Business Case Analysis for the City of Miami Beach Stormwater Resiliency Program

January 27, 2020

Today's Outline

1. Project Overview
2. Project Process
3. Big Picture Results
4. Conclusions & Next Steps

Project Overview

Overall Goal

Understand and communicate the business case for stormwater resilience investments in Miami Beach through robust data analysis and state-of-the-art modeling.

Topline Conclusion

This pilot study has demonstrated that benefits of the City's targeted investments in stormwater and infrastructure improvements significantly outweigh their costs, and provide substantial benefits to the residents, businesses, visitors, and government of Miami Beach.

Key Questions to Answer

- What is the effectiveness of the city's planned infrastructure improvements (e.g., raising roads, increasing drainage capacity) at reducing flood risk?
- How much would additional private sector investments in flood mitigation reduce flood risk?
- What is the effect of these investments on property values?
- What are the other benefits of reduced flooding?
- Overall, what is the business case for public and private sector stormwater resilience investments?

Business case components

- Expected losses/property damage
- Property values
- Insurance premiums
- Property tax revenues
- Tourism revenues
- Operational/response costs
- Traffic disruptions
- Business closures

Ultimate Outcomes

- **Technical analysis products, model results**
  - Detailed flood reduction modeling for proposed First Street investments and hypothetical private home
  - Catastrophe risk modeling of the entire city
  - Property value models to estimate benefits of resilience investments to homeowners
- **Modeling framework**
  - Scalable, repeatable process to explore alternate investment and risk scenarios
  - Expandable to entire city
- **Business case summary materials**
  - For example: 4-pager; presentation materials

Our Interdisciplinary Team

Internationally recognized consultants in climate adaptation and economics.

- Project lead
- Led property value modeling and other economic analyses

World leaders in catastrophe modeling and risk assessment.

- Performed citywide risk modeling, including expected damages/losses
- Provided expertise on flood risk effect on insurance premiums

Experienced stormwater and infrastructure modelers, designers, and engineers.

- Performed integrated flood modeling of detailed stormwater investments

Communication experts and engineering consultants in resilience and adaptation.

- Developed adaptation strategies for individual homeowners
- Coordinated and led communication efforts of the project

Center for Environmental Solutions focused on community resilience.

