

CITY SIMULATOR

**DEP AGREEMENT
22PLN91**

**VULNERABILITY
ASSESSMENT WITH
CITY STIMULATOR**



Image courtesy of City of Clearwater social media
@MyClearwater



The city seeks to further understand the future impacts of both sea level rise and extreme heat by conducting city-wide vulnerability assessments using Atkin's City Simulator tool.

How City Simulator Works

Digital Twin



System Users
System Infrastructure
System Control

Simulate

2020-2100



Measure

Economy

Productivity
Storm damage
Energy Consumed

People

Trips disrupted
Freight disrupted
Heat days disrupted

Environment

Carbon Footprint
Water Quality

Benefits

- **Data-driven process**
- **Able to support grant processes and requirements**
- **Incorporates how the community functions (traffic, housing, job occupations, etc.)**
- **Provides a **planning tool** to stress test the city for expected climate impacts**



Study Goals and Objectives



- Quantify potential future impacts of acute (storms and surge) and chronic (sea level rise) flooding and extreme heat by conducting a city-wide vulnerability assessment
- Measure impacts in terms of economics (lost productivity, damage to structure), people (trips disrupted, heat exposure), and natural systems (water quality, air quality, carbon footprint).
- Measure return on investment of mitigation and adaptation actions to assist in city's capital investment planning process and assist the creation of a future climate action report.

Drivers

- Rain (w/ storm type)
- Max Temperature
- Sea Level

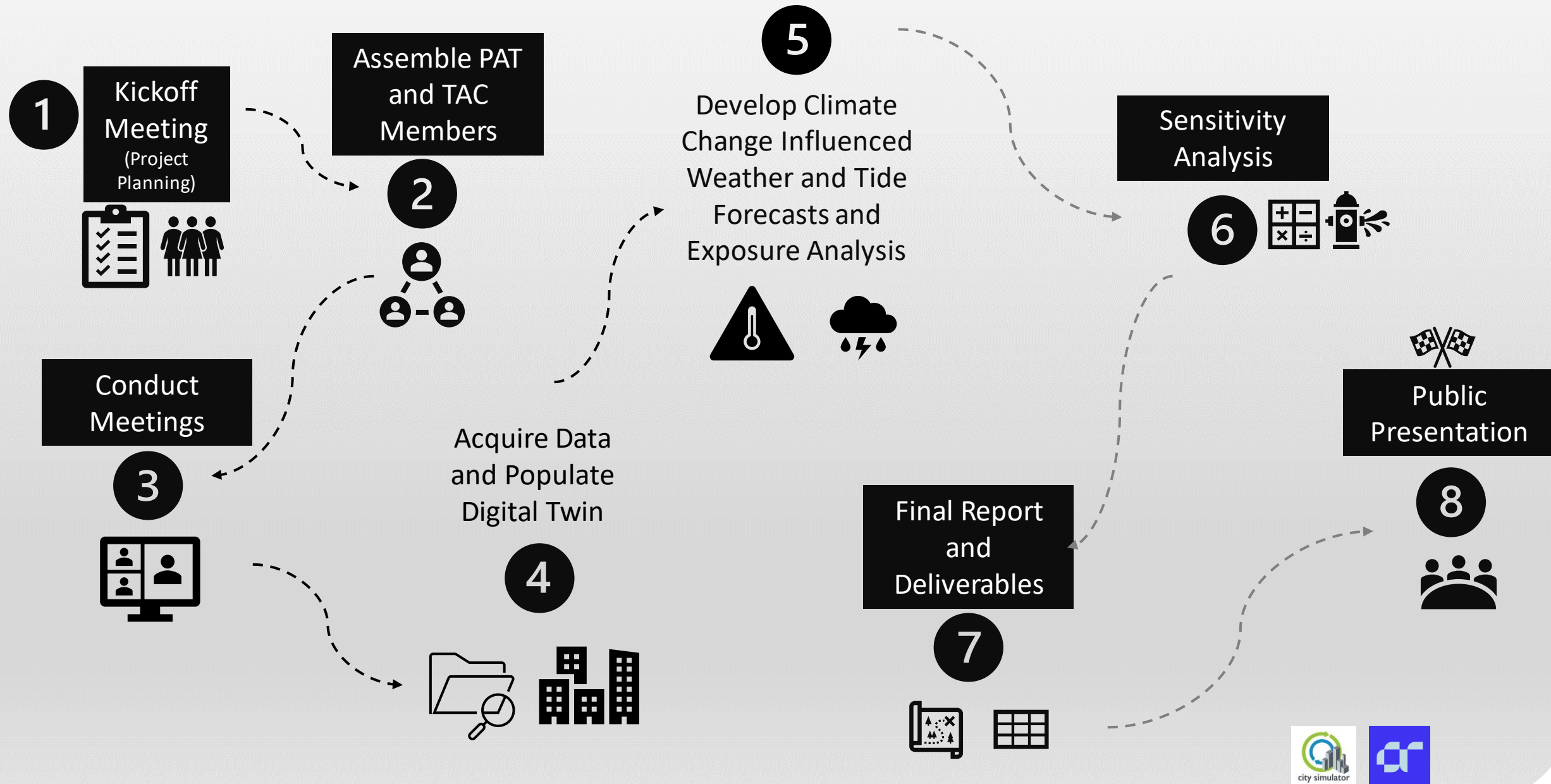
Hazards

- Flood:
 - Inland Flooding
 - Coastal Surge (SLR)
 - Tidal (SLR)
- Extreme Heat
 - Citizen Exposure
 - Increase energy usage

Metrics

- Climate
 - Change in characteristic storms
 - Change in surge levels
 - Change in Temperatures
- Economic
 - Storm Damage to property
 - Storm Damage to assets
- People
 - Disrupted Days
 - Disrupted Trips
 - Flood Damage at Homes/commercial
 - Heat exposure

