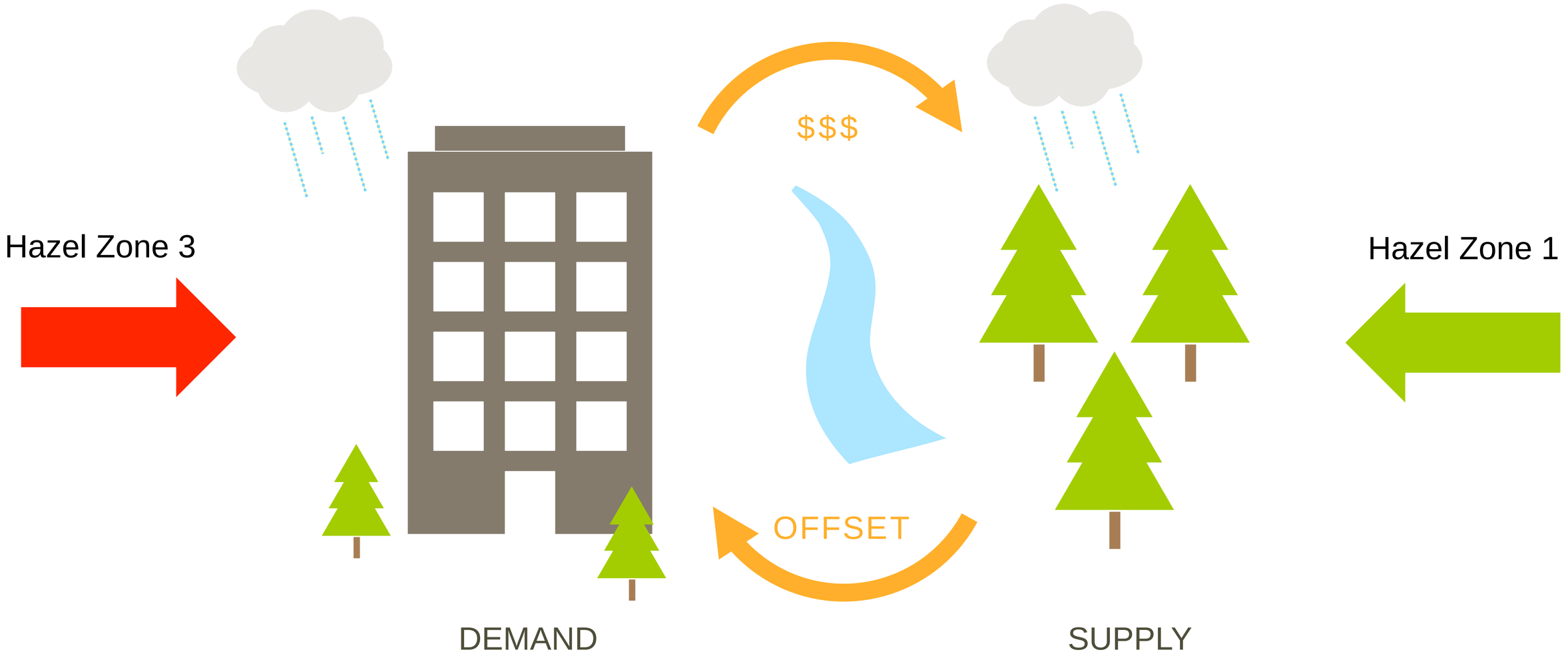
OF U.S. URBAN LAND WILL BE REDEVELOPED BY 2030