- Supported property value analysis and provided other advisory services

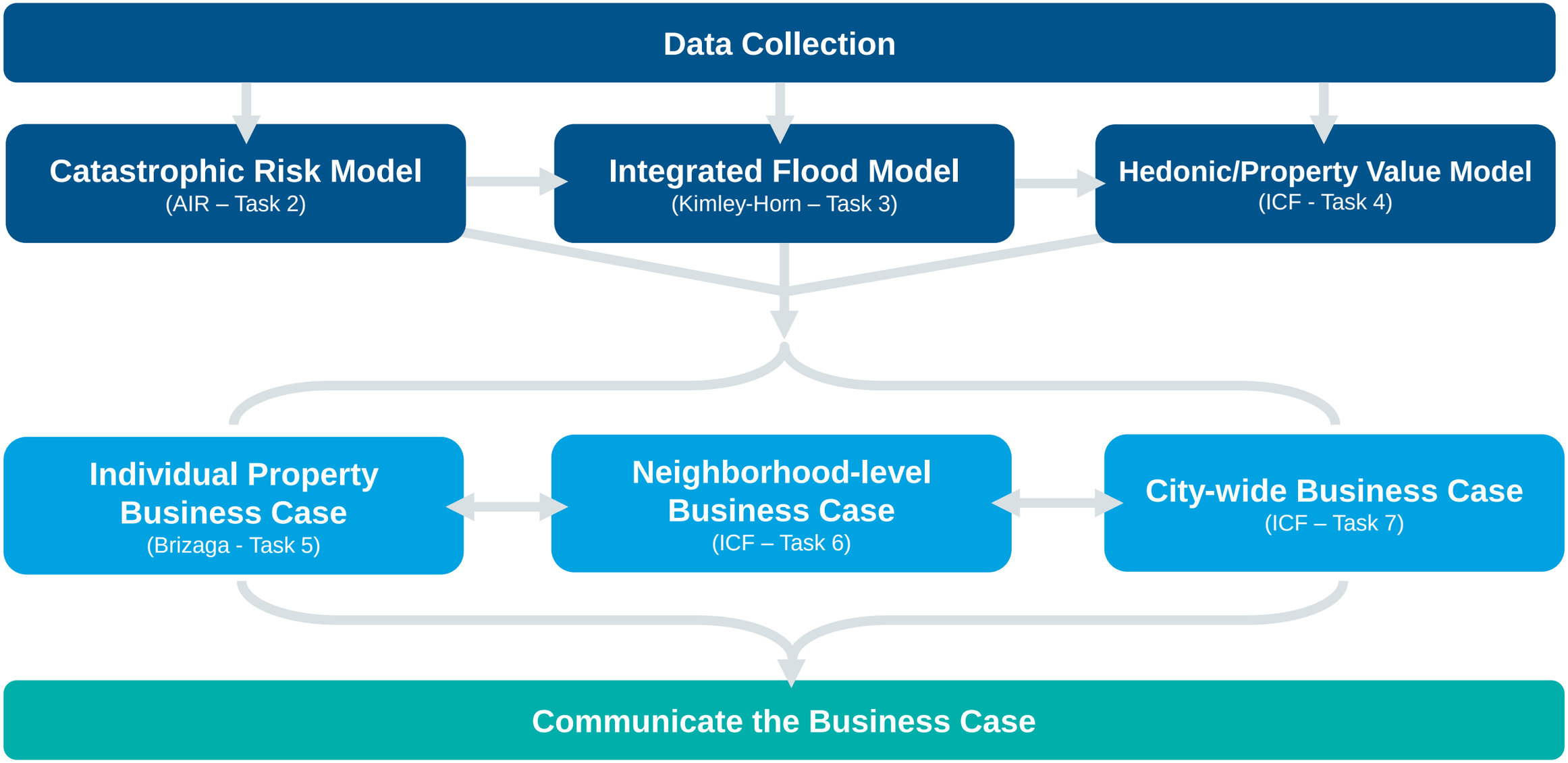
Project Process

Project Process

Modeling

Real-World Application

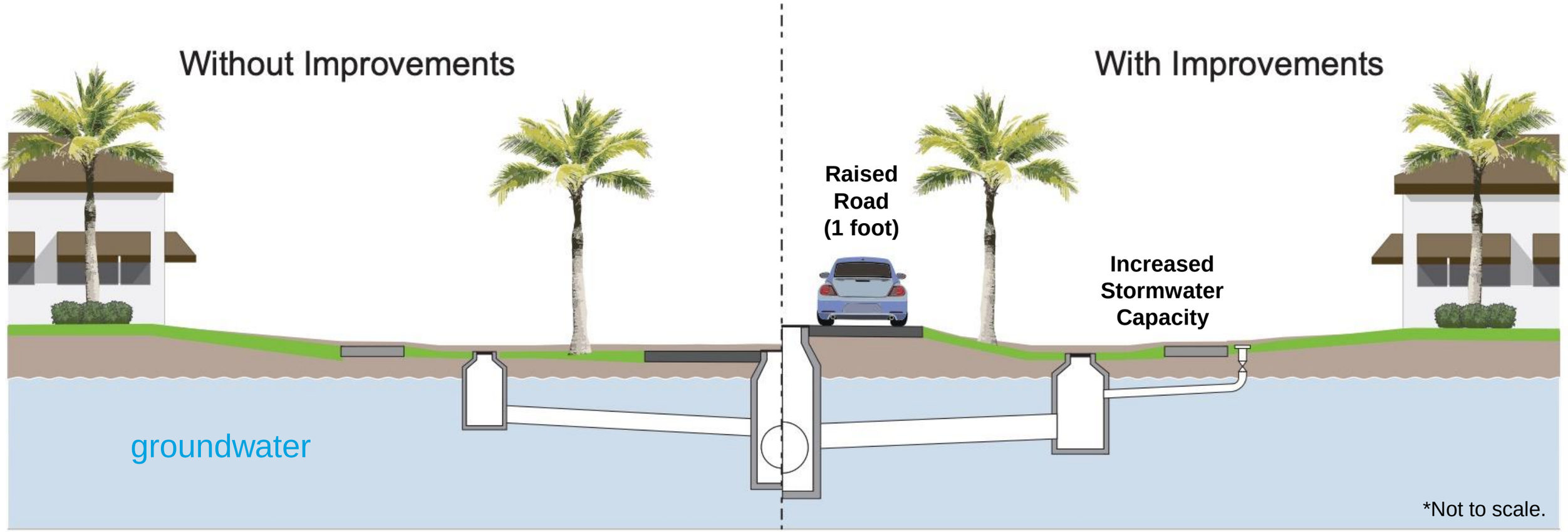
Communication



Key Assumptions & Scenarios Evaluated

- **This study evaluated the business case for the City's 2013 stormwater improvement program policies and plans**
  - This includes an assumption of 1 foot of sea level rise from 2013 (nominally a 30-year planning horizon)
- **We evaluated proposed investments against the following scenarios (with and without sea level rise):**
  - King Tides
  - 5-year, 24-hour rainstorm (occurring at King Tide)
  - 10-year, 24-hour rainstorm (occurring at King Tide)
  - Moderate Hurricane (~25-year storm surge and rainfall)

Key Assumptions & Scenarios Evaluated



Catastrophic Risk Modeling

Approach:

- AIR ran its Tropical Cyclone model to estimate expected losses from storm surge with and without sea level rise.
- Developed an algorithm to model effect of increased sea levels on surge across the city.

Results:

- Average annual loss nearly doubles in the sea level rise scenario.
- Dramatic increases at frequent return periods due to the introduction of new events that previously would not have caused loss (due to sea level rise).
- 25-30% increase in expected loss from sea level rise for most severe events.

Return Period	Annual Probability of Equal or Greater Loss	Current Sea Level Scenario	Mid-Century Projected Sea Level Scenario	Percent Change
		Modeled Loss (USD Millions)	Modeled Loss (USD Millions)	
Average Annual Loss		**37.8**	**74.2**	96%
10	10%	--	8.6	n/a
25	4.0%	404.7	790.4	95%
50	2.0%	748.5	1,128.3	51%
100	1.0%	993.7	1,424.3	43%
250	0.4%	1,270.1	1,752.2	38%
500	0.2%	1,479.5	1,978.3	34%
1,000	0.1%	1,687.5	2,192.1	30%
5,000	0.02%	2,151.6	2,768.8	29%
100,000	0.001%	3,144.6	3,951.5	26%

