


Coastal Resilience - Miami Beach Case Study

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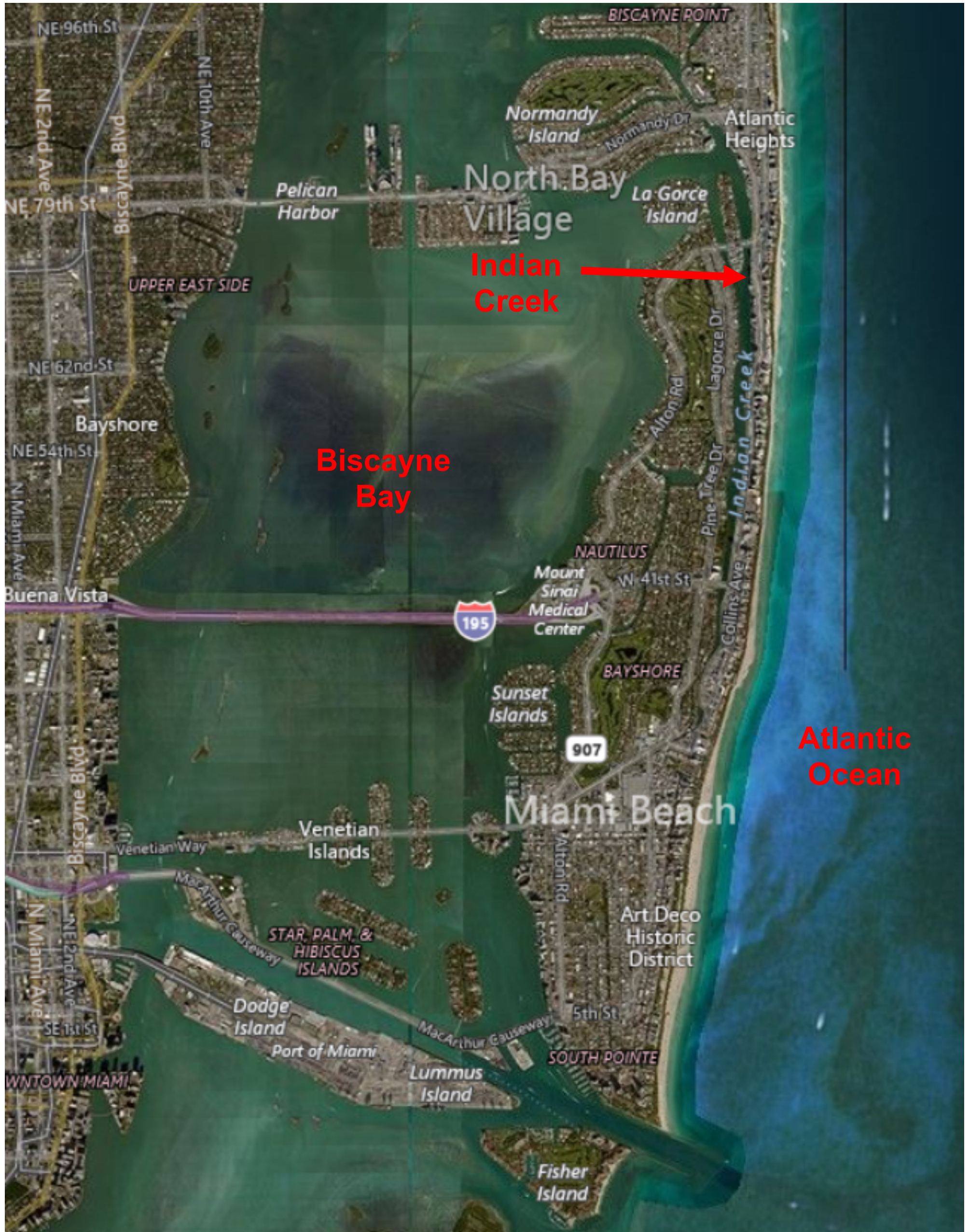
Agenda

1. Geography
2. Topography
3. Sea Level Rise
4. Challenges
5. Solutions

Miami Beach - Geography

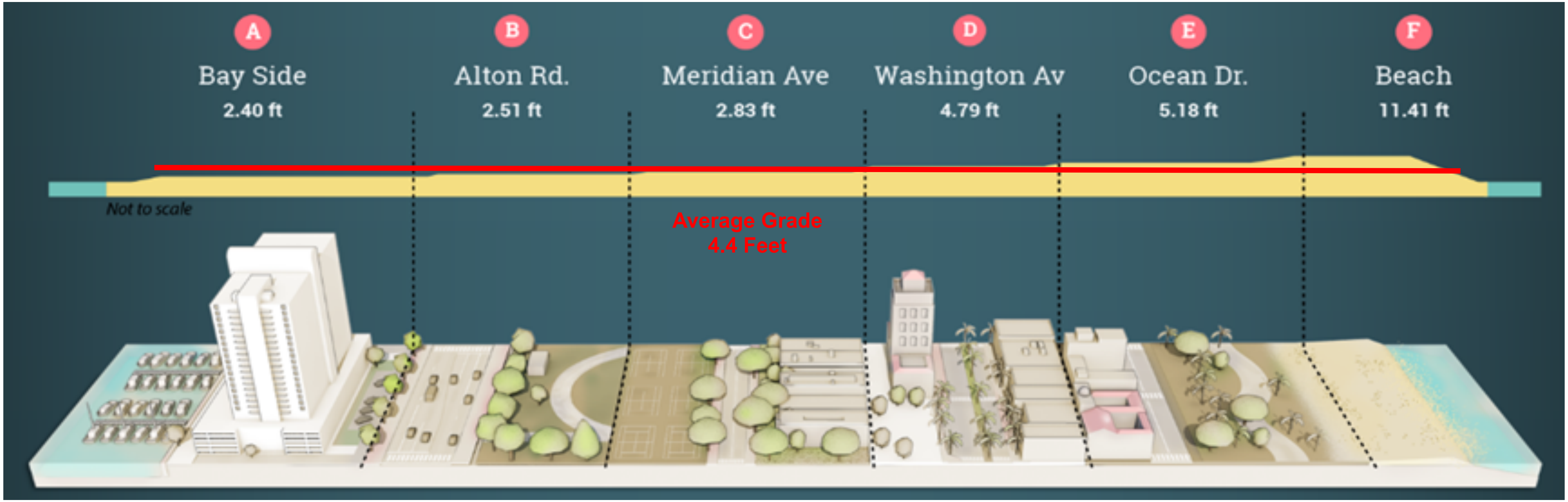
- Southeast Florida
- Barrier Island
- 7 square miles
- Historically, wetlands
- Atlantic Ocean to east
- Biscayne Bay to west
- Indian Creek in middle
- Low Elevation
- High Groundwater
- Porous Limestone