$20B/y

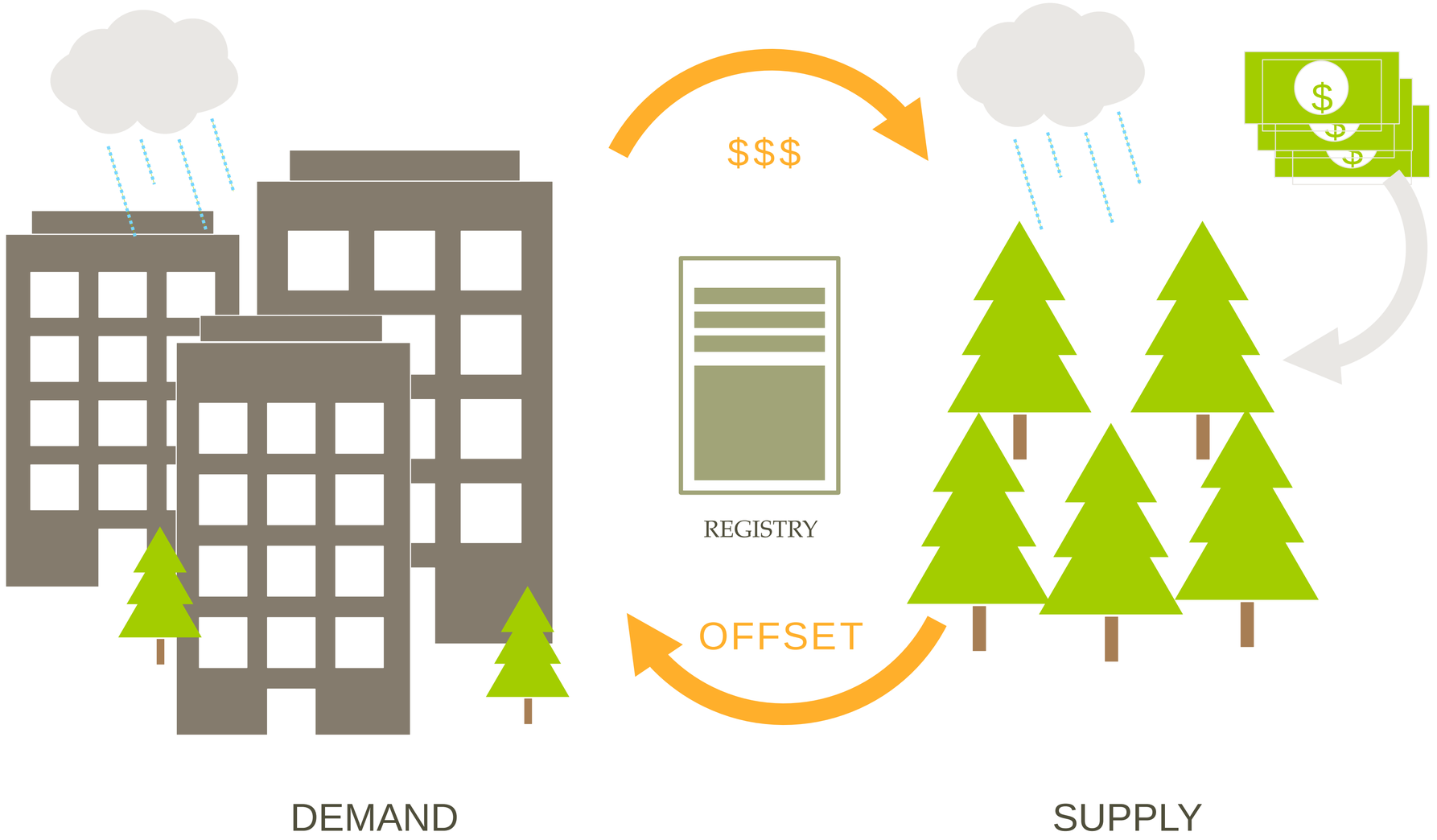
INVESTMENT IN GI COULD CLEAN UP 20% of URBAN RUNOFF