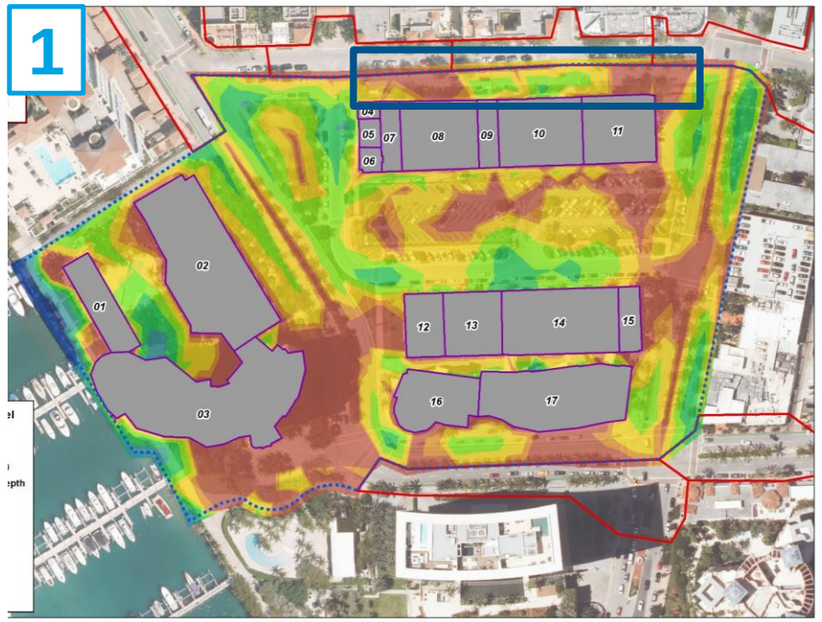
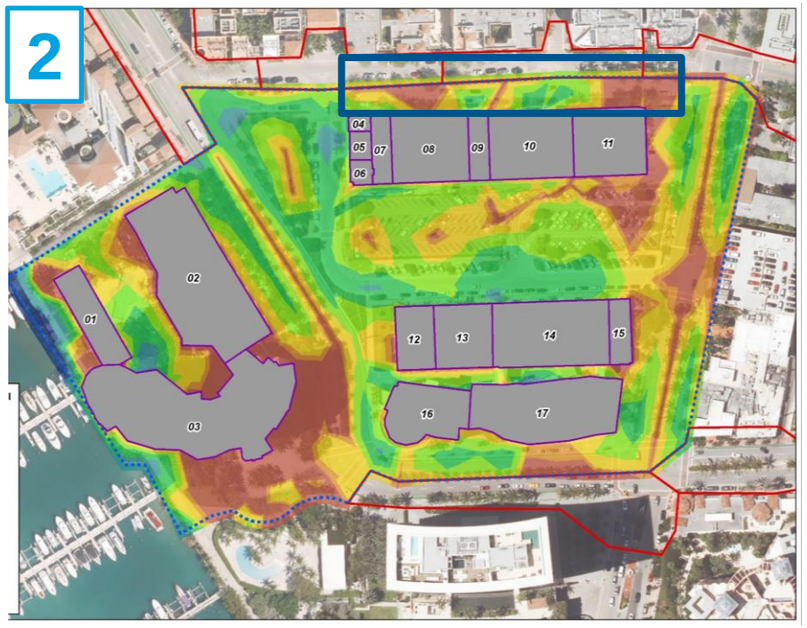
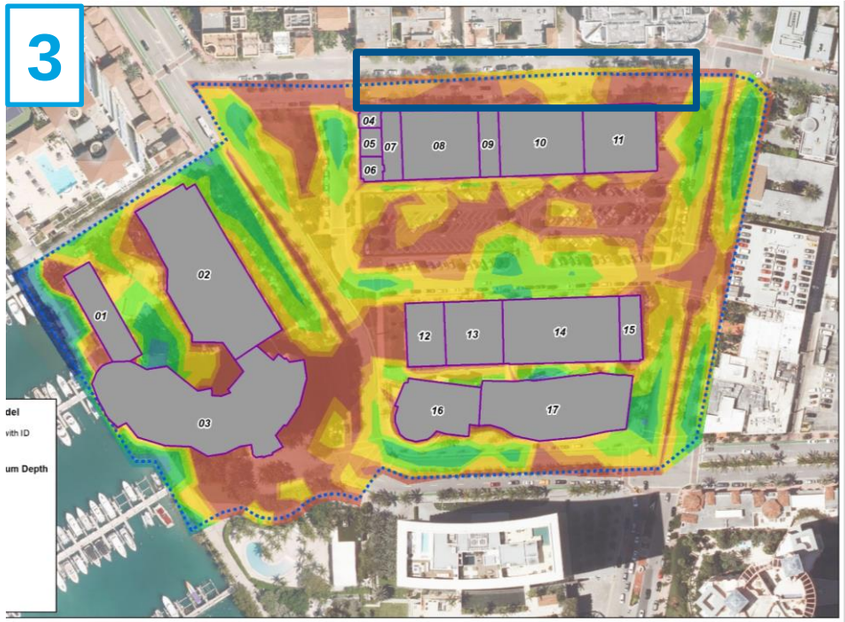
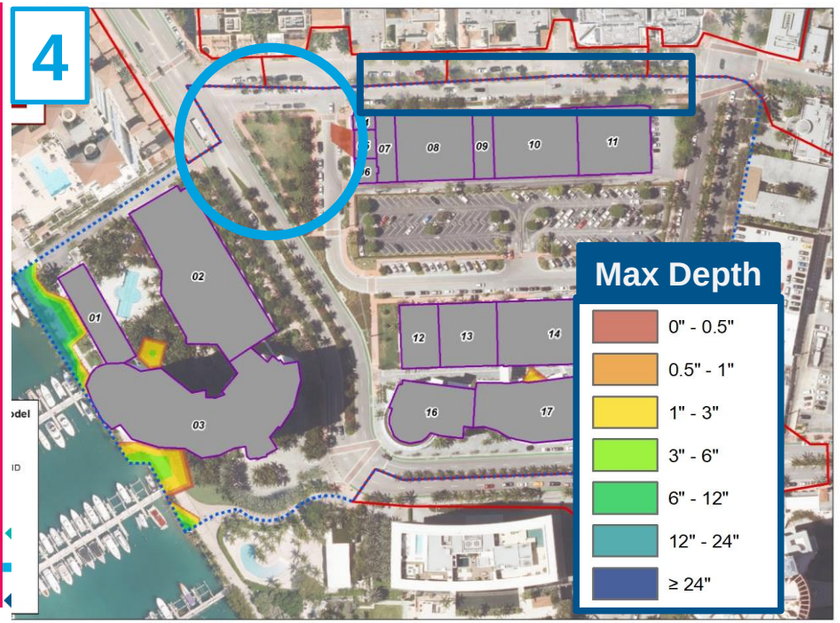
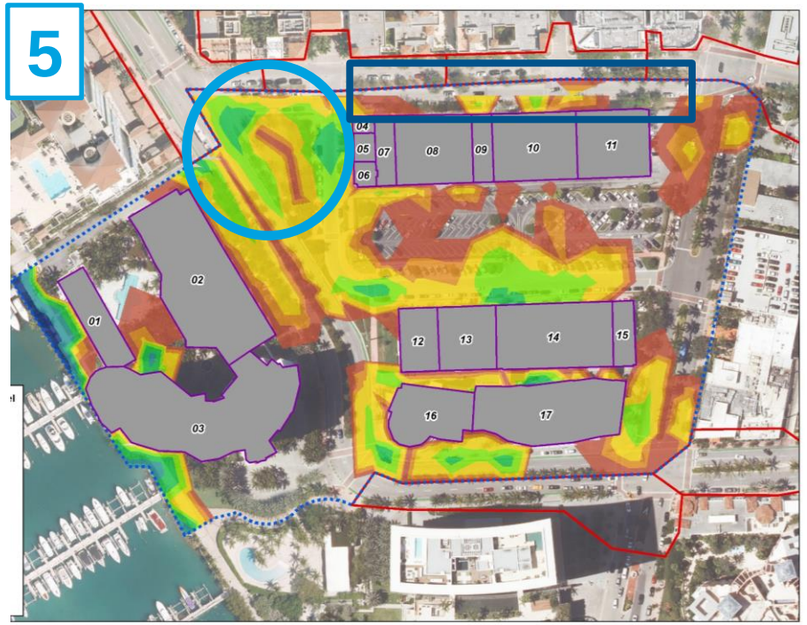
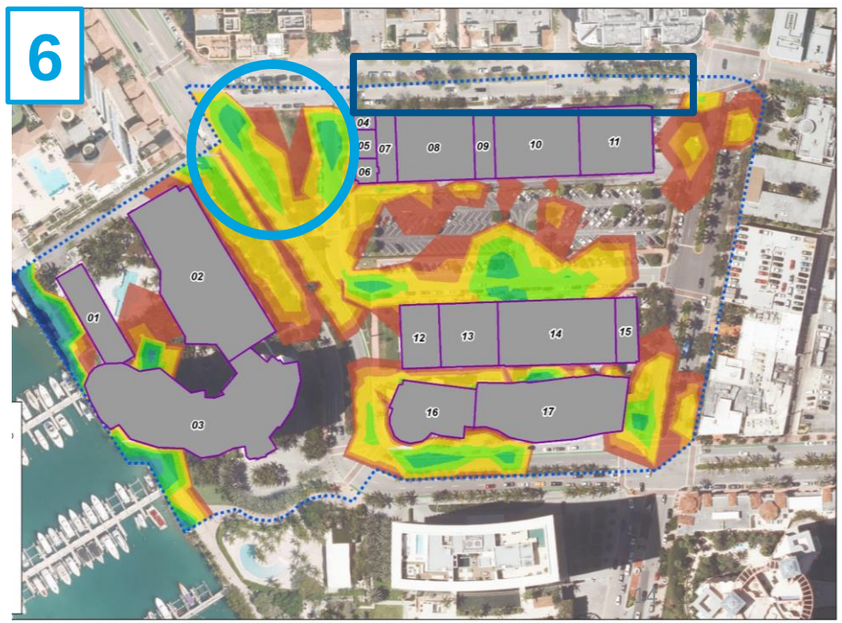
Integrated Flood Modeling