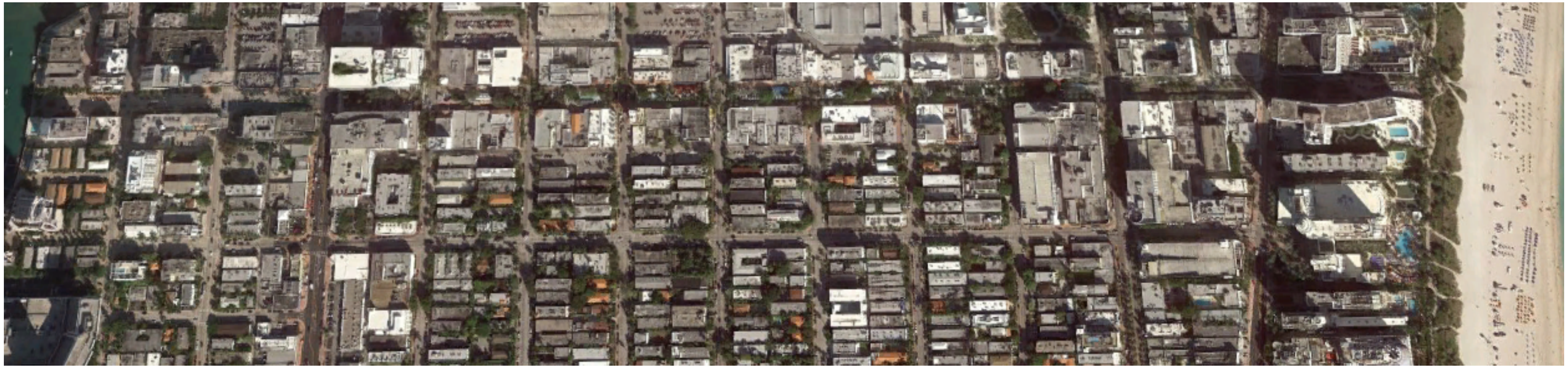
"Billion Dollar Sandbar"

Limestone

Miami Beach - Topographic Profile

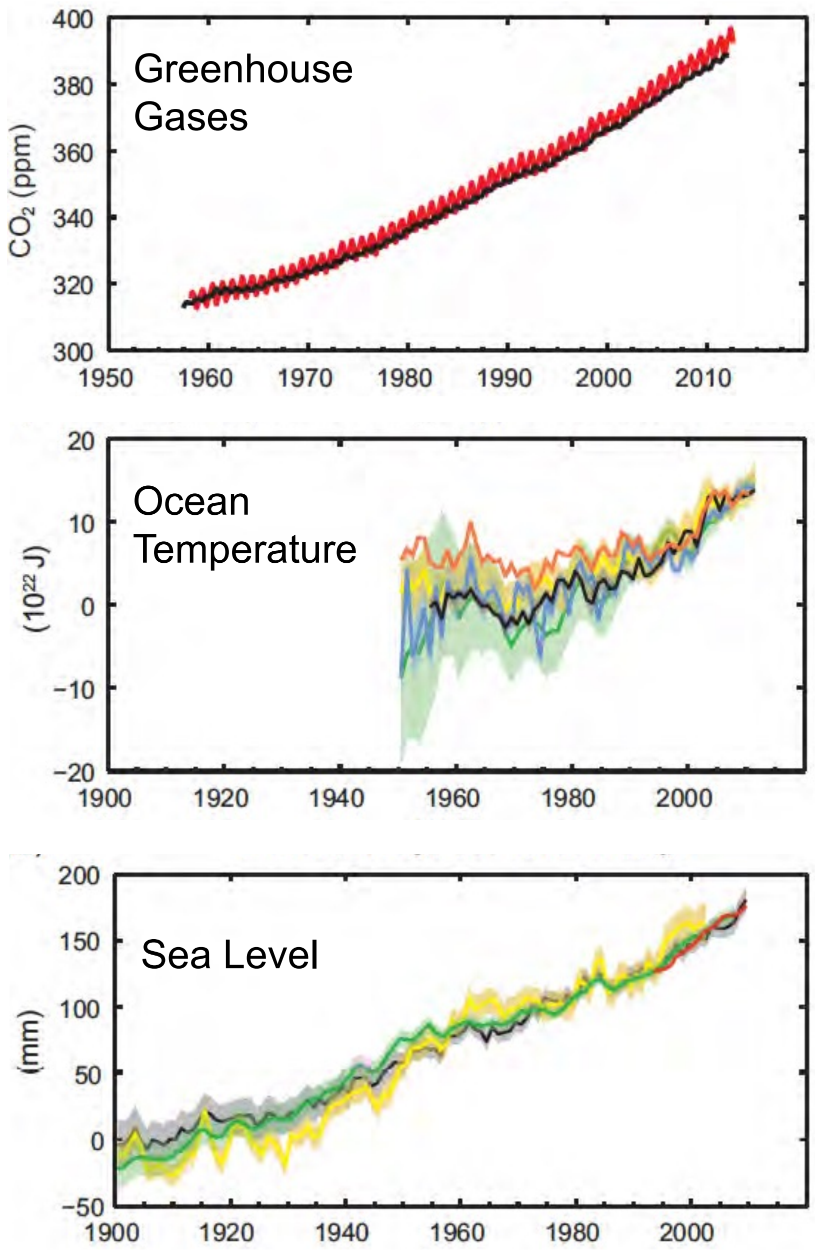


Biscayne Bay



Atlantic Ocean

Climate Change Summary



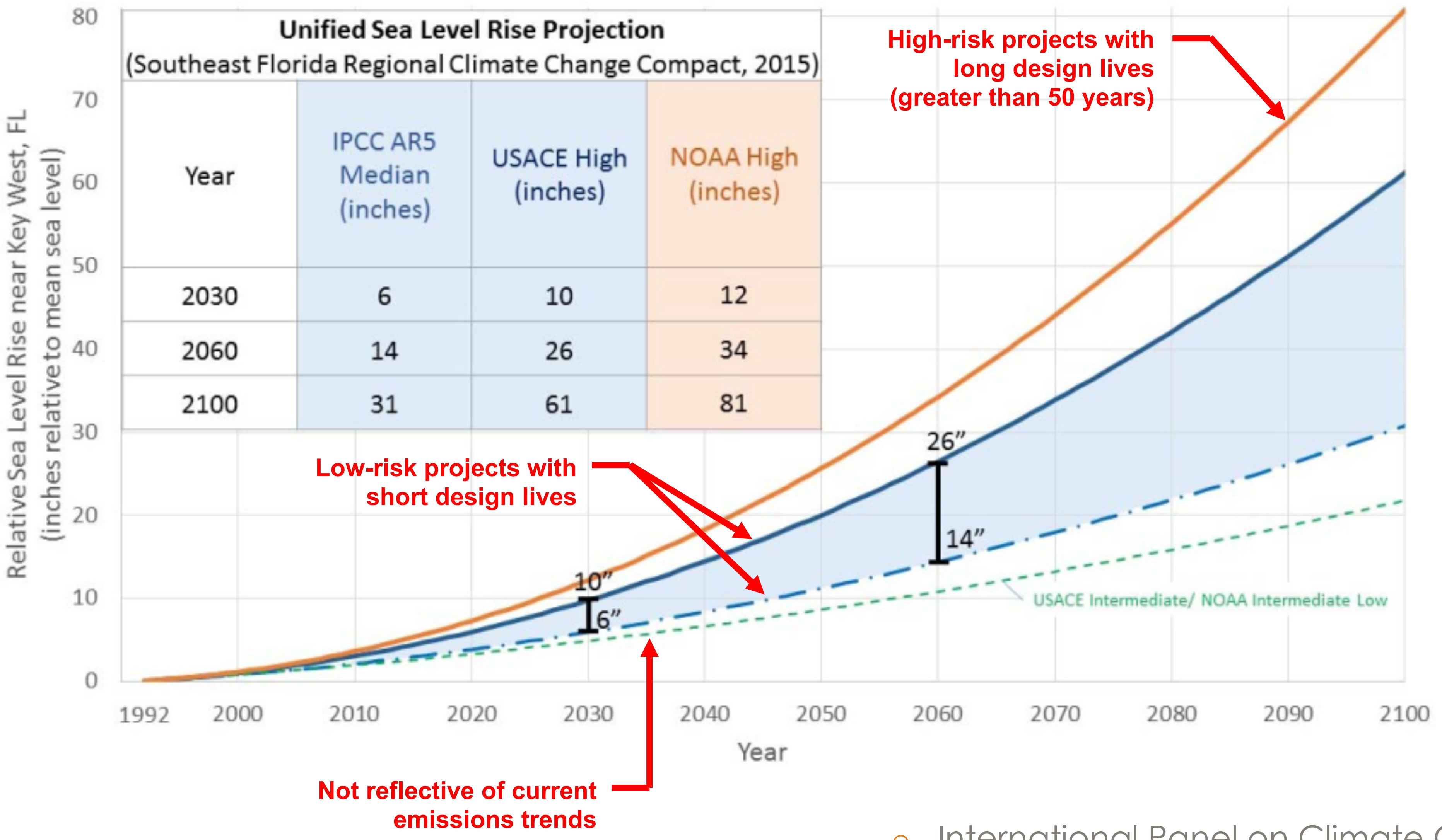
Cause

- Greenhouse gases are high and rising
- Oceans are warming
- Oceans are acidifying (reduction in pH)
- Sea levels are rising