Project Roadmap



Baseline

Digital Twin + **Future Conditions**



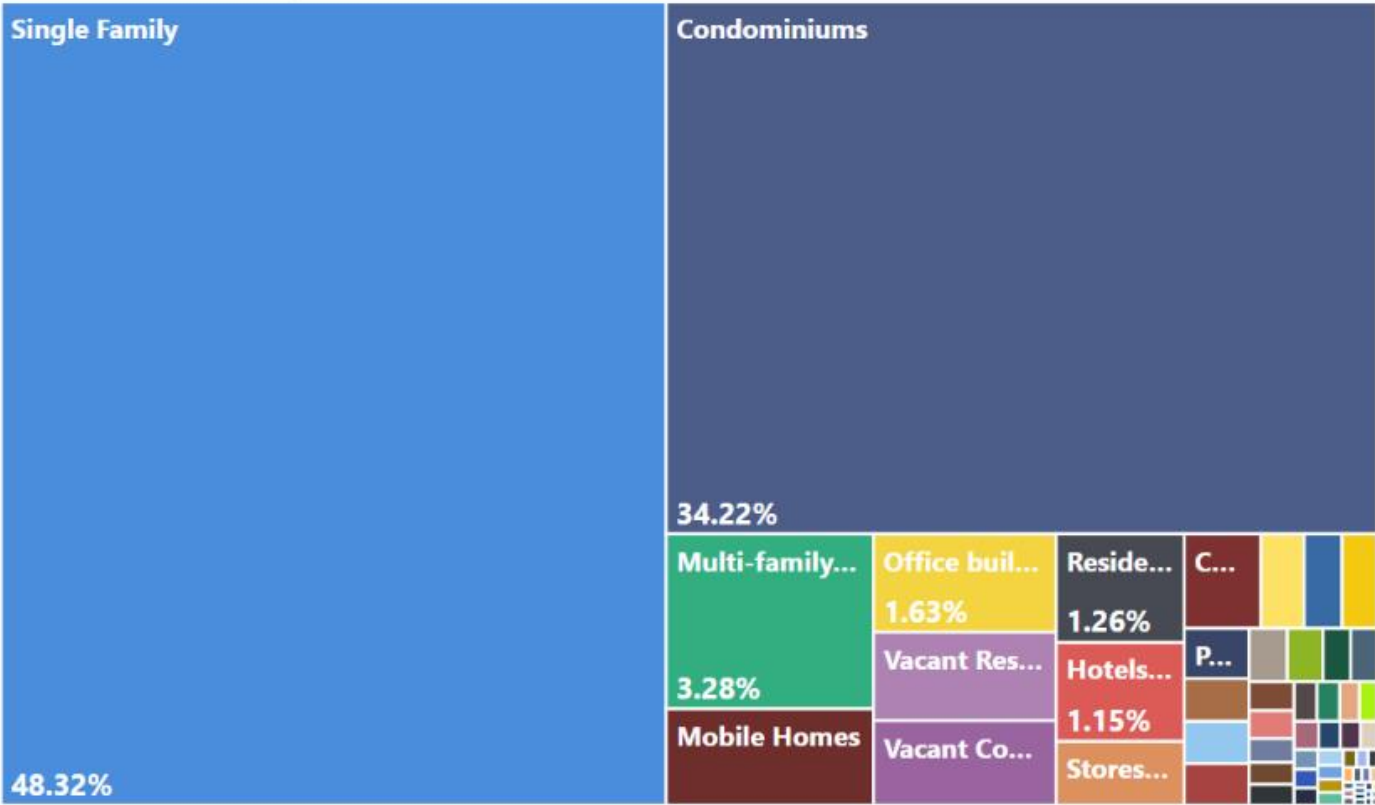
Digital Twin



Building the Model



%GT Count of PARCEL_ID by Definition

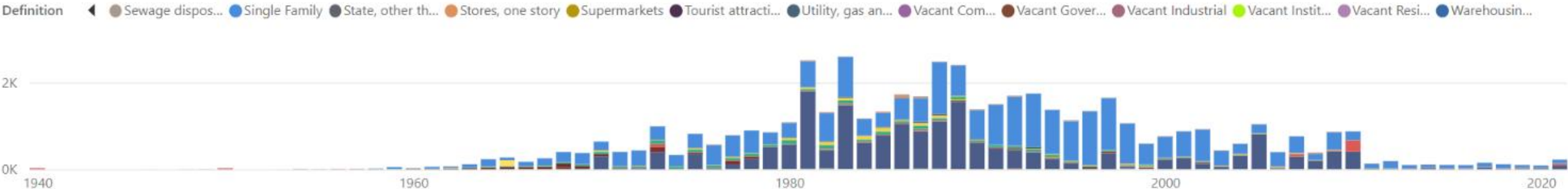


52.41K
Count of PARCEL_ID

\$24.58bn
Sum of JV

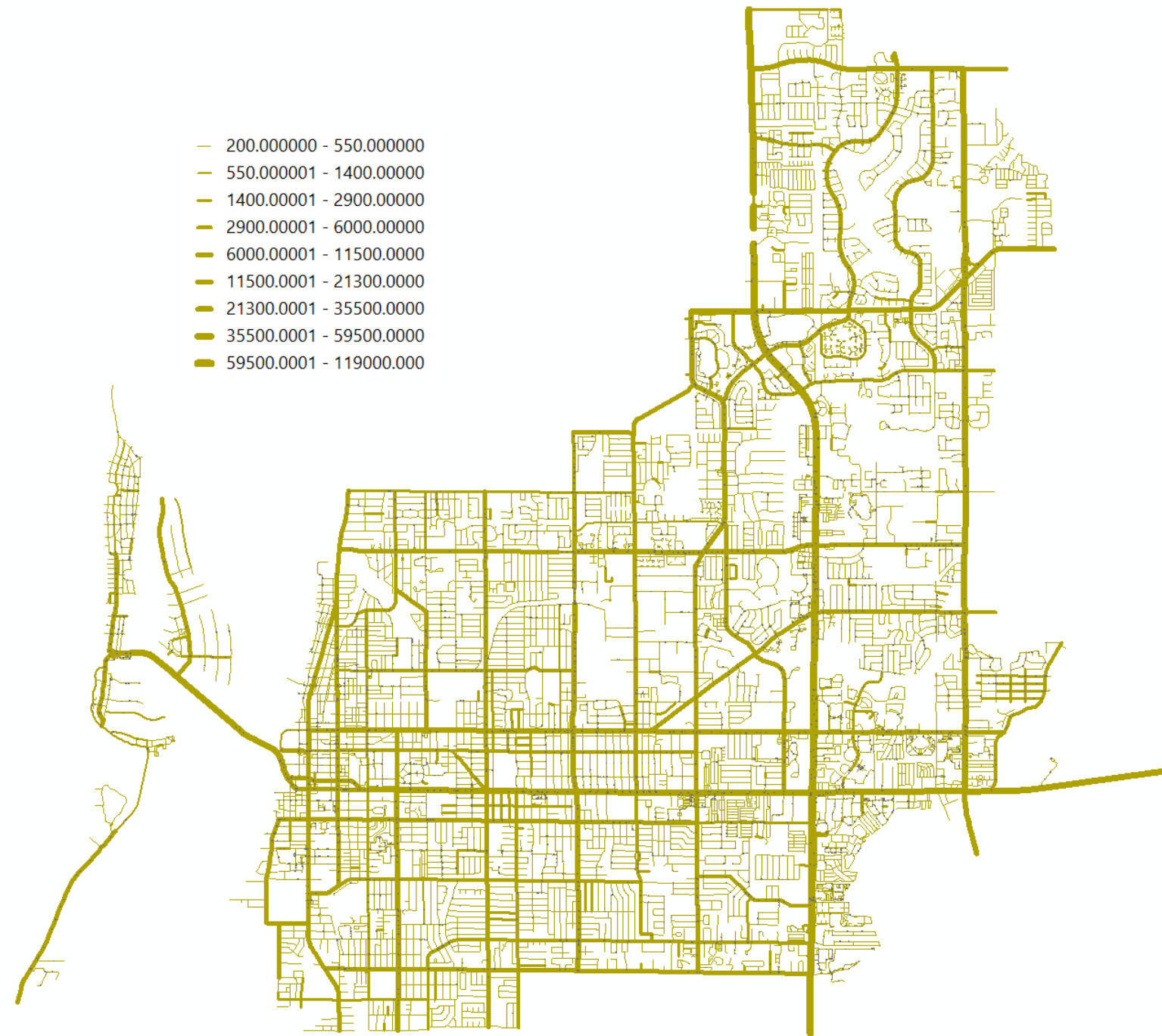
UseCodeAs Num	Definition	Count of PARCEL_ID
0	Vacant Residential	767
1	Single Family	25322
2	Mobile Homes	944
3	Multi-family - 10 units or more	159
4	Condominiums	17935
5	Cooperatives	343
7	Miscellaneous Residential (migrant camps, boarding homes, etc.)	23
8	Multi-family - fewer than 10 units	1720
9	Residential Common Elements/Areas	660
10	Vacant Commercial	731
11	Stores, one story	386
12	Mixed use - store and office or store and residential combination	43
13	Department Stores	4
Total		52406

Count of PARCEL_ID by EFF_YR_BLT and Definition



Annual Average Daily Traffic (AADT QC)

- Used to assess most impacted roadways from various climate threats
- Road network based on original GIS layer provided by the city
- FDOT AADT sampled to road network for FDOT-maintained roads.