Approach:

- Used the Interconnected Pond Routing version 4 (ICPR4), an integrated 2-dimensional surface and groundwater modeling software.
  - Captures combined effects of precipitation, tide levels, and groundwater levels
- Used ICPR4 to estimate flood depths for a King Tide, 5-year, and 10-year precipitation events, and a 25-year moderate hurricane (precipitation and storm surge), with and without public investment, and with and without sea level rise.

Results:

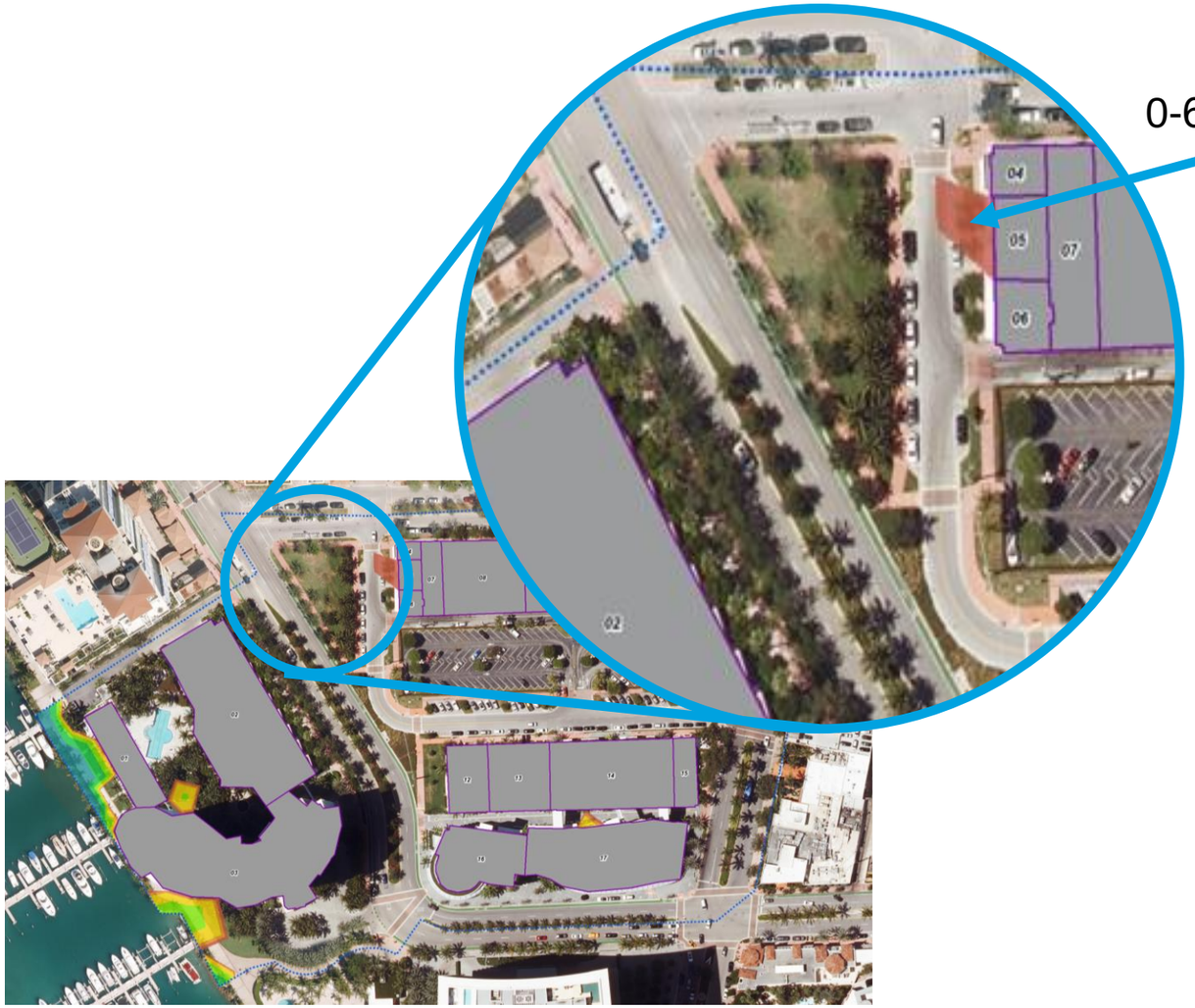
- The modeled improvements reduce flooding, with some areas of the First Street neighborhood seeing a 1’ reduction in water depth during the 5-year rainstorm.
- These improvements draw down the water enough to eliminate flooding of the Finished Floor Elevations of many of the properties in the First Street neighborhood during the 5-year and 10-year rainstorms.