Effect

- Temperature extremes
- Rainfall extremes
- Saltwater intrusion
- Coastal erosion and flooding
- Inland flooding and stormwater management
- Extreme storms

Sea Level Rise Projections



Year	IPCC AR5 Median (inches)	USACE High (inches)	NOAA High (inches)
2030	6	10	12
2060	14	26	34
2100	31	61	81

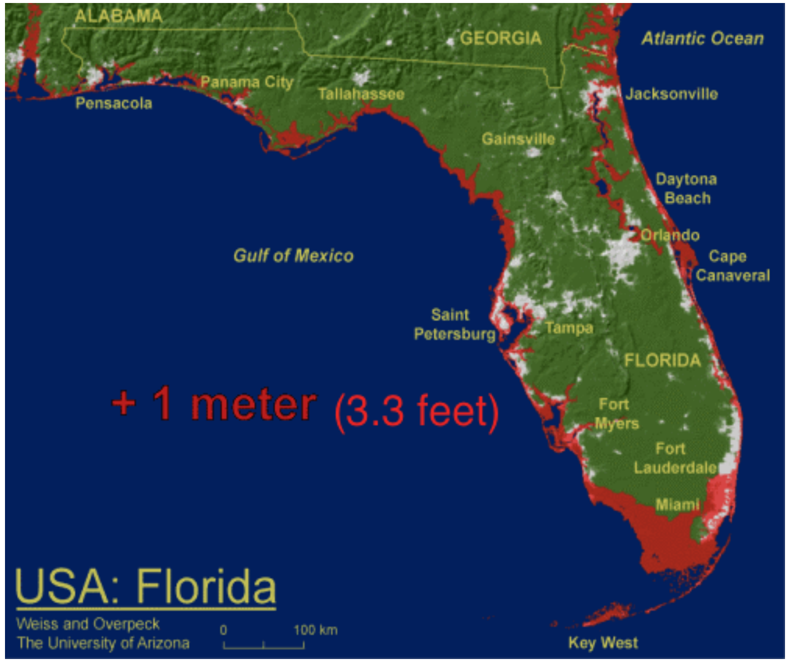
Cause
- Rising sea temperatures
- Thermal expansion of ocean
- Melting ice caps and glaciers

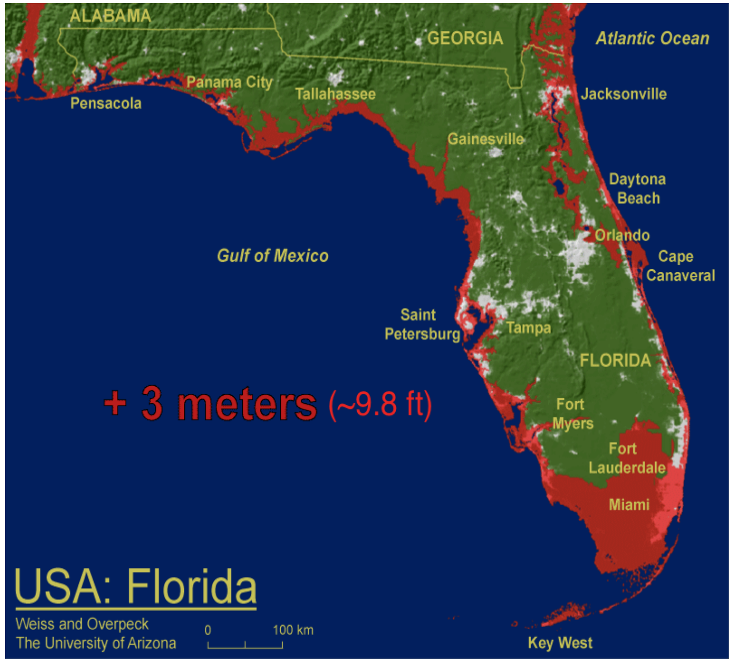
Effect
- 6-12 inches by 2030
- 14-34 inches by 2060
- 31-81 inches by 2100

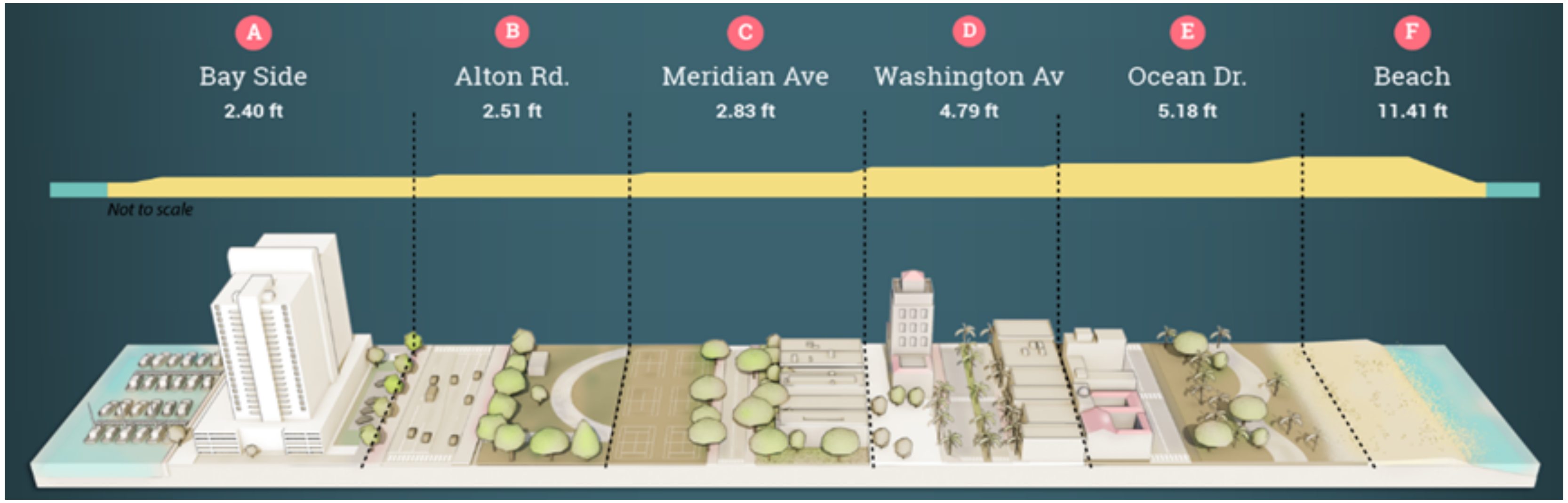
- International Panel on Climate Change (IPCC)
- United States Army Corps of Engineers (USACE)
- National Oceananic and Atmospheric Administration (NOAA)

Sea Level Rise Challenges

- Increased flooding
- Saltwater intrusion
- Impacted drinking water supply
- Environmental Concerns
- Beach Erosion
- Impacted Stormwater system
- Cost
- Politics