Public Private Partnership

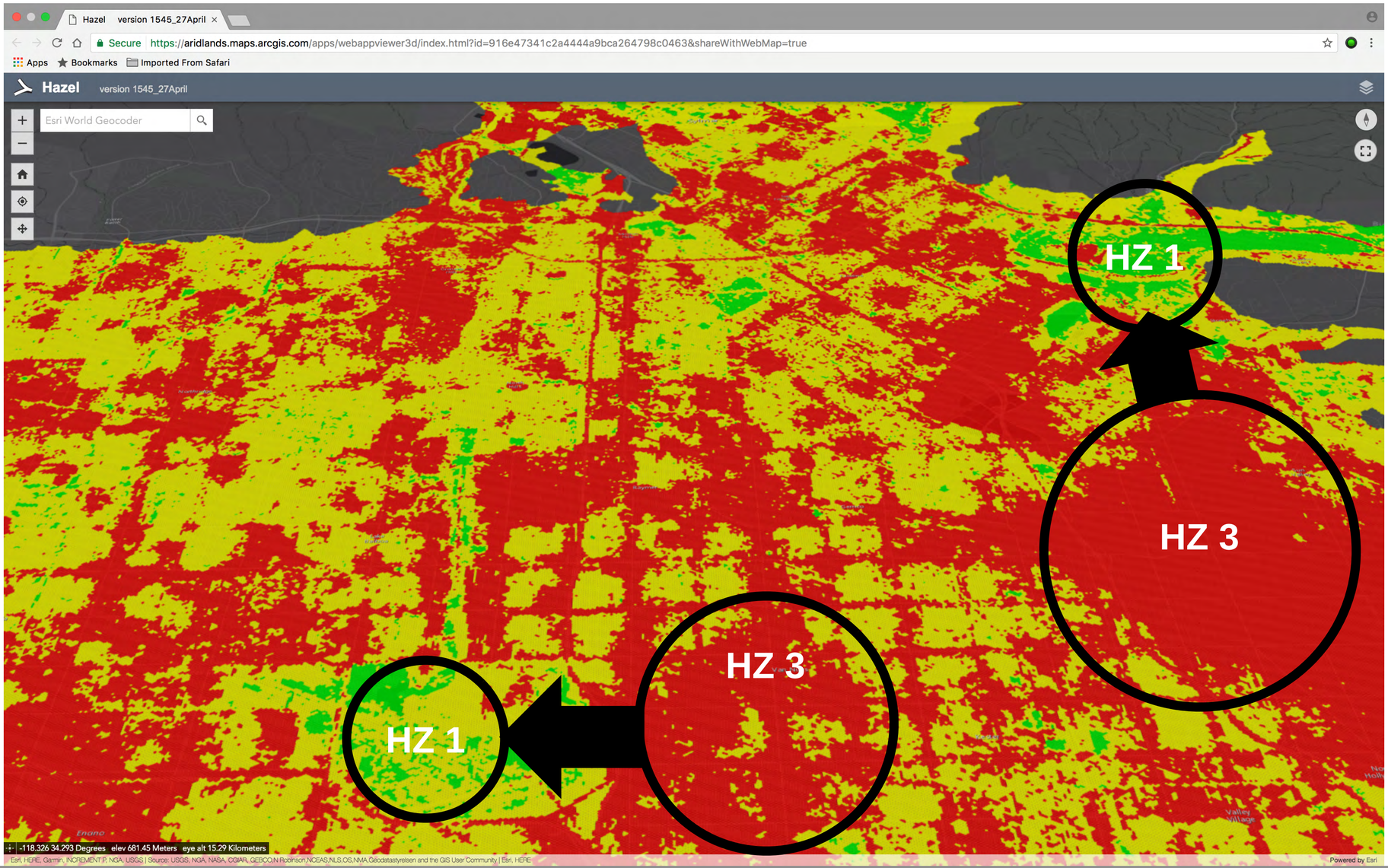
Credit Trading



Creating a Healthy Market

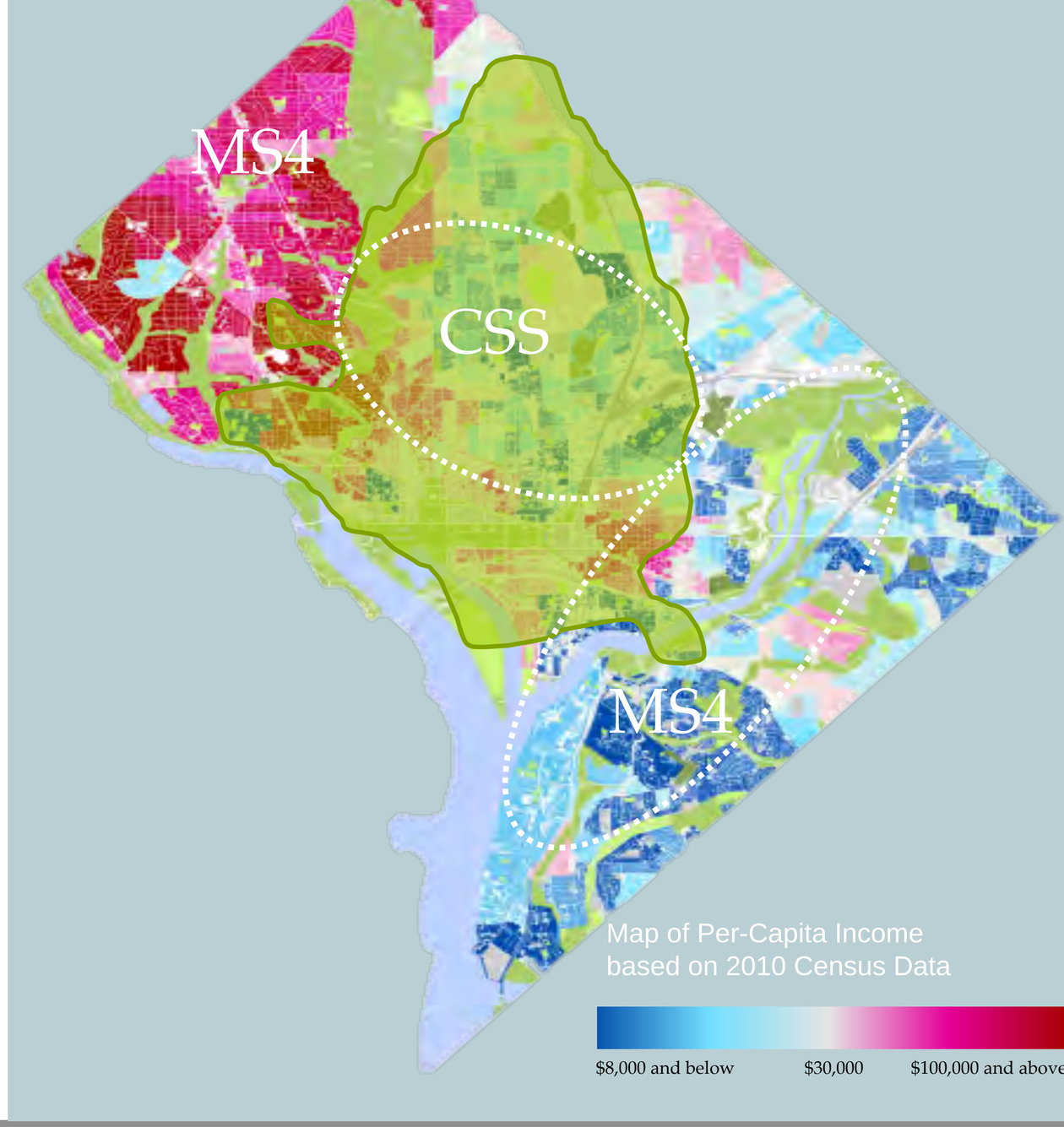


Transferring Priorities



Case Study: Washington, D.C.