	Current Conditions (No Investment, No SLR)	Baseline (No Investment, 1’ of SLR)	Public Investment (Investment, 1’ of SLR)
10-Year Storm			
King Tide			

Building ID	Finished Floor Elevation (ft NAVD 88)	Baseline (with sea level rise, no investment) Maximum Water Elevation (ft NAVD 88)				Public Investment Maximum Water Elevation (ft NAVD 88)			
		King Tide	5-year Heavy Rainfall	10-year Heavy Rainfall	Moderate Hurricane	King Tide	5-year Heavy Rainfall	10-year Heavy Rainfall	Moderate Hurricane
1	6.48	2.7	2.8	2.8	6.4	2.7	2.8	2.8	6.2
2	6.48	2.7	3	3.1	6.4	2.7	3.1	3.1	6.1
3	6.48	2.7	3	2.9	6.2	2.7	2.7	2.7	6.2
4	2.79	2.7	3	3.1	6.3	1.6	1.9	2.2	6.4
5	2.79	2.7	3	3.1	6.4	2.3	2.6	2.6	6.1
6	2.79	2.7	3	3.1	6.3	2.3	2.9	2.9	6.1
7	2.5	2.7	3	3.1	6.5	0	2.8	2.8	6
8	3.05	2.7	3.1	3.1	6.3	0	2.1	2.7	6.2
9	2.7	2.7	3.1	3.2	6.3	0	2.1	2.7	6.2
10	2.96	2.7	3.1	3.1	6.3	0	2.1	2.7	6.2
11	3.3	2.7	3.1	3.2	6.2	0	2.4	3	6.1
12	4.49	2.7	3	3.1	6.4	2.4	2.5	2.6	6.2
13	3.59	2.7	3	3.1	6.3	2.6	2.6	2.6	6.2
14	2.85	2.7	3	3.1	6.3	2.6	2.5	2.5	6.2
15	3.37	2.7	3	3.1	6.3	2.6	2.5	2.5	6.2
16	2.85	2.7	3	3	6.4	2.1	2.4	2.7	6.2
17	2.85	2.7	2.8	2.9	6.4	2.6	2.1	2.7	6.1

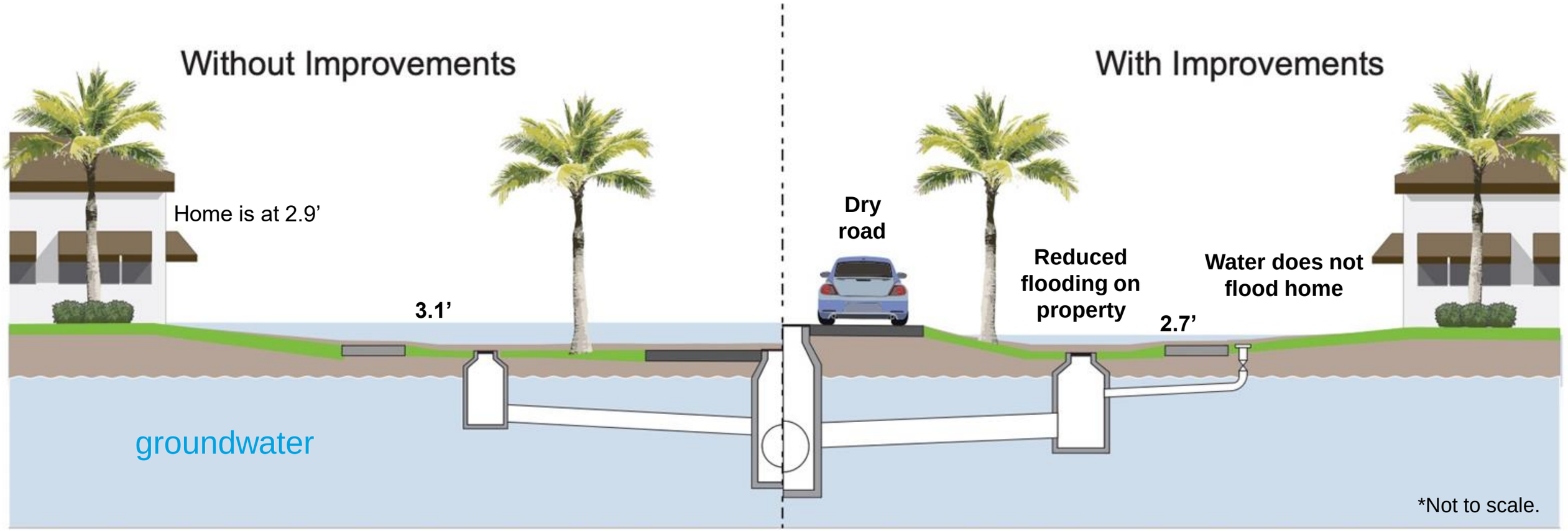
Example:

King Tide Flooding on Sept. 30, 2019 (2.1’ Tide)



Example:

10-year, 24-hour storm (with sea level rise)



Property Value Model

Approach:

- Developed a hedonic pricing model to estimate effects of flood risk and infrastructure investments on residential property values in Miami Beach specifically.
- Developed models for: all homes, condos-only, standalone-homes only.
- Included independent peer-review.