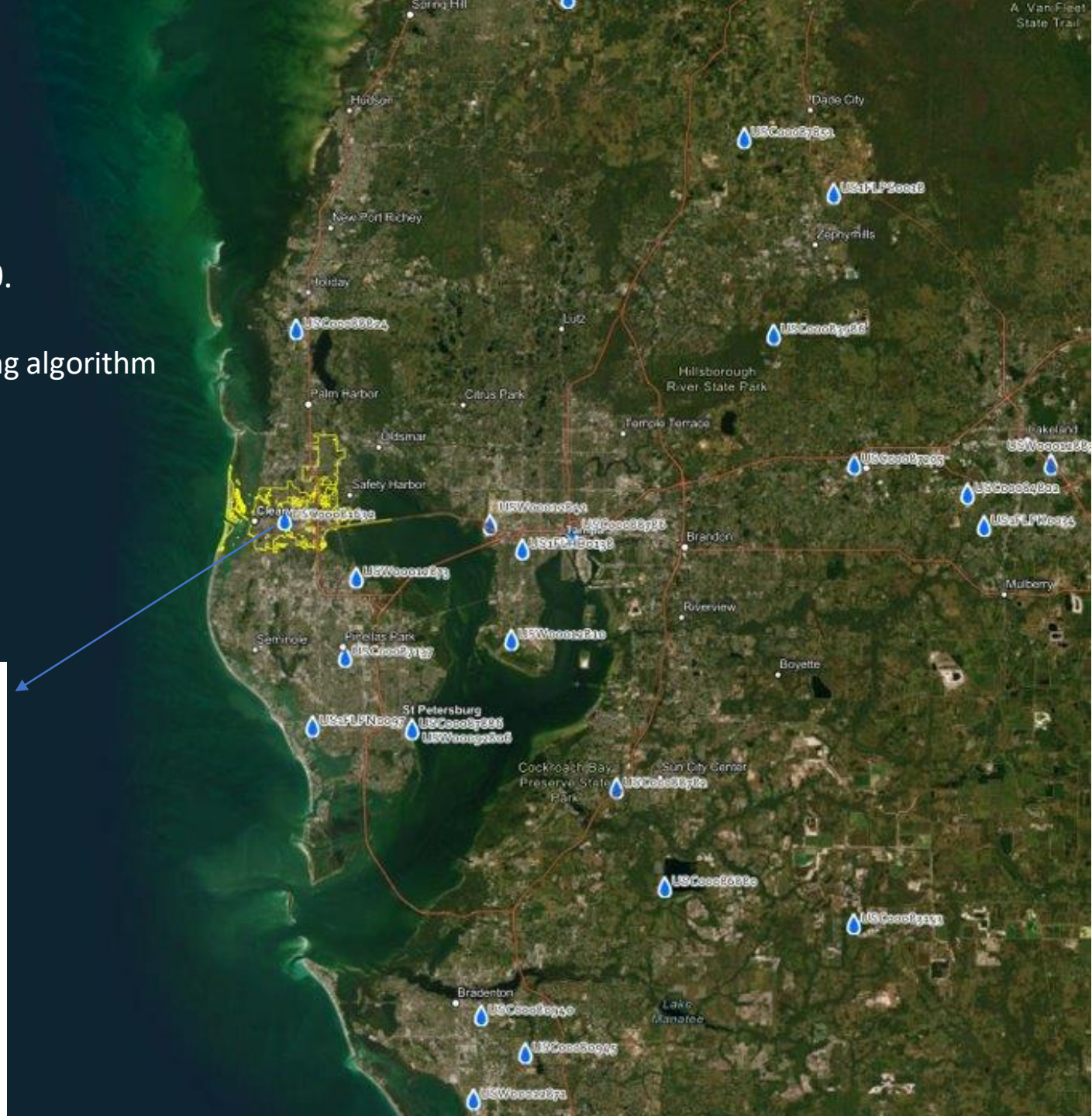


Future Conditions



↑ 24%

- Rain Projection developed through City Simulator downscaling algorithm
- Using 100th percentile most severe future for simulations
- **Projections:**
 - **(2) Ian-sized storms from 2020 – 2100.**
 - **(6) 8" rainstorms (50-year event).**



Findings: Future Sea Level

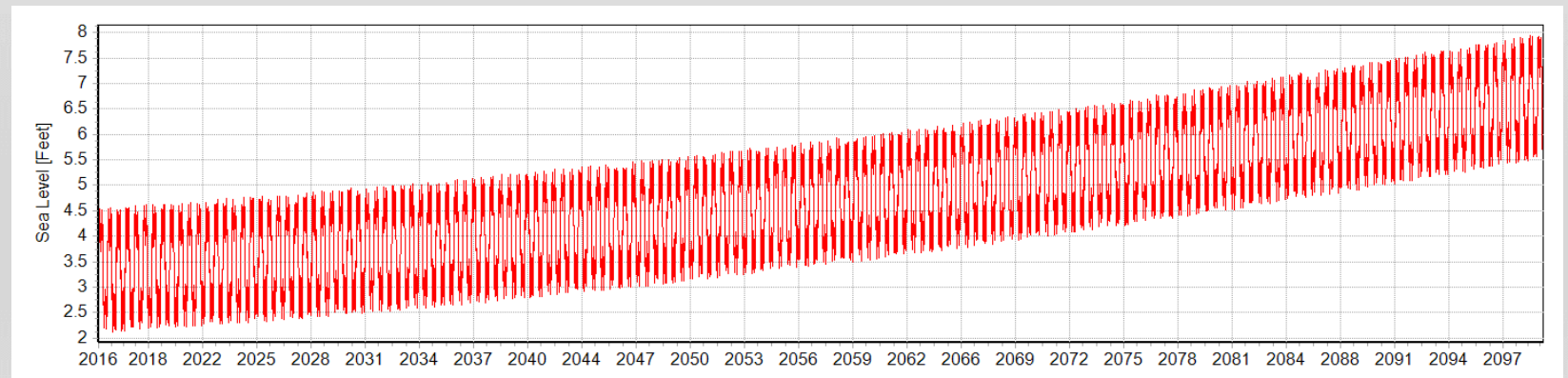
- Using NOAA Intermediate-High with Tide Predictions from the Clearwater Tide Gauge
- Tide predictions are used to estimate King Tide levels

↑ 3.25 ft. by 2100

- NOAA Intermediate High projection
- Aligns closest with 2000-2020 observed rise.

Long Range Forecast Members

	Include	Source	Title
	<input type="checkbox"/>	NOAA - 2022 SLR report	Low
	<input type="checkbox"/>	NOAA - 2022 SLR report	Intermediate-Low
	<input type="checkbox"/>	NOAA - 2022 SLR report	Intermediate
▶	<input checked="" type="checkbox"/>	NOAA - 2022 SLR report	Intermediate-High
	<input type="checkbox"/>	NOAA - 2022 SLR report	High
*	<input type="checkbox"/>		