How a Healthy Credit Market Helps DC Meet its Stormwater Objectives

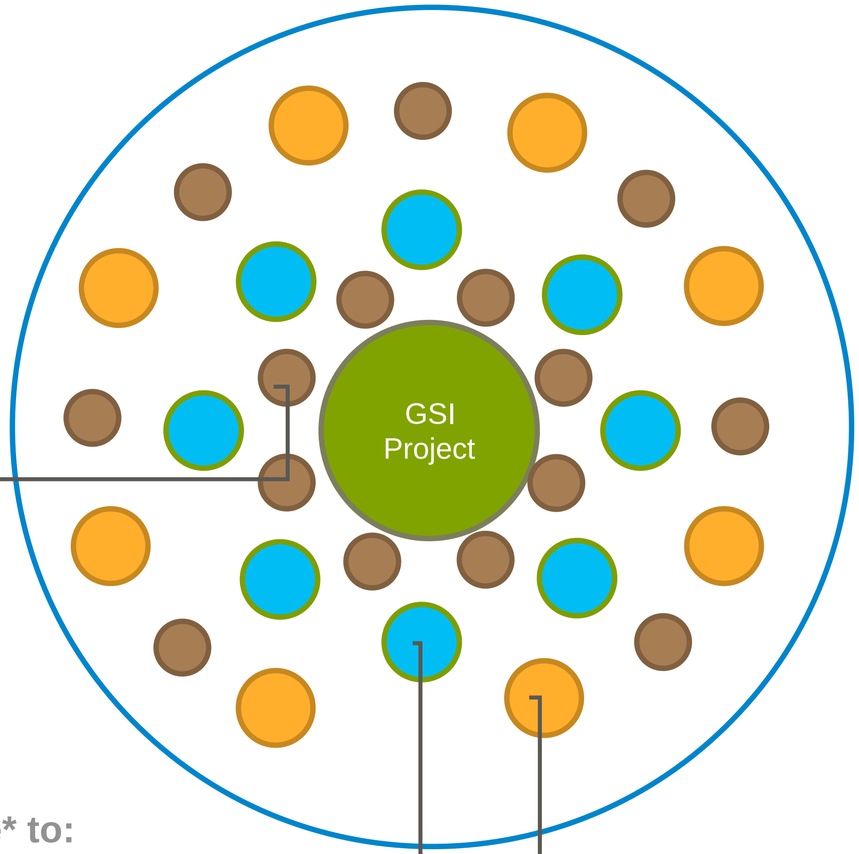
Development in dense urban core finances/ transfers positive social and environmental outcomes to other parts of the city.