What is a Hedonic Model?

Statistical analysis technique to isolate how much people are willing to pay for a particular characteristic.

What is a Hedonic Model?

Square footage

Neighborhood

Elevation

Lot size

No. of bedrooms

Building age

Nearby amenities (waterfront, historical districts, golf courses, highways)

Home Value

Grandfathering status of flood insurance

Walking and transit accessibility

Sale year

Nearby road elevation

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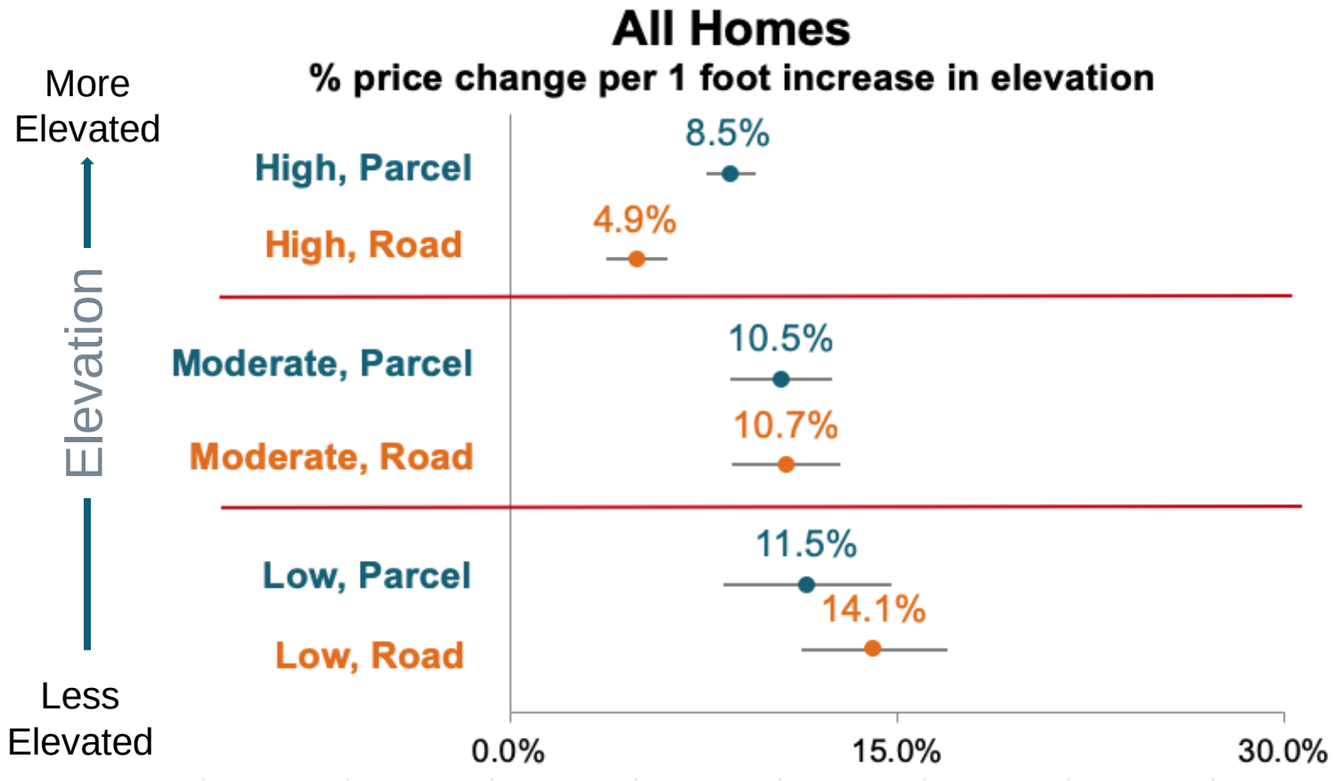
Results

- **Both factors – parcel elevation and road elevation – positively affect property values**
- Home prices are higher for parcels at higher average elevations
  - 8.5-11.5% increase per foot
- Home prices are higher for parcels with more elevated surrounding roads
  - 4.9-14.1% increase per foot
- Average parcel and road elevation increases have greater price effects when the initial average parcel or road elevation is lower



Hedonic Model Application: Sunset Harbour

- **Use the models to estimate home value improvements from infrastructure investments**
- **Sunset Harbour application:**
  - Using “Condos Only” model – nearby homes primarily condos
  - 1,349 condos with a total assessed value of $346.12 million
  - Estimated effect of road elevation project on assessed condo values: 11.9% increase, or $41.2 million

Sunset Harbour post-elevation (Source: Wade Trim)

Flood Risk and Investment Effects on Property Values

No Action Scenario

Purchase Price

±

Market Fluctuations

Common factors that change a property's value unrelated to stormwater

−

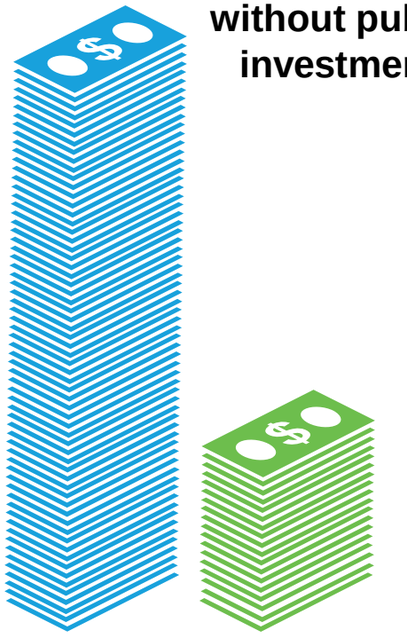
Value Loss Due To Flooding

Homes with lower parcel and road elevations are likely to have lower property values

=

Current Value

without public investment



Flood Risk and Investment Effects on Property Values

Investment Scenario

Purchase Price

±

Market Fluctuations

Common factors that change a property's value unrelated to stormwater

+

Value Gain Due To Public Investments

This is the value increase due to city's action to address flooding and sea level rise