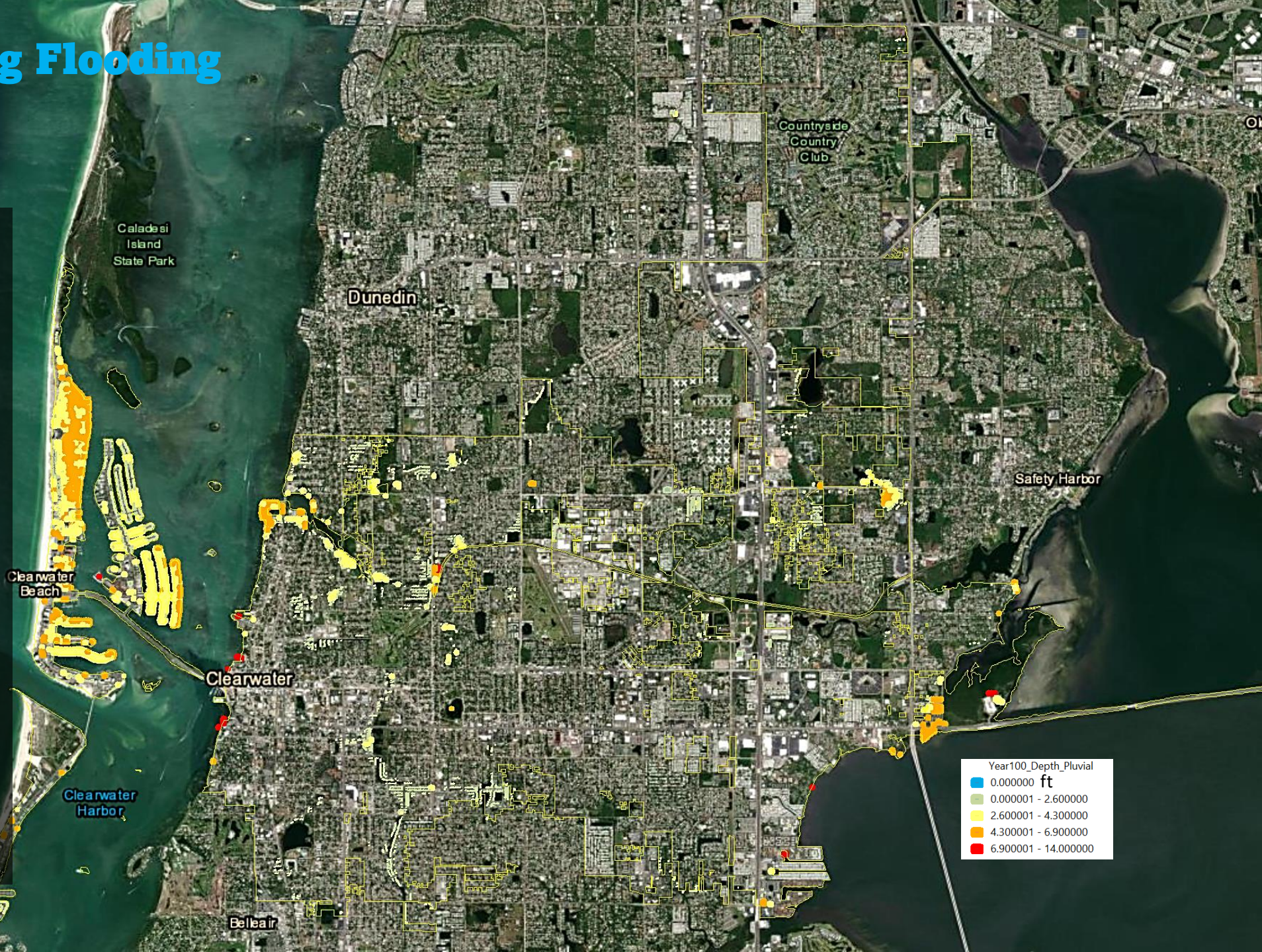


Findings: Building Flooding

1290

buildings with
above-FFE
flood risk

- 150 Commercial
- 1140 Residential
- Assumed FFE
 - Commercial
 - Single Family Residential
 - Multi-Family Residential



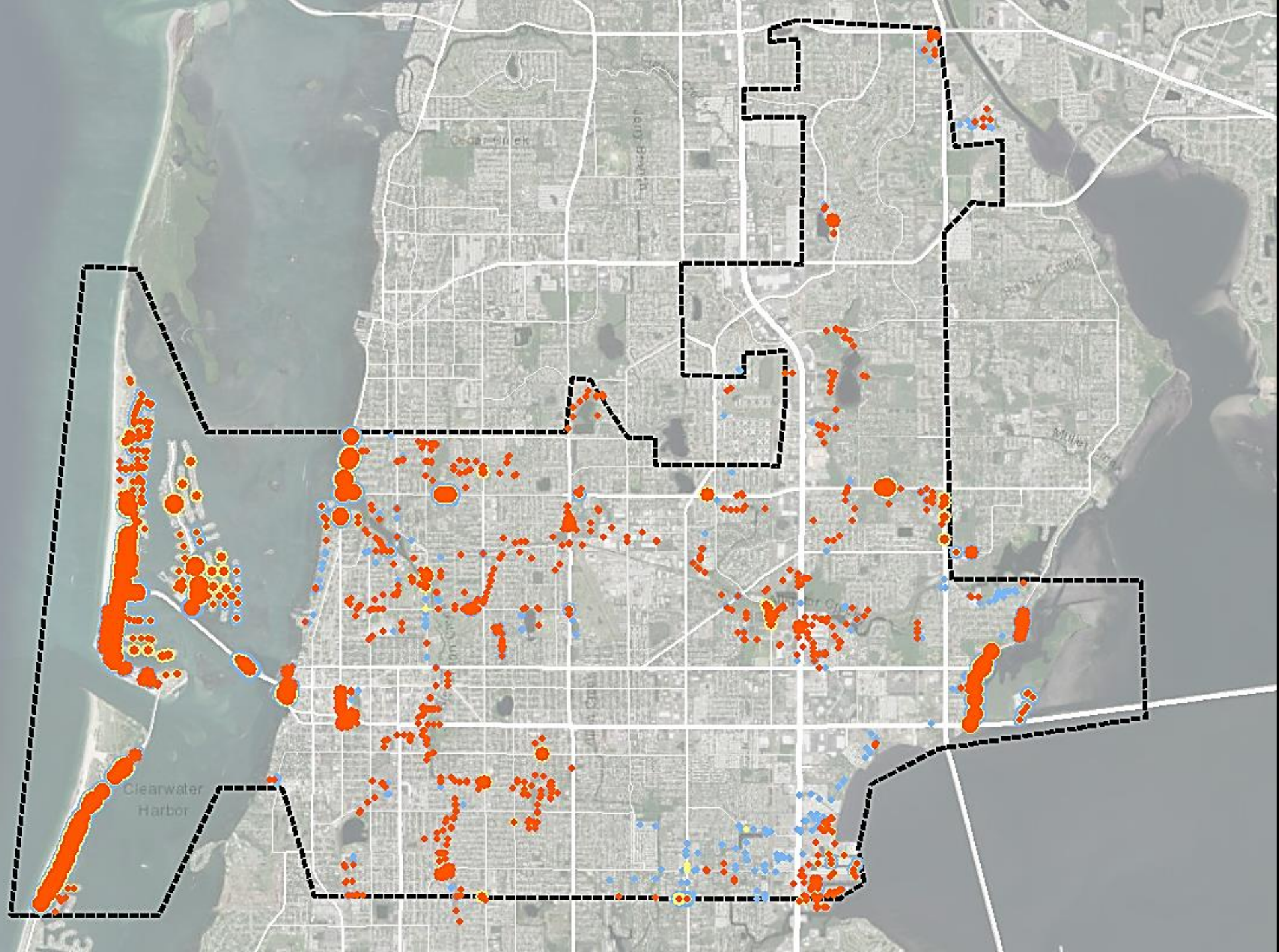
Findings: Trip Disruptions

424

Stormwater tracking
points with Avg.
Annual Disrupted
Trips > 10,000

Gulf of
Mexico

- Major disruptions in coastal islands
- N. Fort Harrison Ave & Sunset Point Rd
- Stevenson Creek area



Findings: Future Temperature

↑300%

increase in days > 90F

- All models agree in pronounced and sustained increase in Avg. Max Temp between 2020 and 2100.
- Lower emissions scenario (RCP2.6 and RCP4.5) shows level off by 2050-60.
- Used Higher Emissions Scenario in this study (RCP8.5) to stress test.