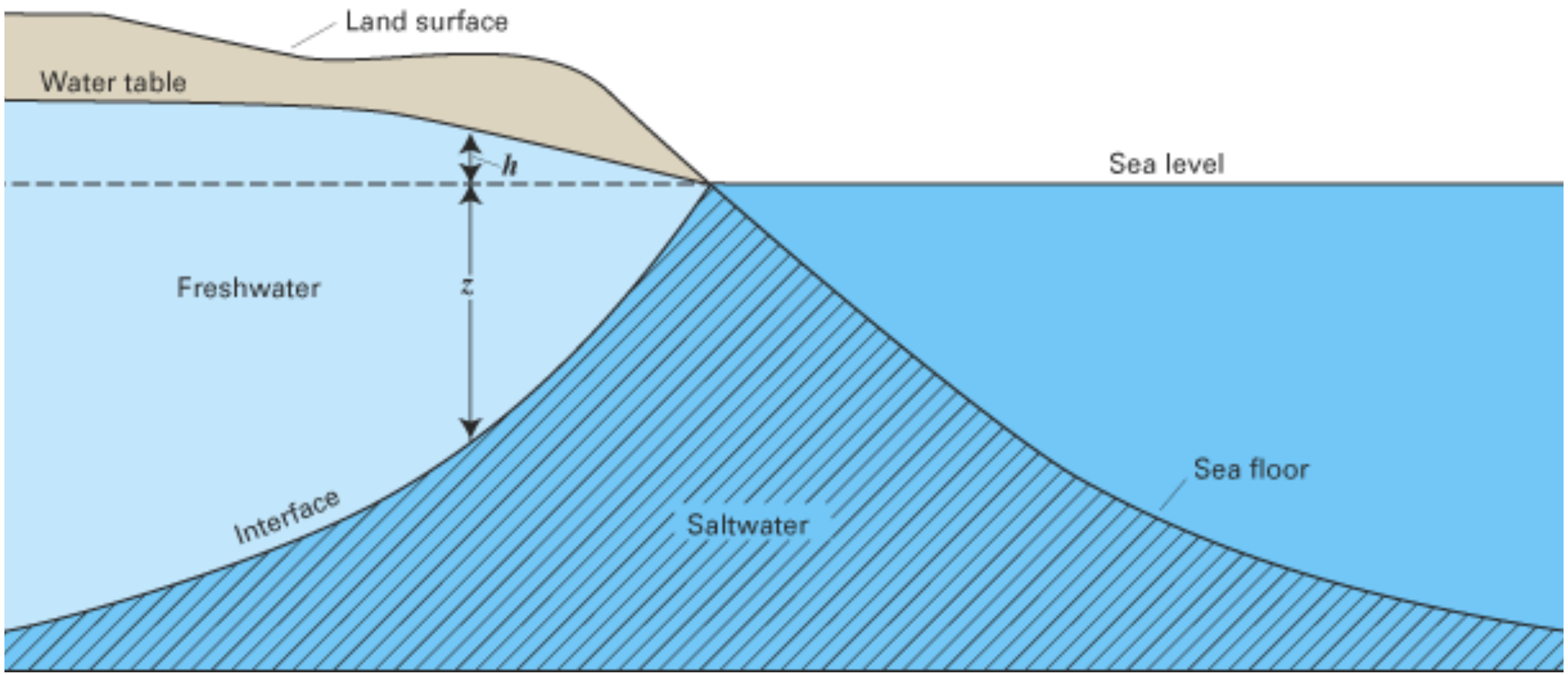
Challenge: Increased Flooding

Social Challenges
- Historic South Beach
- High value properties
- Commercial/Tourist hub

"Sunny Day" Flooding

Natural Challenges
- Low ground level
- Permeable limestone
- High groundwater
- High tides
- Sea level rise
- Tropical storms

Challenge: Saltwater Intrusion

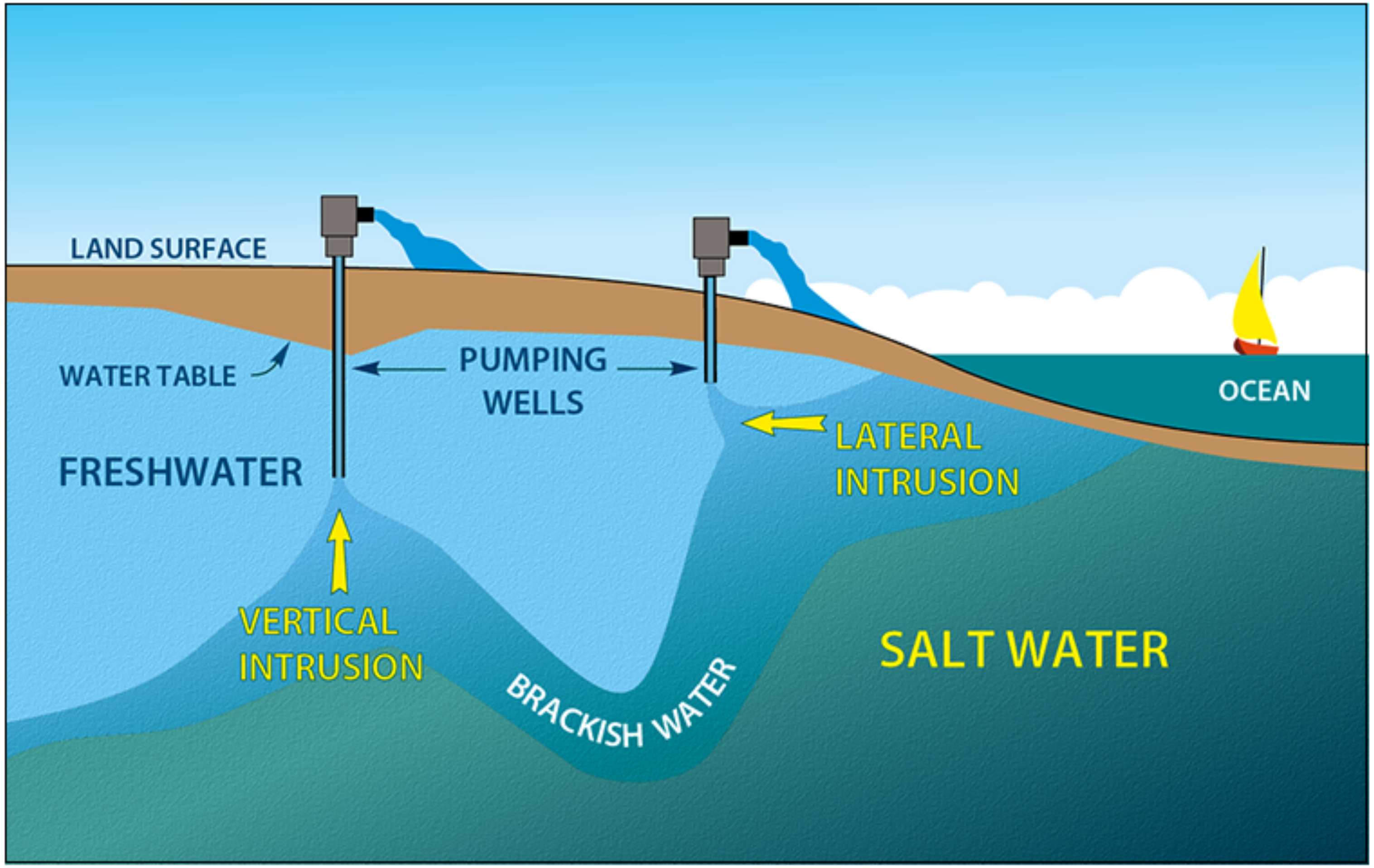


Causes

- Draining of the Everglades
- Pumping of groundwater
- Droughts
- Drainage canals
- Permeable limestone
- Sea Level Rise