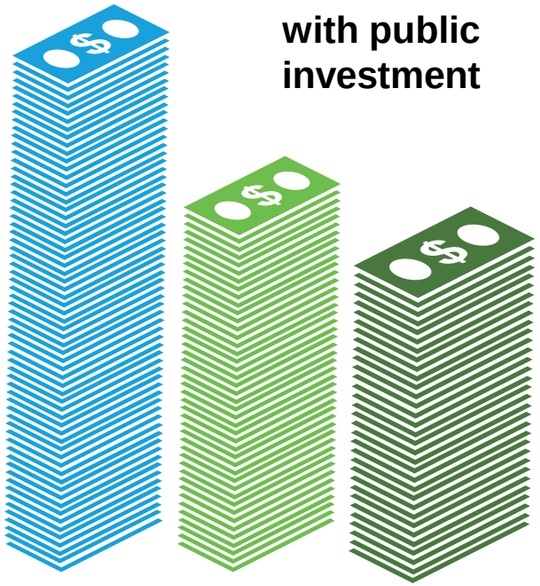
−

Value Loss Due To Flooding

Public infrastructure investment reduce flooding and associated value loss

=

Current Value with public investment



Big Picture Results

Project Process

Modeling

Real-World Application

Communication

Data Collection

(AIR – Task 2)

(Kimley-Horn – Task 3)

(ICF – Task 4)

Applying the model results to the real-world using the unique formula created for Miami Beach.

Individual Property Business Case
(Brizaga - Task 5)

Neighborhood-level Business Case
(ICF – Task 6)

City-wide Business Case
(ICF – Task 7)

Communicate the Business Case

(1)
What does this mean for an individual homeowner?

Analysis Assumptions

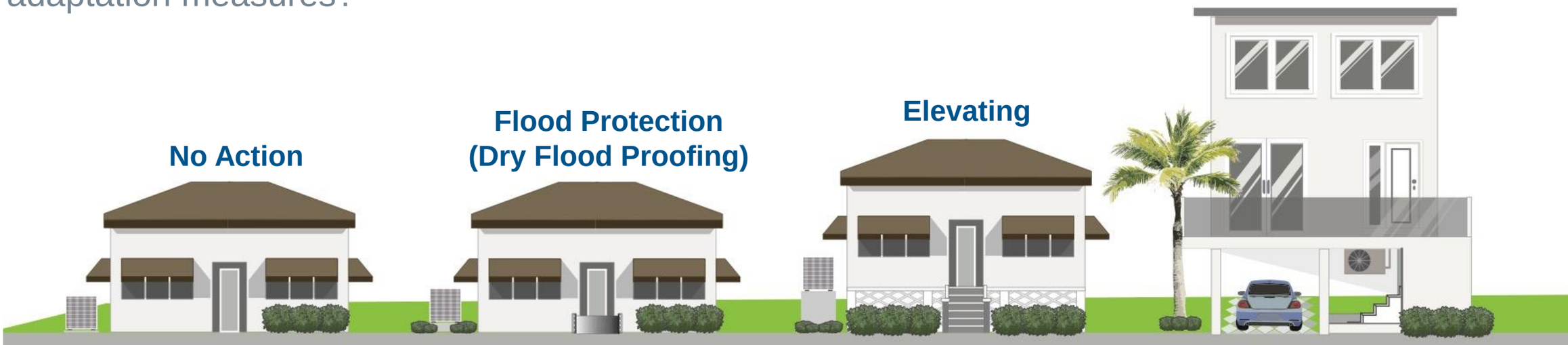
- One-story single-family slab-on-grade home with no basement
- 2,500 square feet
- Assessed at $493,695*
- Finished Floor Elevation of **2.9 feet NAVD88** (First Street median)
- Property elevation is 7” (one step) below the Finished Floor Elevation: 2.3 feet NAVD88
- Flood elevations based on First Street median
  - Public investments remove flooding to the first-floor elevation of home from the 5-year and 10-year event

Insurance Coverage
- Pre-FIRM in AE Zone
- $250,000 Coverage
- $50,000 Contents Coverage
- 25% CRS Discount

*2018 median assessed value for single-family homes in Miami Beach with a square footage between 2,000 and 3,000

Adaptation Options Evaluated

- Evaluated three different adaptation types: flood protection, elevating the home, and complete reconstruction with elevation.
- Examined cost and benefit of adaptation measures for the four storm types relative to:
  - **Reduction in property damage –** How much will the personal adaptation reduce flooding (beyond the public investments) and how does that relate to reduced property damage?
  - **Home value increase –** How much will the value of the home increase from reduced flood risk?
  - **Reduction in annual flood insurance premium –** How much will the annual flood insurance premium change based on adaptation measures?



Key Findings

- The City's improvements reduce the flood risk to an individual property but do not remove the need for individual adaptation actions.
- City investments in the right-of-way increase property values by 4.9-14.1% for each foot of additional road elevation. Lower elevation properties see the greatest increase from elevation.
- If you are reconstructing a home, elevating the home is a good investment and the home would see a 3.6% increase in property value for each foot of increase in elevation – outweighing marginal cost to elevate.
- Dry flood-proofing can be a cost-effective strategy for homeowners.
- If insurance rates increase, individual property adaptation becomes even more cost effective.
- Personal adaptation is a vital component of Miami Beach's resilience.

3.6%

increase in home value for each foot of elevation for single-family homes.

(2)
What does this mean for a neighborhood?