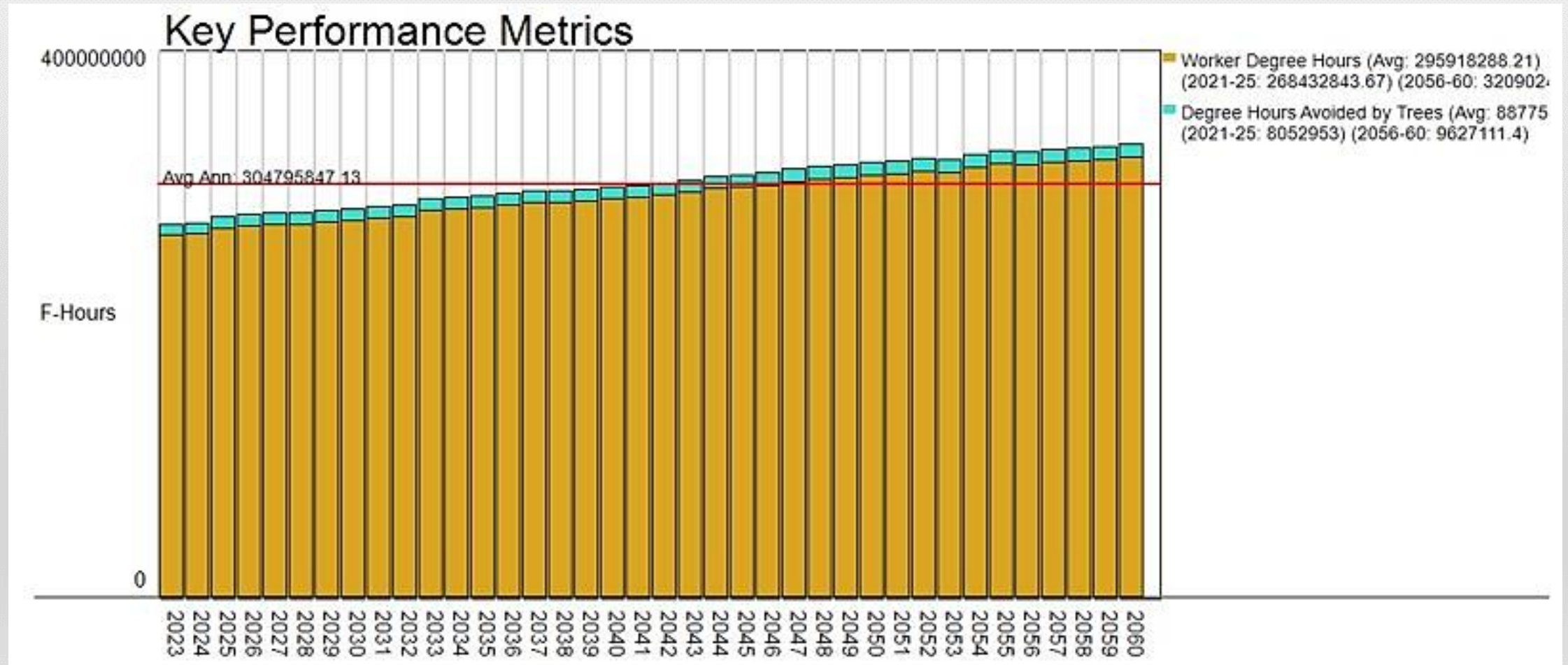


Findings: Heat Exposure

↑ 14%

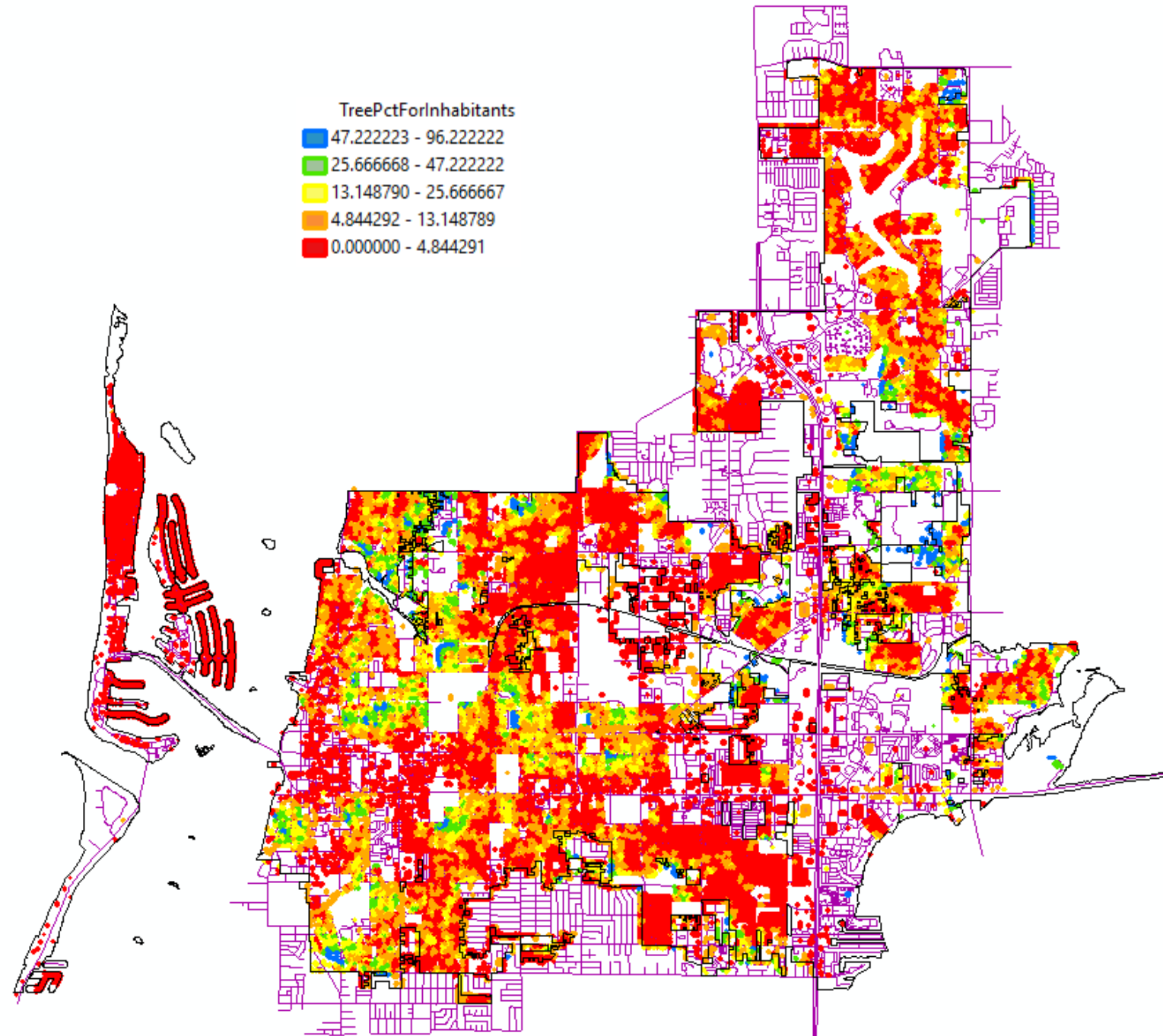
Heating Degree Hours over
2020-2060

- Highest in low tree percentage locations
- Highest in impervious areas



Building Inhabitant Tree Percentage

- Average tree percentage for workers or residents who are outdoors during the day.
- Note that 30% is considered high for tree percentage.
- Parts of city at 30% or higher, but majority is below.
- Particularly impactful to outdoor workers and residents.



Scenario Development



Initial Scenarios

Scenario Planning

Scenario #	Geography of Interest	Actions to Evaluate	Value to the Study
1	Stevenson Creek	Elevate <u>roads</u> ; Acquire structures	High exposure to flooding; ongoing studies in the area.
2	Citywide	Increase tree coverage	City has Greenprint 2.0 plan for sustainability and intends to mitigate for heat exposure.
3	Barrier Islands	Elevate seawalls	High exposure to flooding; ongoing studies in the area.
4	Coastal Zone 3	Elevate roads	High exposure to flooding; ongoing studies in the area.
5	Barrier Islands	Elevate structures	High exposure to flooding; ongoing studies in the area.
6	Citywide	Acquire structures	Help the city identify good candidates for acquisition due to high return on investment.
7	Hercules and US 19 Corridors	Acquire structures	These are economic development areas of interest.
8	Coastal Zone 1, Central Business District, and North Greenwood	Acquire structures; Add tree coverage	These are income-impacted areas where the <u>City</u> is currently investing in improvements.
9	SR 60, Drew Street, and S. Missouri (Alt 19)	Stormwater improvements; Tree coverage; Density changes	These are future investment corridors with expected redevelopment activities.
10	Citywide	Elevate structures	Help the city identify good candidates for elevation due to high return on investment.