Challenge: Drinking Water Supply

Sea level rise + population growth = threatened urban water supply

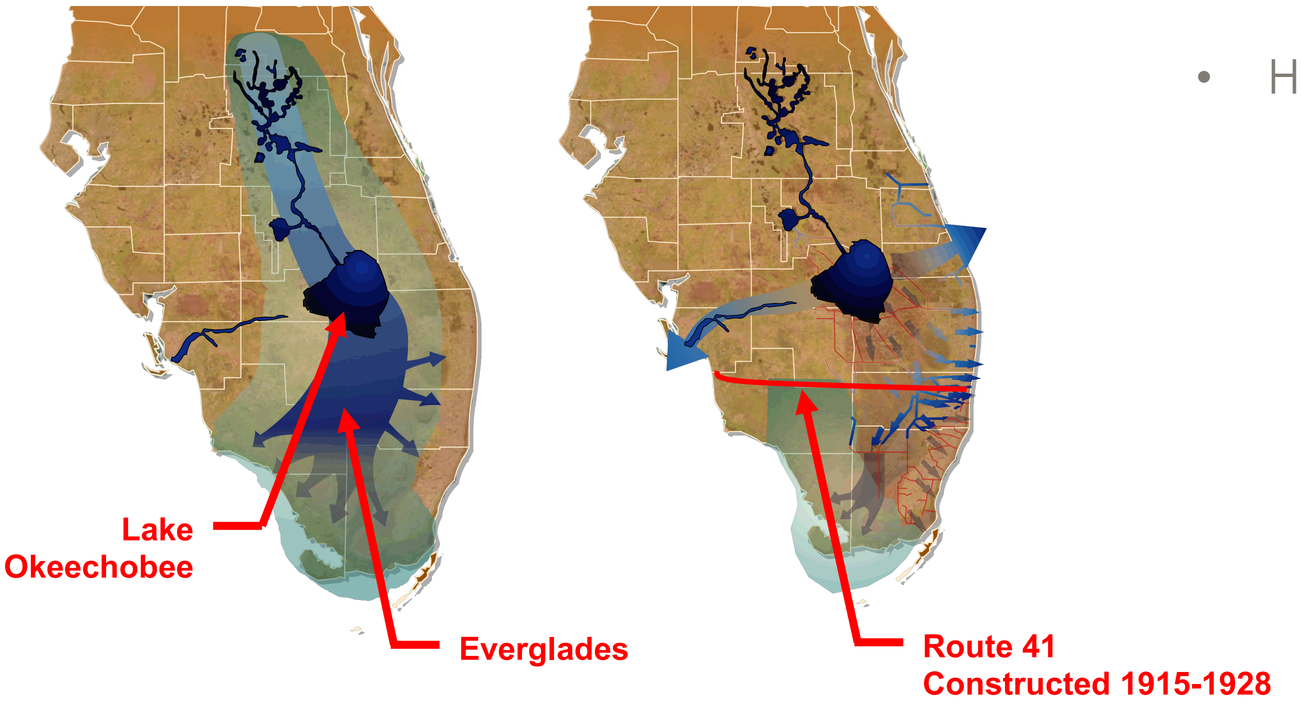


In 2010
- Population = 5.6 million
- Water demand = 1.8 billion GPD

By 2030
- Population = 6.6 million
- Water demand = 2.1 billion GPD

Challenge: Environmental Concerns

Historic Flow **Current Flow**



Challenges

- Salt water intrusion into freshwater ecosystems
- Ecological imbalance in the Everglades
- Habitat change impacting many native species

Challenge: Beach Erosion

Challenges

- Miami Beach is out of sand
- Sensitive coral reefs restrict off-shore dredging
- Color and texture must match existing
- Nourishment is needed often
- Most expensive land is typically along beach

Miami Beach spends ~ $6 Million annually on beach restoration.

Challenge: Stormwater System

- High volume of water
- Nutrient loading
- Turbidity
- Water velocity
- Land ownership
- Impacts to seagrass
- Impacts to wildlife

The Plan

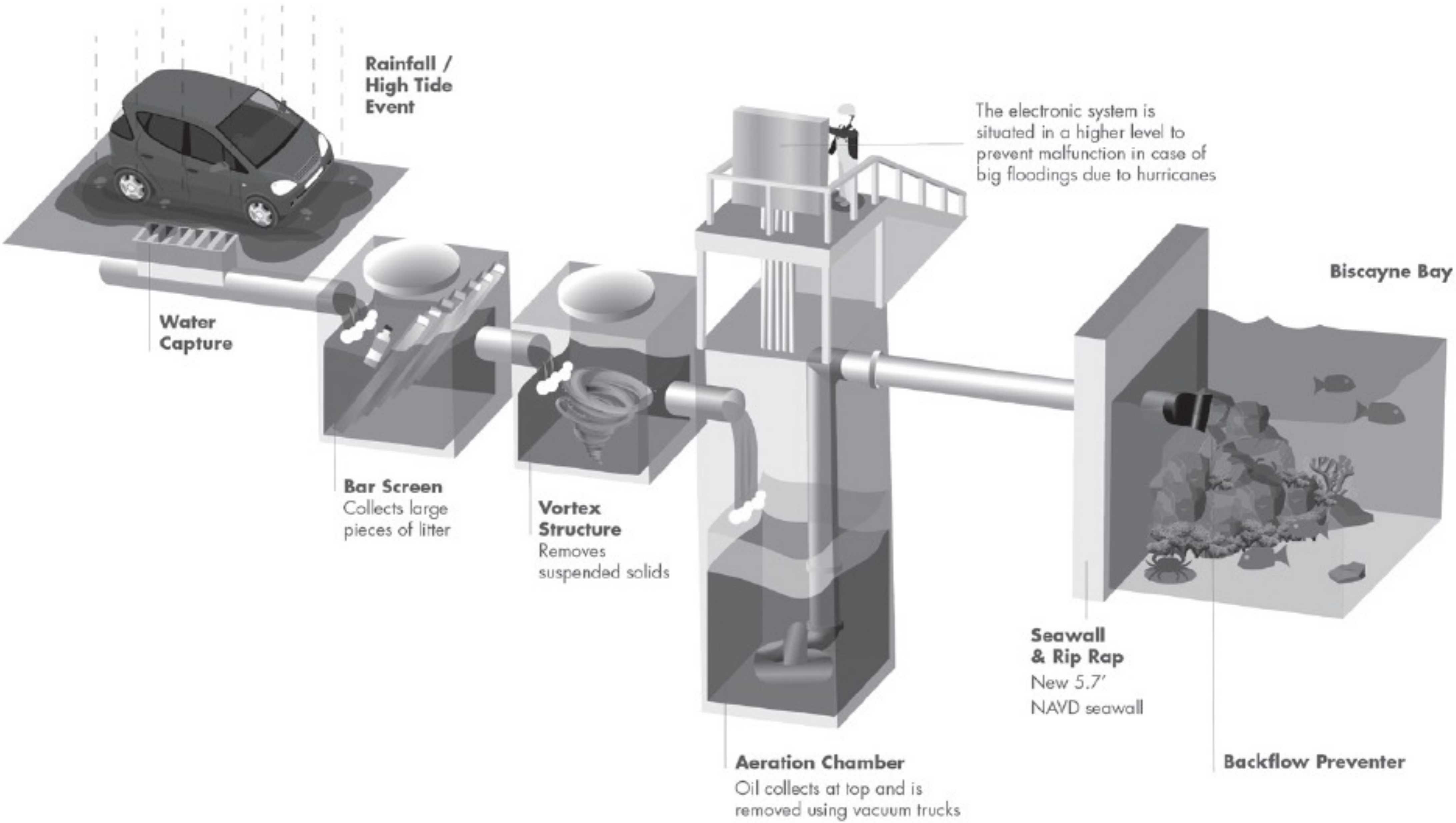
- $400 - $500 million investment
- Implement policy changes
- Upgrade stormwater management system
- Raise roadways
- Raise sea walls
- Restore beaches and dunes
- Restore water to the Everglades
- Protect mangroves
- Install shoreline protection
- Construct living shorelines
- Incentivize adaptation on private property