HZ3-equivalent development parcel:
Off-site: Buys stormwater credit in HZ1-equivalent voluntary green infrastructure site.
On-site: Increased revenues from more underground parking and rooftop amenities.

HZ1-equivalent voluntary green infrastructure site:
P3 builds cost-effective infiltration with environmental and social equity co-benefits.
Increased local revenues, open space access, urban heat island reduction, habitat.

Special Assessment District: Impact Fee Concept



No Fee Levied
Existing Properties

Fees levied in tiered structure* to:

1st Tier New/Redevelopment Projects

2nd Tier New/Redevelopment Projects

**Tier is based on proximity to GSI project*

Detroit: Watershed Improvement Districts – P3 delivery

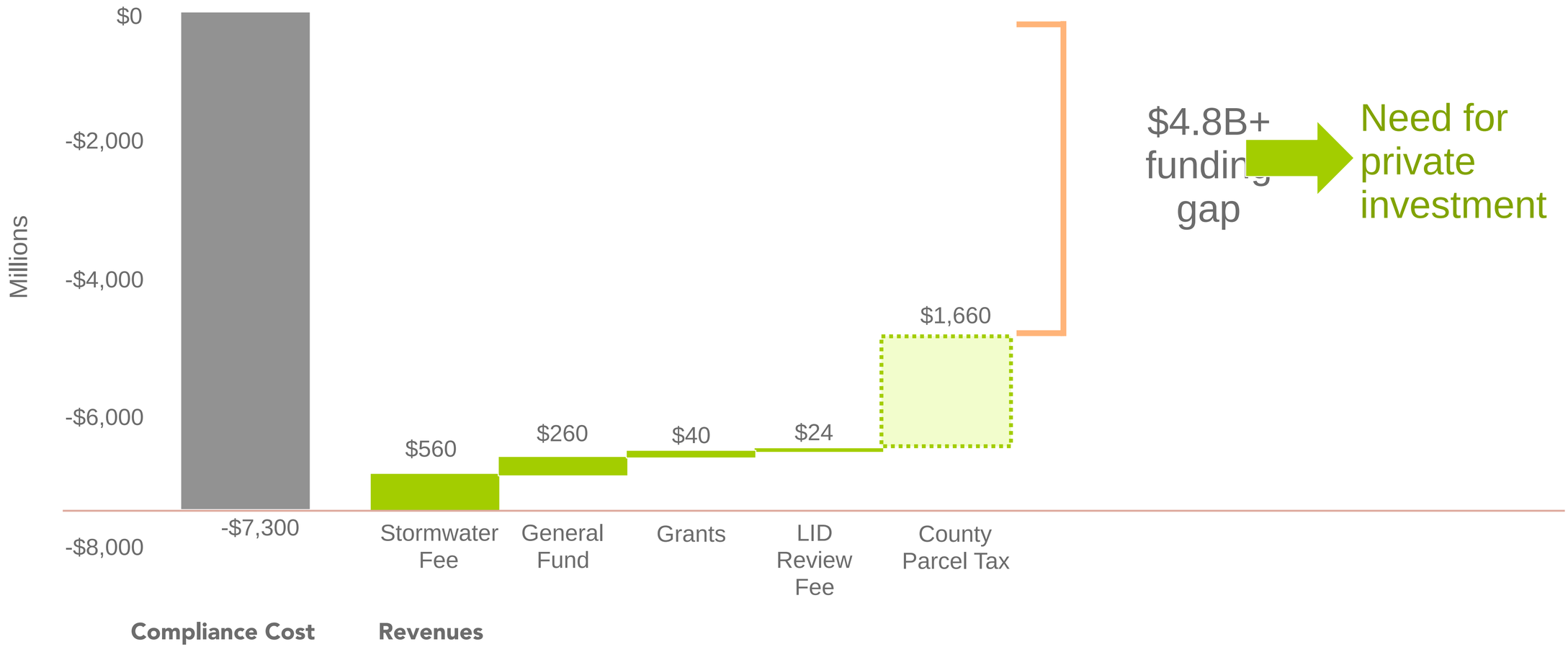
Washington, DC: Stormwater Credit Trading