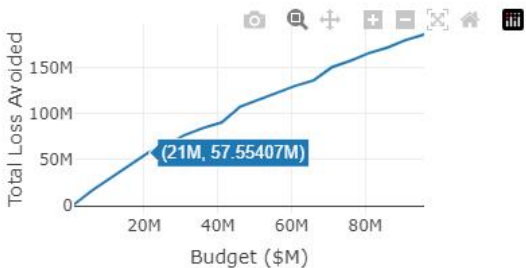
Scenario 1 – Stevenson Creek: Elevate Roads and Acquire Structures

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Basic Assessment Setup Digital Twin Vulnerability Explorer Scenario Analysis Action Plan

New Scenario Evaluate selected scenario

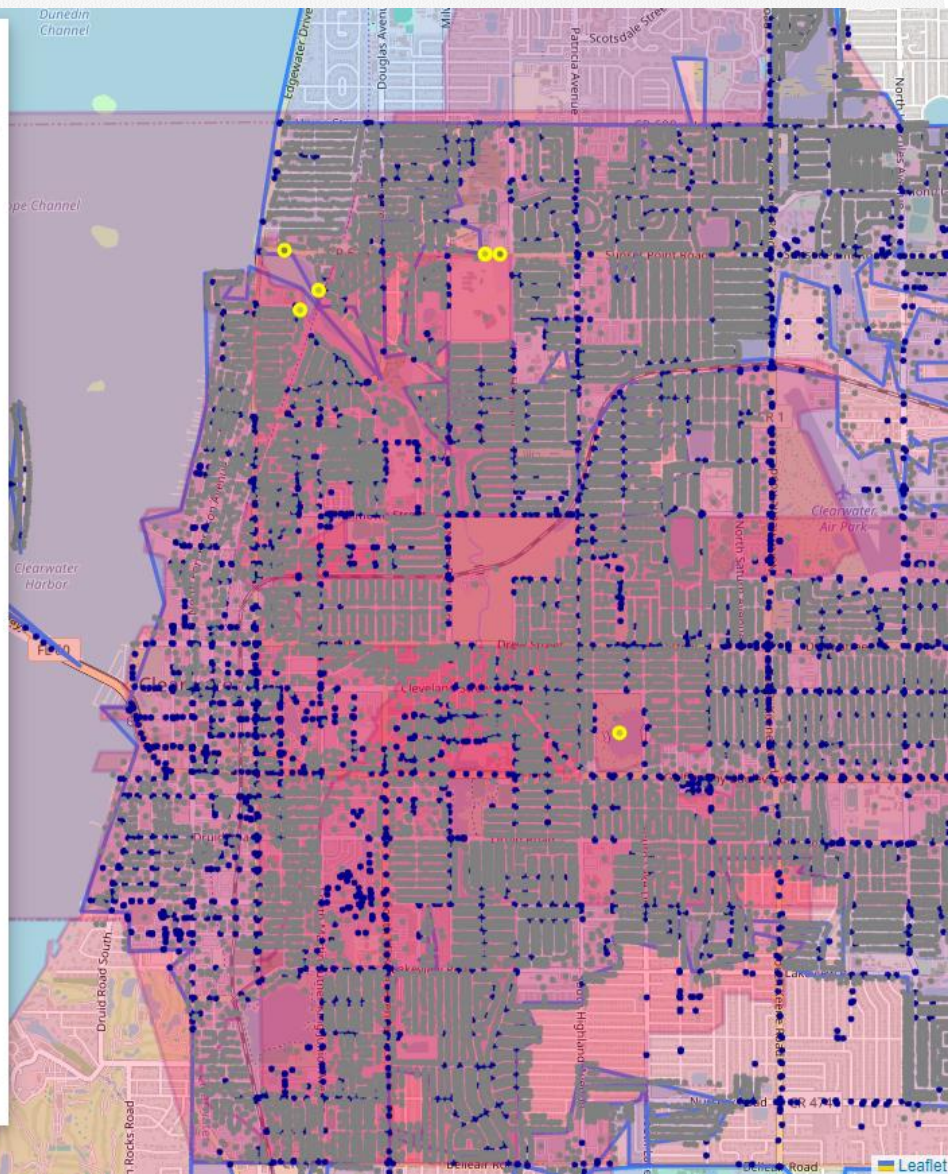
Index	Name	Actions	Focus Area	Target Budget (\$M)	Preferred Action Types	Status
1	Scenario 1 - Stevenson Creek	0	Stevenson Creek	1 - 100	Elevate Roads, Buyout Program,	Not Evaluated



Show Actions on Map

7 Actions. Total Cost: \$20.98M

Index	Name	Action Type	ROI	Cost (\$K)
1	Elevate_2083	Elevate Road	3.0534293999999997	5000
2	Elevate_6727	Elevate Road	2.7172936	5000
3	Elevate_5930	Elevate Road	2.6859182	5000
4	Elevate_5931	Elevate Road	2.6859182	5000
5	Acquire_null	Acquire Building	2.0500000000000003	356
6	Acquire_null	Acquire Building 2		324
7	Acquire_null	Acquire Building	1.5499999999999998	299



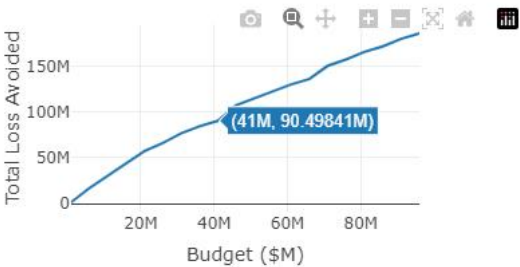
Scenario 1 – Stevenson Creek: Elevate Roads and Acquire Structures

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Basic Assessment Setup Digital Twin Vulnerability Explorer Scenario Analysis Action Plan