Solution: Policy Changes

- Increased freeboard
- Reduced impervious cover
- Building height allowances
- Elevated lot grades
- Incentivized private resiliency
- LEED
- Integration of LID
- Water conservation and reuse

	Existing Requirements	Proposed Requirements
Base Flood Elevation (BFE)	5.44 FT	6.44 FT
Freeboard	0 feet above BFE	+1 to +3 feet above BFE
Seawall Elevation (Private)	3.2 FT	4 to 5.7 FT
Seawall Elevation (Public)	3.2 FT	5.7 FT
Minimum required yard elevation	No minimum required	5.0 FT

Solution: Upgrade Stormwater System

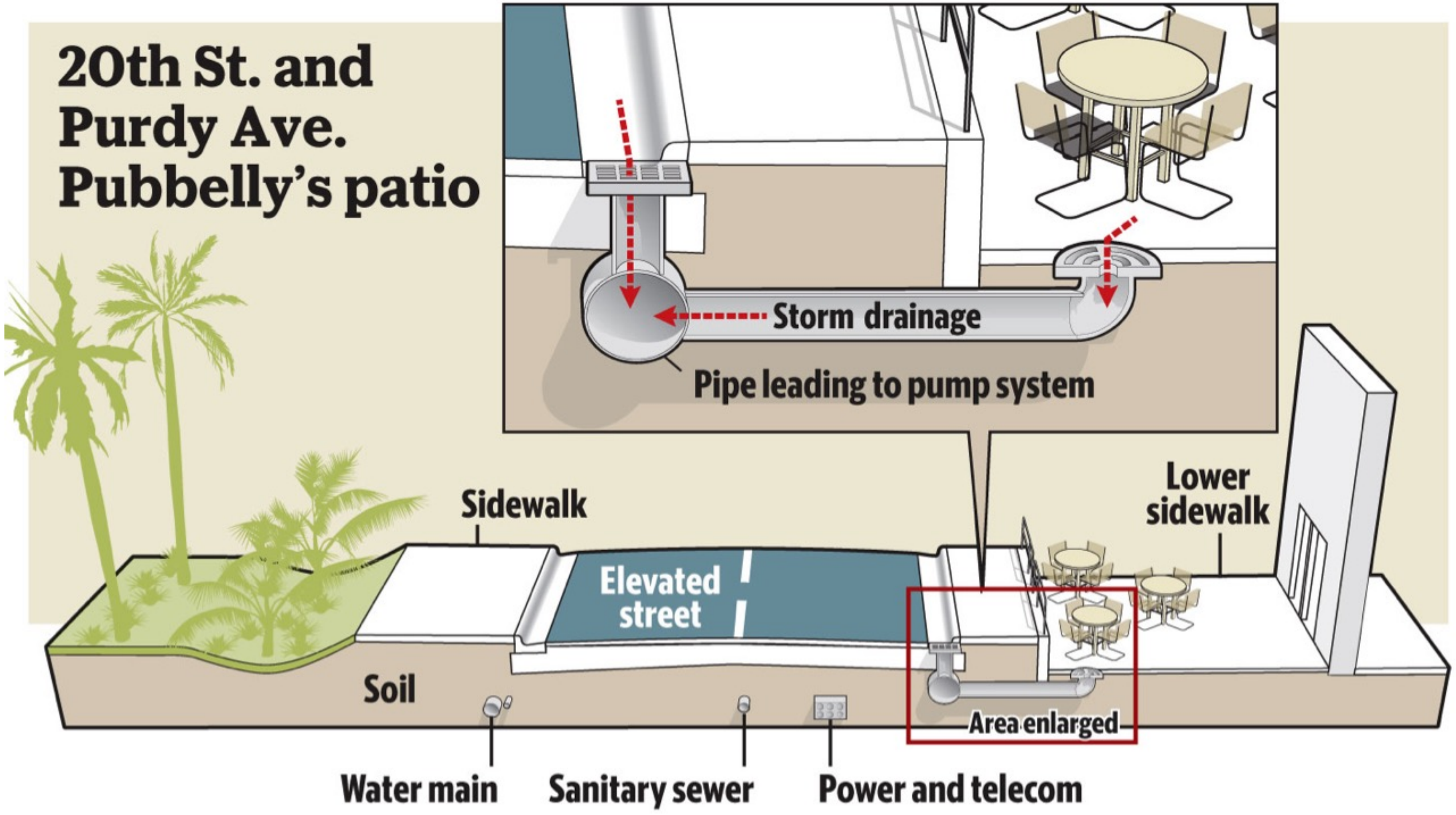


Solution: Upgrade Stormwater System

Design Considerations

- Power supply
- Water quality treatment
- Pumps
- Backflow prevention
- Manatee grates