Evaluation of Proposed First Street Improvements

Costs:

- Capital Costs: $8,200,000
- Operations & Maintenance Costs: $205,000 per year

Benefits:

- Reduced property damage (per event): $1,300 - $204,000
- Increased residential property value: $10,740,000
  - Associated property tax revenue: $48,000 per year
- Reduced insurance premiums: 7%
- Reduced traffic-related disruptions: Relatively minimal in this case
- Reduced business closures: Relatively minimal in this case

Overall Benefit/Cost Ratio

1.28-1.31

Most benefits accrue to private sector

Evaluation of Private Property Investments in First Street

Costs:

- Capital Costs: $960,000
- Operations & Maintenance Costs: $70,000 per year

Benefits:

- Reduced property damage (per event): $2.8 M (hurricane)
- Reduced insurance premiums: 17%

Overall Benefit/Cost Ratio

2.79

Higher than public investments

Key Findings

- The City's investments reduce flooding on the roadways, keeping them drier and passable during King Tides, 5-year and 10-year rainstorms, and reduce flooding on neighboring properties by over 1' in some areas.
- Resilience investments are beneficial from a societal perspective in all cases. The largest benefits come from protecting property values and the City's tax base. Most benefits accrue to private property owners.
- The analysis made conservative assumptions, and we believe the benefits are underestimated. Despite this, the investments are cost-effective.

(3)
What does this mean for the City of Miami Beach?

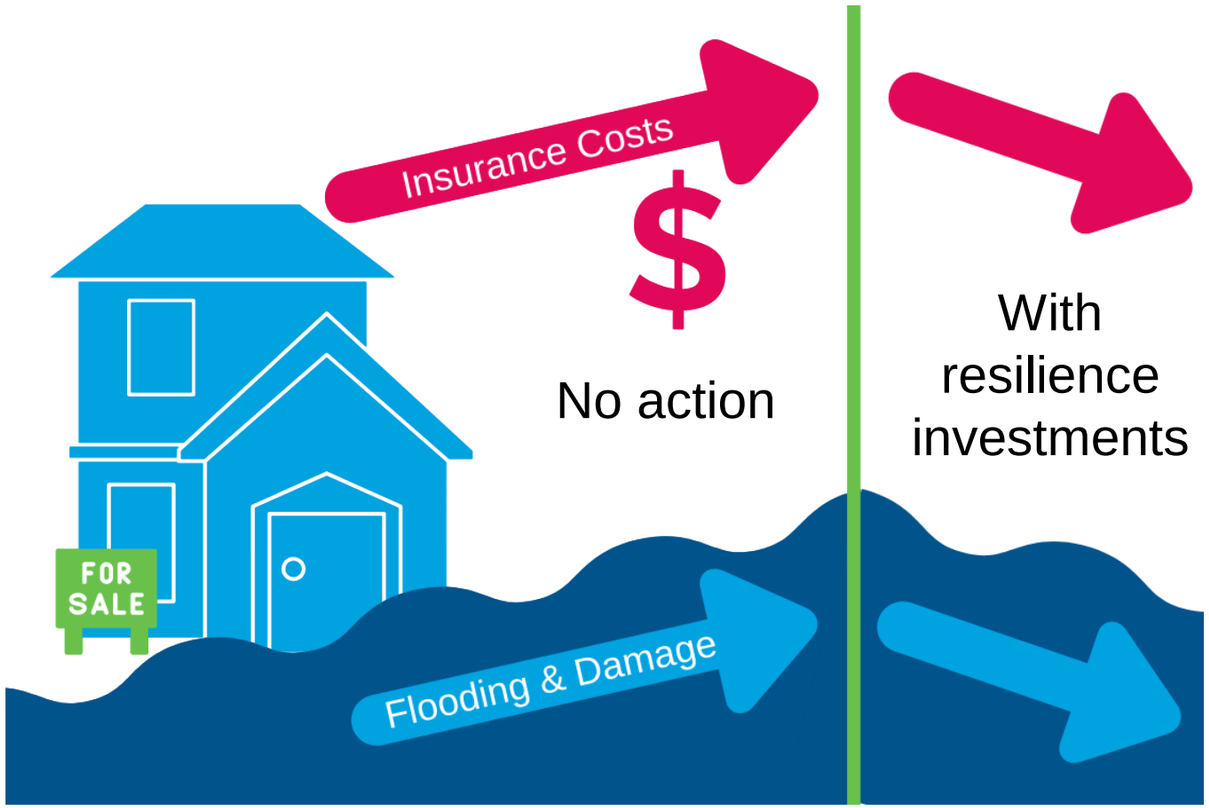
City-wide Business Case Summarized

- If the City does not invest in the stormwater program, the damages associated with sea level rise are significant.
- Investments of at least $1 billion over the next 30 years would be cost-beneficial to prevent surge-related flood damages.
- In addition, raising roads to 3.7’ NAVD across the city could conservatively increase property values citywide by over $1 billion in assessed value.
  - This is a $6.6 million annual increase in tax revenue to the city.
- Therefore, city-wide public and private investments of at least $2 billion would be cost-beneficial.

$2B

for road elevation and storm protection would be cost-beneficial

Insurance Impacts



- Currently, flood insurance premiums are established by FEMA and are subsidized, not reflecting the actual cost of risk.
- Insurance rates are expected to increase as FEMA sets rates that are closer to actual flood risk costs.
- Insurers work with firms like AIR to understand their expected Average Annual Losses (AAL) and set rates accordingly.
- AIR modeling shows that with one foot of sea level rise from 2013, the average annual losses from flooding will increase 96%.
- Without adaptation this could mean a near doubling in flood insurance costs.
- In First Street neighborhood, public and private investments would decrease AAL by 7% and 17%, respectively.

Conclusions & Next Steps

What Do These Investments Mean For You?

- Increased home value
- Reduced likelihood of flood damage
- Lower insurance rates

- Less flooding
- Fewer flood disturbances
- Higher property values
- More desirable

- Stronger property value base
- Well-protected citizenry
- Better qualify of life

Topline Conclusion

This pilot study has demonstrated that benefits of the City's targeted investments in stormwater and infrastructure improvements significantly outweigh their costs, and provide substantial benefits to the residents, businesses, visitors, and government of Miami Beach.

Potential Next Steps

Underway:

- Develop 4-pager and share results
- Publish hedonic analysis in peer-reviewed journal

Potential next steps:

- Evaluate business case for additional adaptation scenarios
- Create guide for homeowners with adaptation options, costs, and benefits
- Apply integrated flood modeling City-wide to evaluate the effectiveness of additional proposed infrastructure improvements
- Develop a decision-support calculator to evaluate and compare investment options

Thank you