New Scenario Evaluate selected scenario

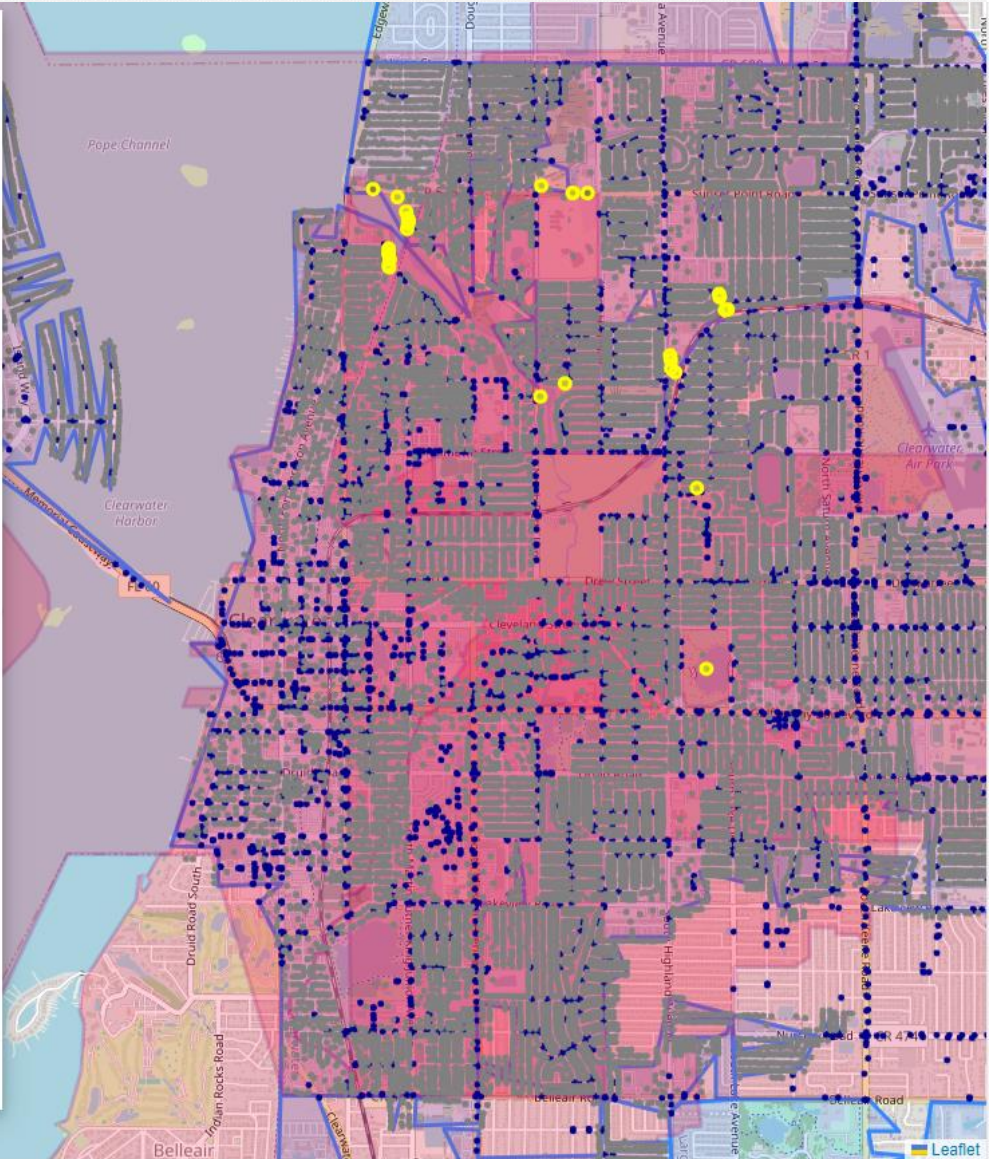
Index	Name	Actions	Focus Area	Target Budget (\$M)	Preferred Action Types	Status
1	Scenario 1 - Stevenson Creek	0	Stevenson Creek	1 - 100	Elevate Roads, Buyout Program,	Not Evaluated



Show Actions on Map


29 Actions. Total Cost: \$40.96M

Index	Name	Action Type	ROI	Cost (\$K)
1	Elevate_2083	Elevate Road	3.0534293999999997	5000
2	Elevate_6727	Elevate Road	2.7172936	5000
3	Elevate_5930	Elevate Road	2.6859182	5000
4	Elevate_5931	Elevate Road	2.6859182	5000
5	Acquire_null	Acquire Building	2.0500000000000003	356
6	Acquire_null	Acquire Building	2	6178
7	Acquire_null	Acquire Building	2	1384
8	Acquire_null	Acquire Building	2	324
9	Acquire_null	Acquire Building	2	977
10	Acquire_null	Acquire Building	1.55	546
11	Acquire_null	Acquire Building	1.55	520



Scenario #	Geography of Interest	Actions to Evaluate	Value to the Study
2	Citywide	Increase tree coverage	City has Greenprint 2.0 plan for sustainability and intends to mitigate for heat exposure.

In development



City Simulator

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Basic

Assessment Setup

Digital Twin

Vulnerability Explorer

Scenario Analysis

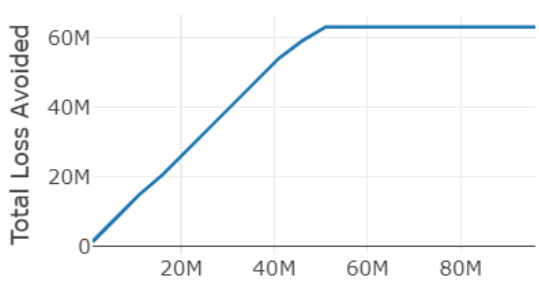
Action Plan

New Scenario

Evaluate selected scenario

Index	Name	Actions	Focus Area	Target Budget (\$M)	Preferred Action Types	Status
1	Citywide Heat	0	Citywide	1 - 100	Plant Trees.	Not Evaluated

Total Loss Avoided

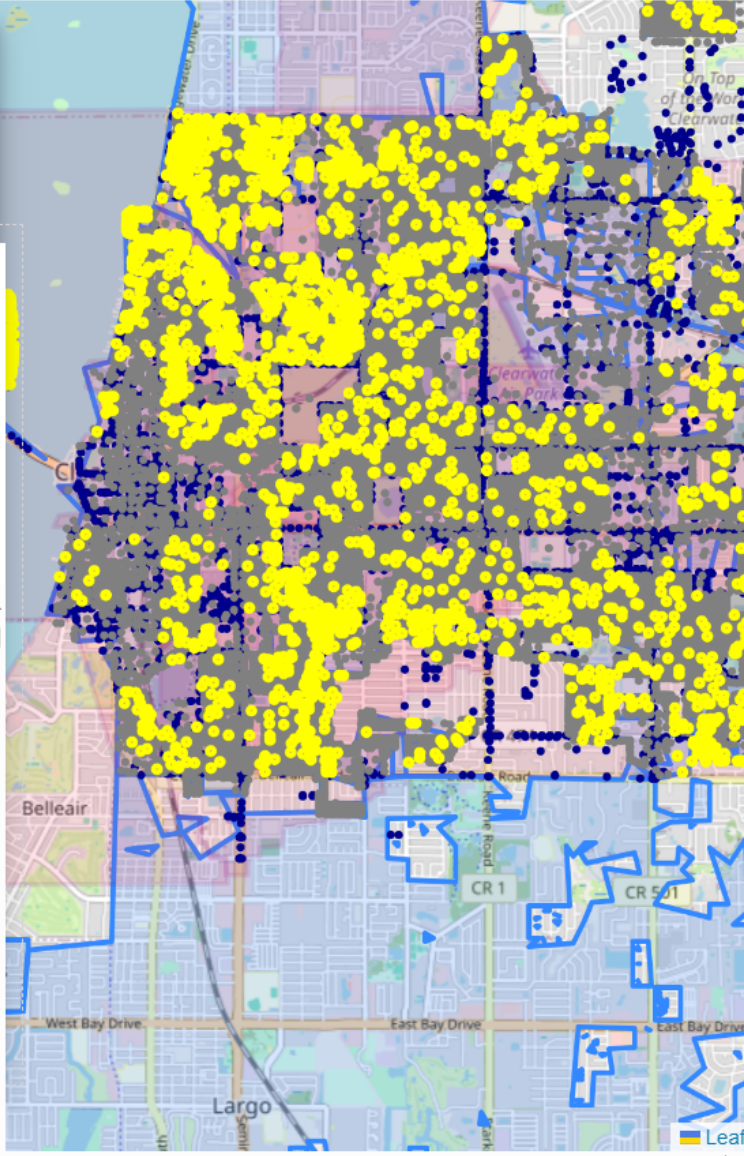


Budget (\$M)

Show Actions on Map

3933 Actions. Total Cost: \$6.00M

Index	Name	Action Type	ROI	Cost (\$K)
1	PlantTrees_null	Plant Trees	1.3500000000000008	3
2	PlantTrees_null	Plant Trees	1.3500000000000005	1
3	PlantTrees_null	Plant Trees	1.3500000000000005	5
4	PlantTrees_null	Plant Trees	1.3500000000000005	2
5	PlantTrees_null	Plant Trees	1.3500000000000005	2
6	PlantTrees_null	Plant Trees	1.3500000000000005	1
7	PlantTrees_null	Plant Trees	1.3500000000000005	3
8	PlantTrees_null	Plant Trees	1.3500000000000005	1



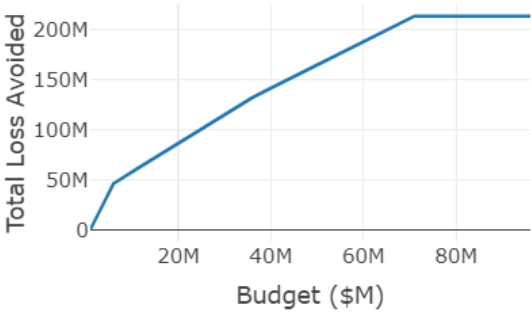
Scenario #	Geography of Interest	Actions to Evaluate	Value to the Study
4	Coastal Zone 3	Elevate roads	High exposure to flooding; ongoing studies in the area.