Philadelphia: Greened Acres - P3

Atlanta GA: 4th Ward Special Assessment District

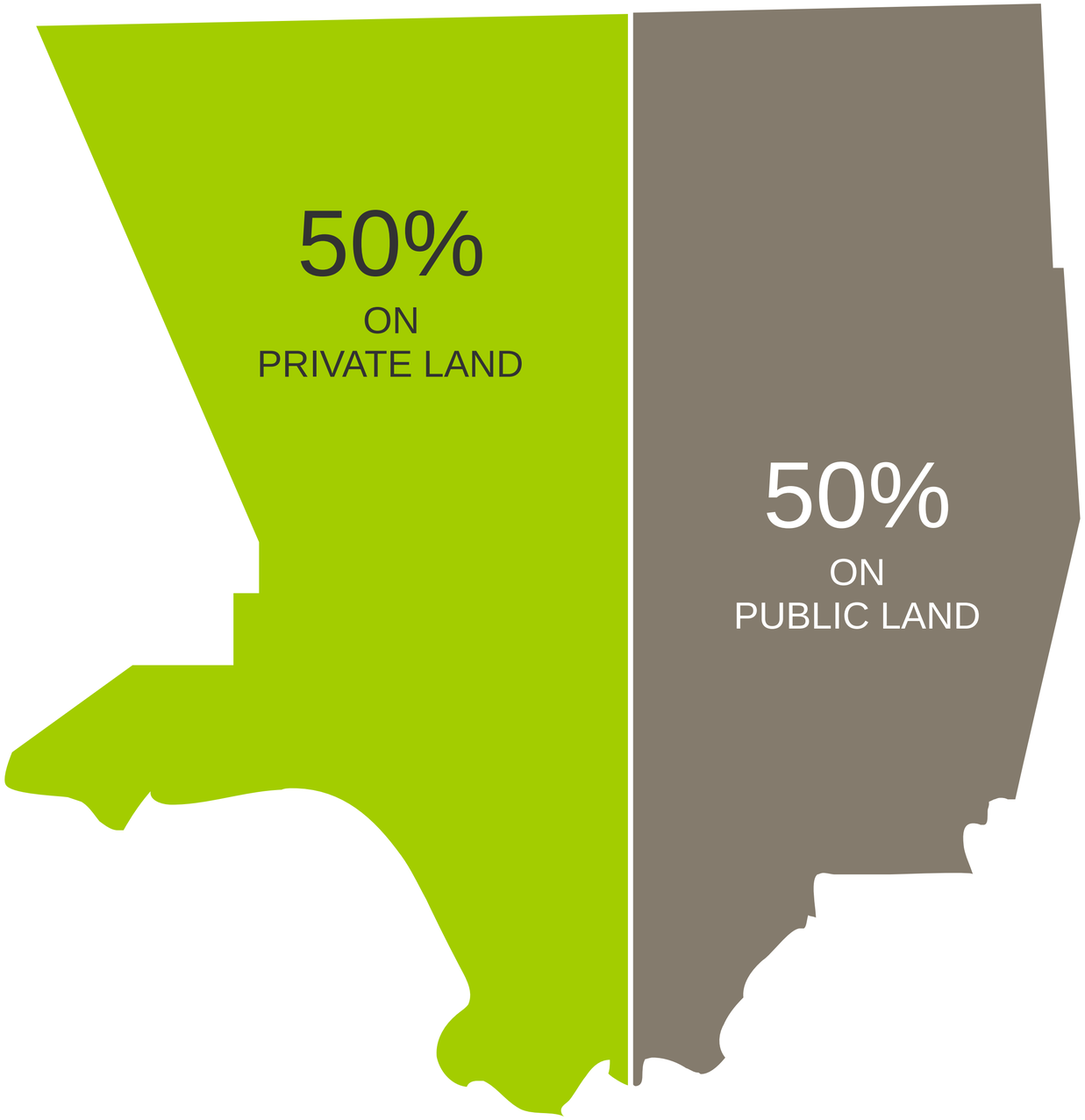
City of LA's Stormwater Funding Gap

Costs and Revenues Over 20 Years