Solution: Raise Roadways



Design Considerations

- Emergency routes
- Adjacent elevations
- ADA accessibility
- Stormwater runoff

Solution: Raise Roadways

20th Street and Purdy Avenue

Before

After

Solution: Raise Roadways

Before

After

Solution: Raise Roadways

Before

After

Solution: Raise Sea Walls

Solution: Beach Renourishment

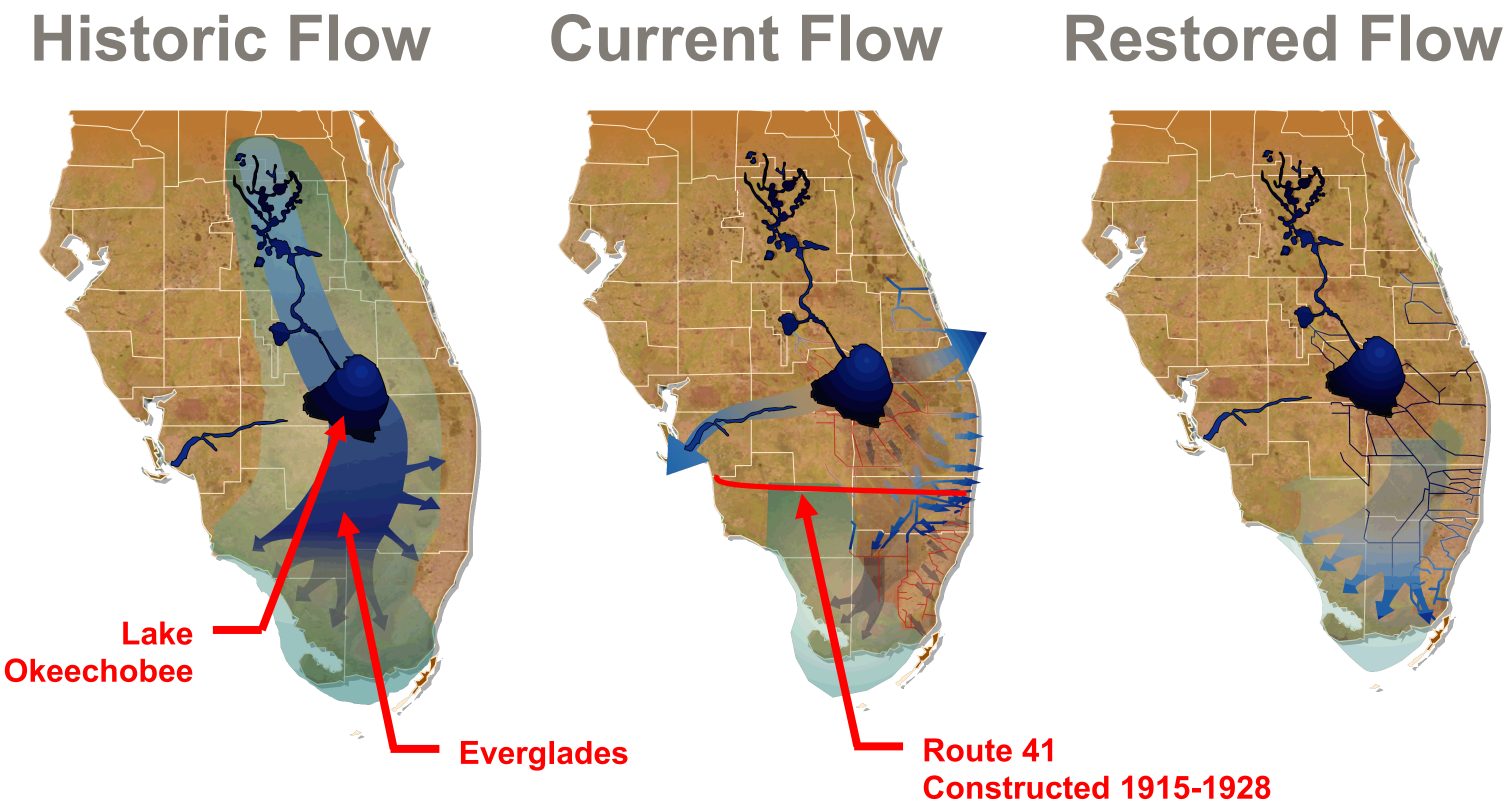
Need

- Protect infrastructure
- Preserve wildlife
- Support economy
- Build coastal resiliency

Design Considerations

- Remediation techniques
- Design for future
- Source of sand
- Disruption
- Cost

Solution: Restore Water to Everglades



- Increase water storage
- Restore freshwater flows
- Push back saltwater
- Secure drinking water
- Prevents peat collapse
- Protect water quality
- Protect soils, mangroves
- Protect native species
- Protect native wildlife
- Prevent barriers to wildlife movement

Everglades restoration will increase the resilience of the natural & built ecosystem

Solution: Protect Mangroves

- Increases drag on water motion
- Absorbs wave action
- Traps sediment in roots
- Tolerates salty soil
- Enhances juvenile fish nurseries
- Stores substantial amount of Carbon

Solution: Install Shoreline Protection









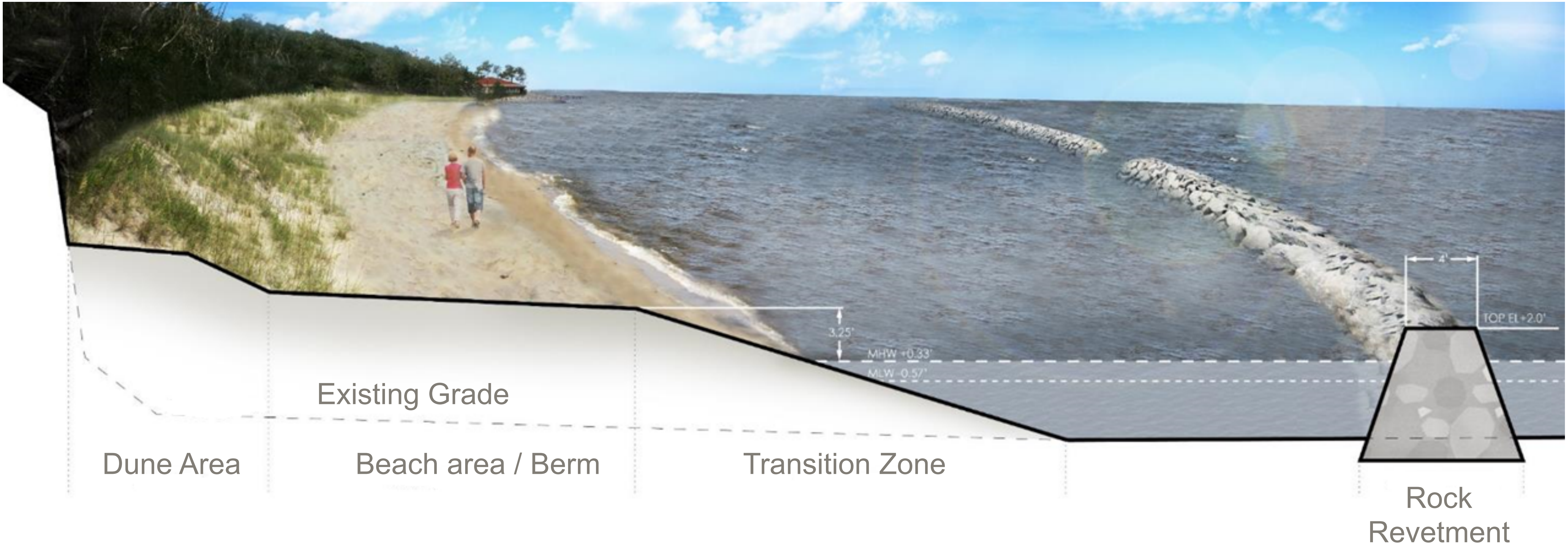
Solution: Install Shoreline Protection

Living Shorelines

- Stabilization of the shoreline
- Protection of surrounding intertidal zone
- Improvement of water quality
- Creation of habitat