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[New Scenario](#)

[Evaluate selected scenario](#)

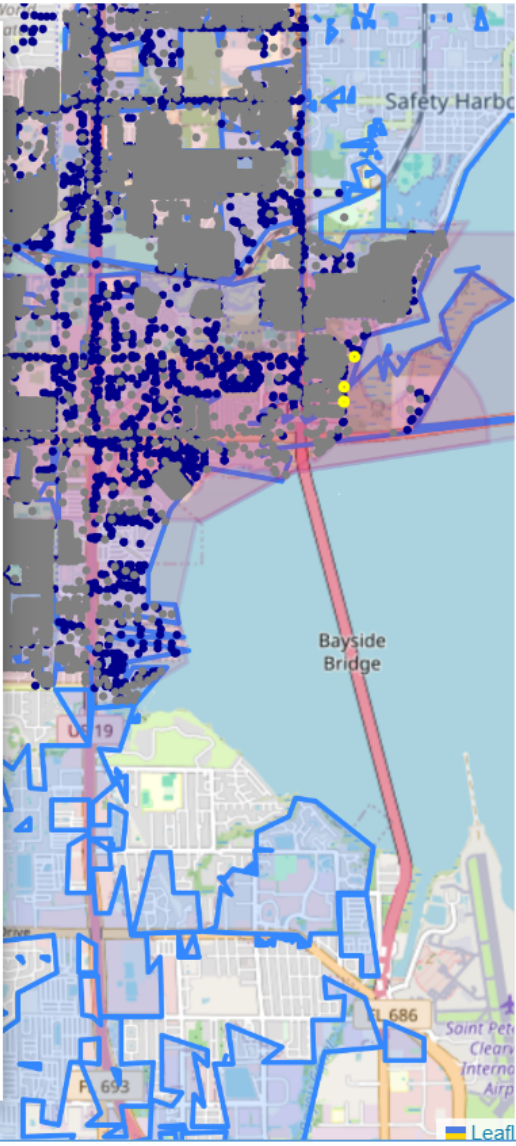
Index	Name	Actions	Focus Area	Target Budget (\$M)	Preferred Action Types	Status
1	Scenario 3 - Coastal Zone 3 Roads	0	<div>Coastal Zone 3</div>	1 - 100	Elevate Roads	Not Evaluated



[Show Actions on Map](#)

4 Actions. Total Cost: \$20.00M

Index	Name	Action Type	ROI	Cost (\$K)
1	Elevate_4547	Elevate Road	9.2114904	5000
2	Elevate_392	Elevate Road	2.8722288	5000
3	Elevate_7547	Elevate Road	2.8722288	5000
4	Elevate_7548	Elevate Road	2.8722288	5000



Scenario #	Geography of Interest	Actions to Evaluate	Value to the Study
10	Citywide	Elevate structures	Help the city identify good candidates for elevation due to high return on investment.

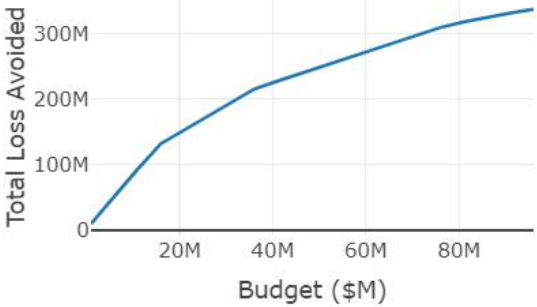


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[New Scenario](#) [Evaluate selected scenario](#)

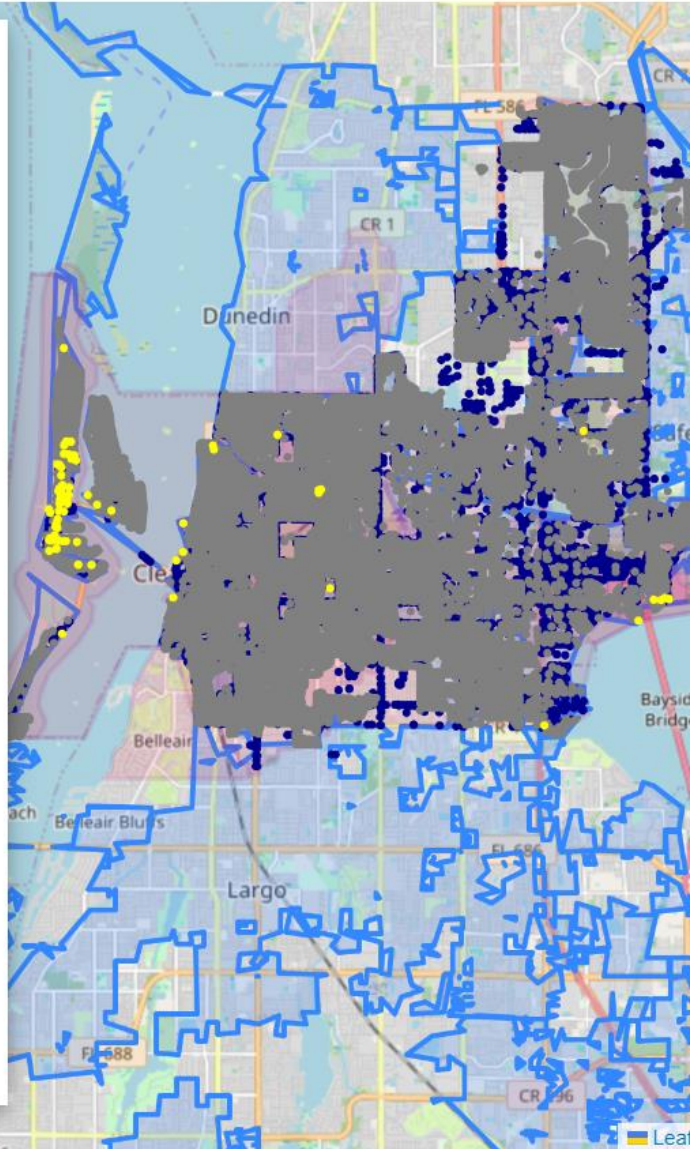
Index	Name	Actions	Focus Area	Target Budget (\$M)	Preferred Action Types	Status
1	Scenario 10 - Citywide Elevation	0	<div>Citywide</div>	1 - 100	Elevate Homes,	Not Evaluated



[Show Actions on Map](#)

86 Actions. Total Cost: \$20.99M

Index	Name	Action Type	ROI	Cost (\$K)
1	Elevate_null	Elevate Building	25.000000000000004	28
2	Elevate_null	Elevate Building	10	767
3	Elevate_null	Elevate Building	8.333333333333334	6
4	Elevate_null	Elevate Building	8.333333333333334	465
5	Elevate_null	Elevate Building	8.333333333333334	183
6	Elevate_null	Elevate Building	8.333333333333334	188
7	Elevate_null	Elevate Building	8.333333333333334	425
8	Elevate_null	Elevate Building	8.333333333333334	147



Next Steps:

- **Refine scenarios and update results**
- **Finalize report**
- **Prioritize areas for adaptation planning and future grant funding**