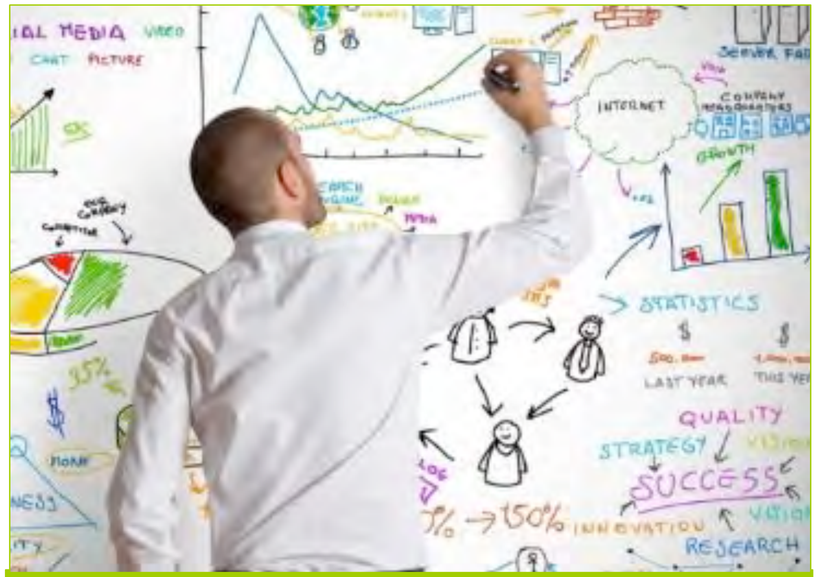


The Need for Private Investment

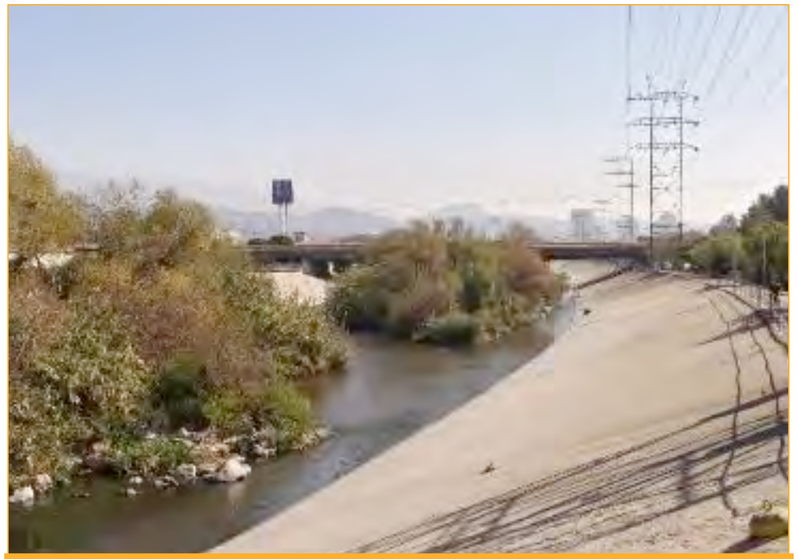
Proposed Natural Infrastructure Projects
in Los Angeles County



Challenges Facing L.A.: How does Hazel help?