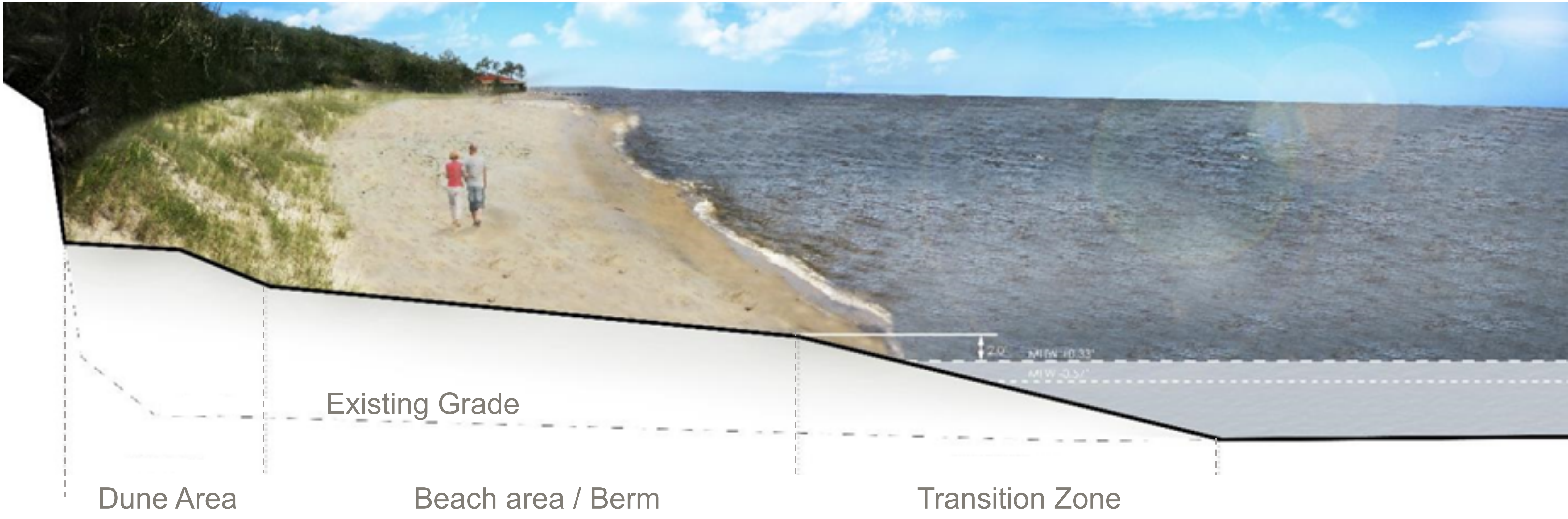
Solution: Install Shoreline Protection

Living Shoreline with Rock Breakwater



Solution: Install Shoreline Protection

Beach Fill and Dune Creation



Solution: Install Shoreline Protection

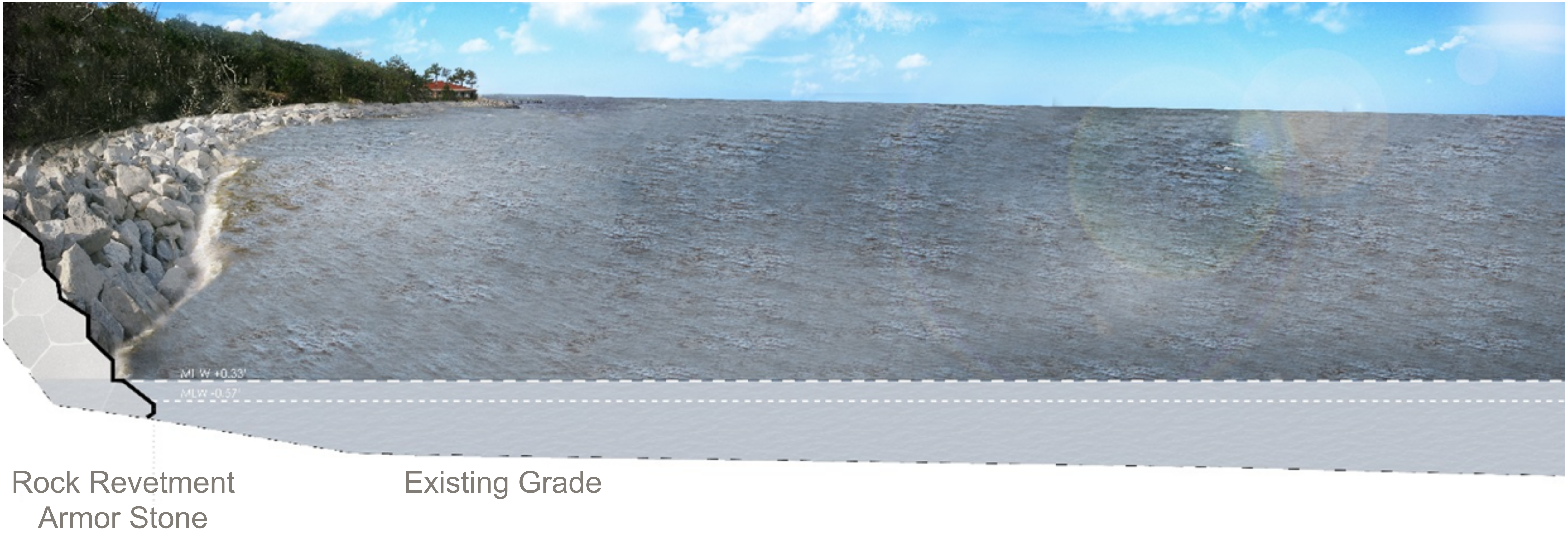
Living Shoreline with Vinyl Sheet Pile Breakwater

Solution: Construct Living Shorelines

Living Shoreline with Concrete Breakwater

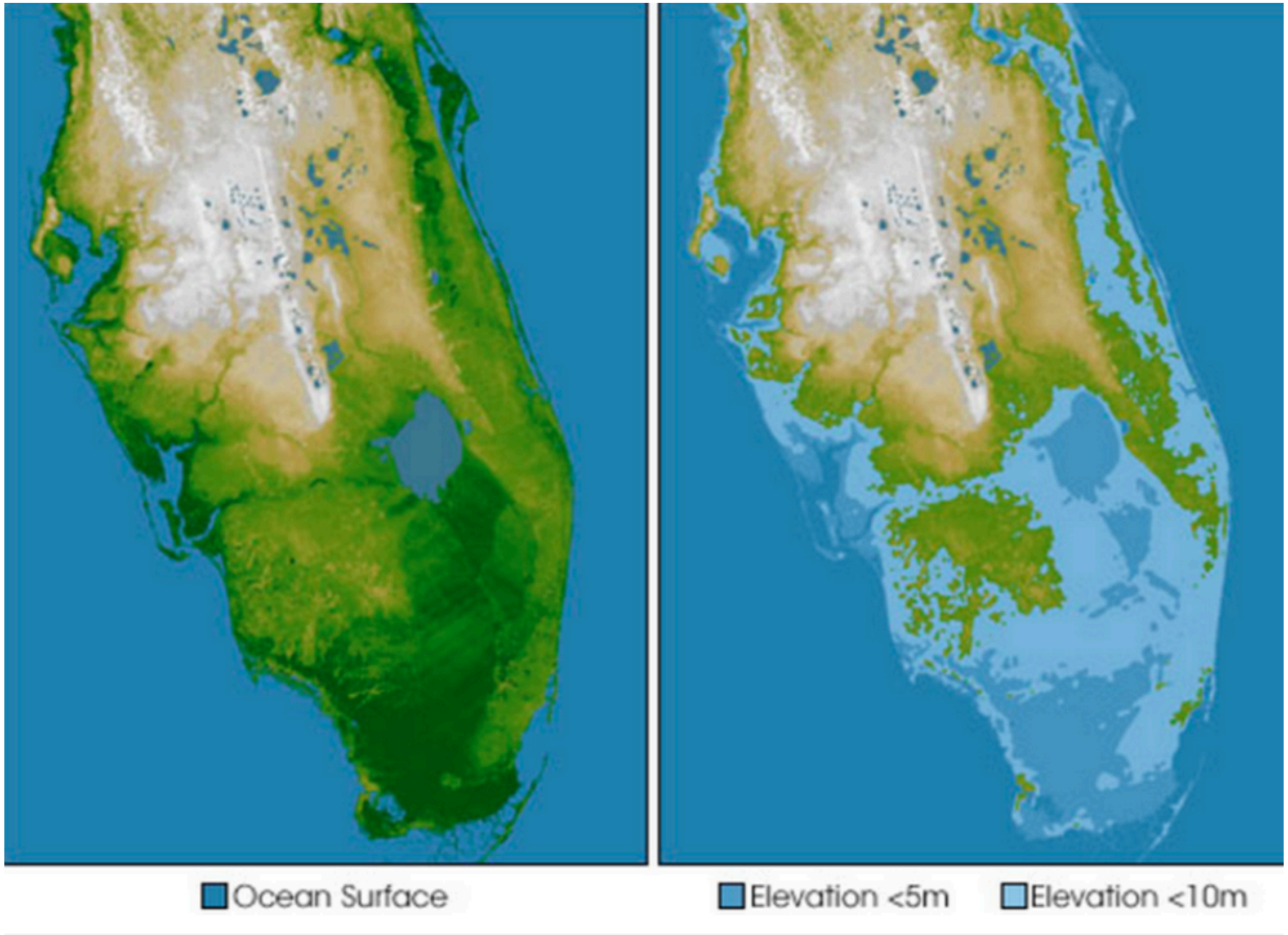
Solution: Construct Living Shorelines

Rock Revetment



Conclusions

- Sea levels will continue to rise
- Projections will improve over time
- Adaptation strategies exist
- Education is key
- Invest in codes and standards
- Being proactive is more affordable
- Partnerships are necessary
- Sustain resources, buy us time to adapt



THANK YOU

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