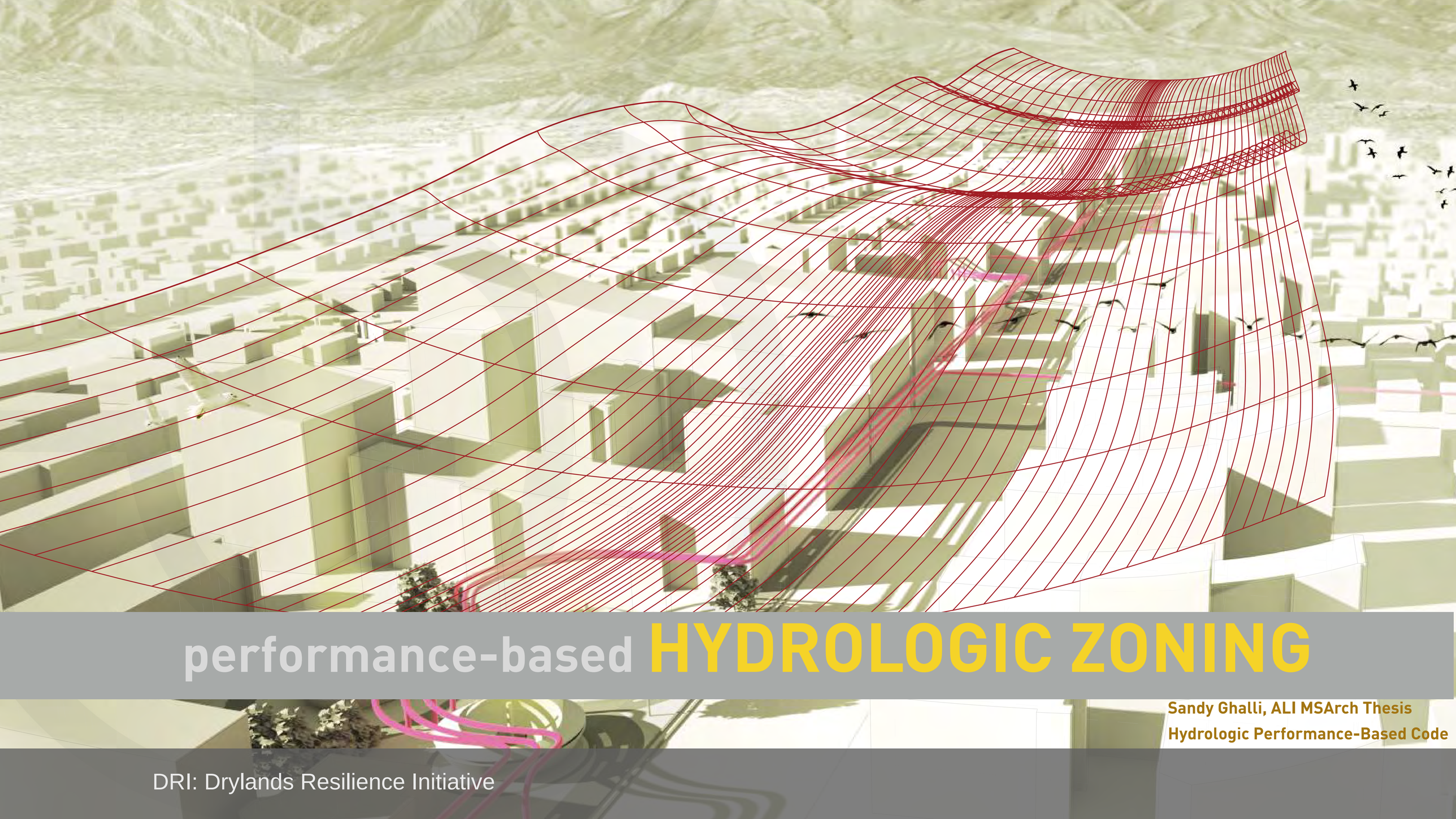


Design the market



Build on-the-ground projects

Secure the funding



performance-based HYDROLOGIC ZONING

Sandy Ghalli, ALI MSArch Thesis
Hydrologic Performance-Based Code

DRI: Drylands Resilience Initiative

cooperative GOVERNANCE FRAMEWORKS

Coopelluvia, Stephanie Newcomb, ALI MSArch 2016

enhanced WATER LITERACY

Connect the Dots | Van Nuys, February 2016
City of Los Angeles Great Streets Initiative Challenge Grant Winner
Aja Bulla-Richards, Arid Lands Institute, Connect the Dots Creative Director
Photo by SRA Photo

DRI: DRYLANDS RESILIENCE INITIATIVE

enriched ARCHITECTURAL LEXICON

The Arid Lands Institute: House of Retention
2014 Design Leadership Council Competition
Los Angeles, CA | ALI and Perkins+Will

DRI: Drylands Resilience Initiative

The Arid Lands Institute: House of Retention
2014 Design Leadership Council Competition
Los Angeles, CA | ALI and Perkins+Will

DRI: DRYLANDS RESILIENCE INITIATIVE

5

Q + A

THANK YOU