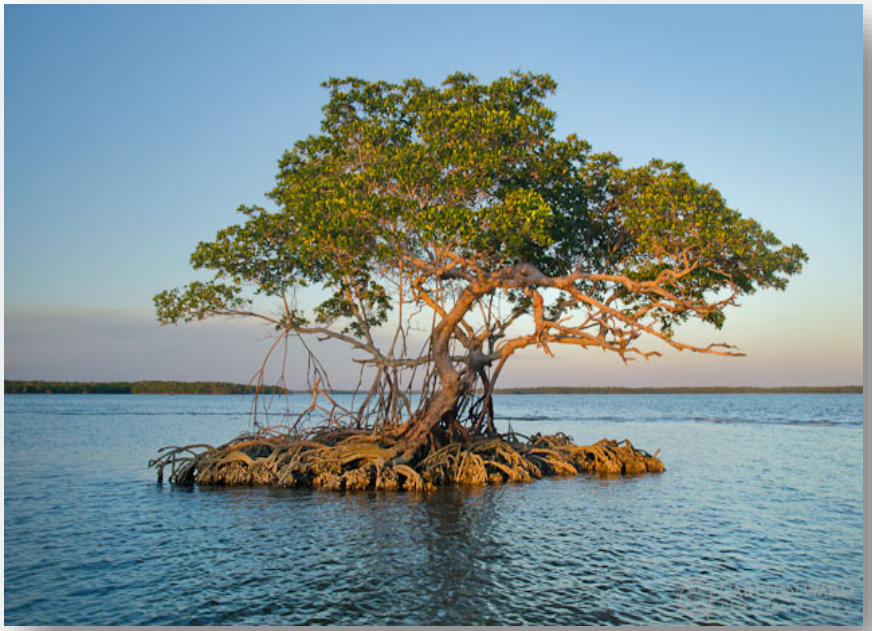
SEA LEVEL RISE IN THE FLORIDA KEYS

INFRASTRUCTURE VULNERABILITY FOR 2030 AND 2060



6th ANNUAL SE FL CLIMATE SUMMIT

Rhonda Haag
Sustainability Director
Monroe County

SUSTAINABILITY AND CLIMATE MILESTONES

YEAR 2007-2011

- US Mayor's Climate Agmt
- Green Building/Green Initiatives Task Force
- EECBG Grant
- Climate Change Adv Comm
- Sustainability Vision Stmt
- GHG Inventories
- SLR Scenarios @ 1, 2 & 3'

YEAR 2012

- EAR for Comprehensive Plan (Energy & Climate Element)
- Communitywide GHGs
- Energy Study for County GHG reductions
- Compact's Regional Climate Action Plan

YEAR 2013

- Monroe County Climate Action Plan
- Sustainability Action Plan Started

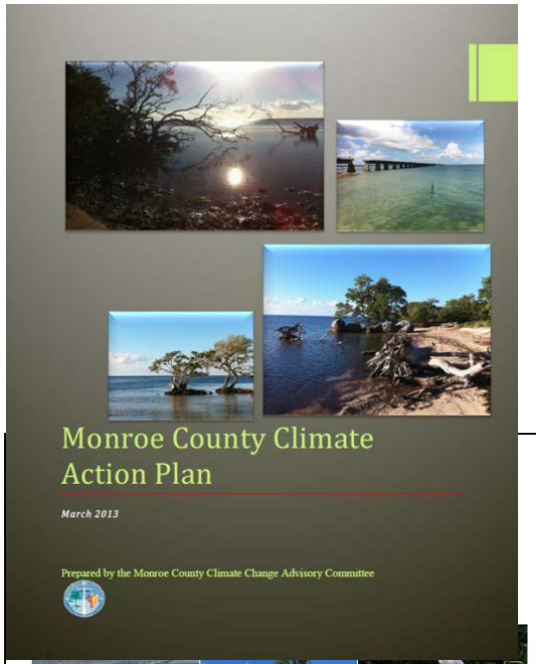
YEAR 2014

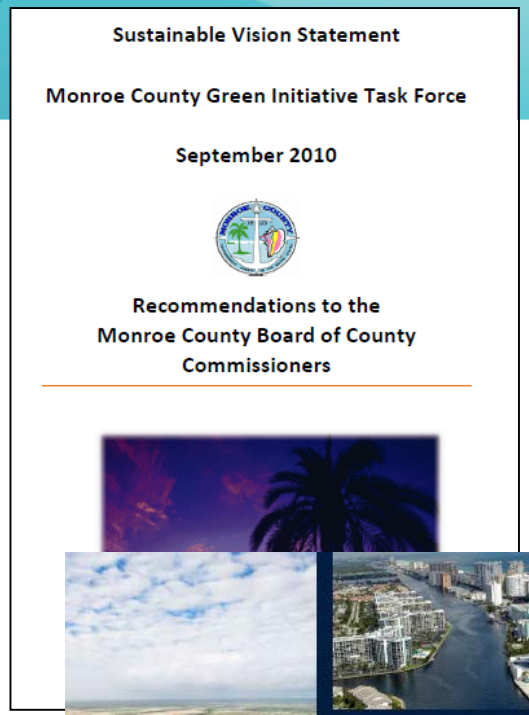
- GreenKeys! Launched
- SLR Data collection
- SLR modeling for 2030 and 2060
- Community SLR Modeling
- Community Outreach
- Plan Development

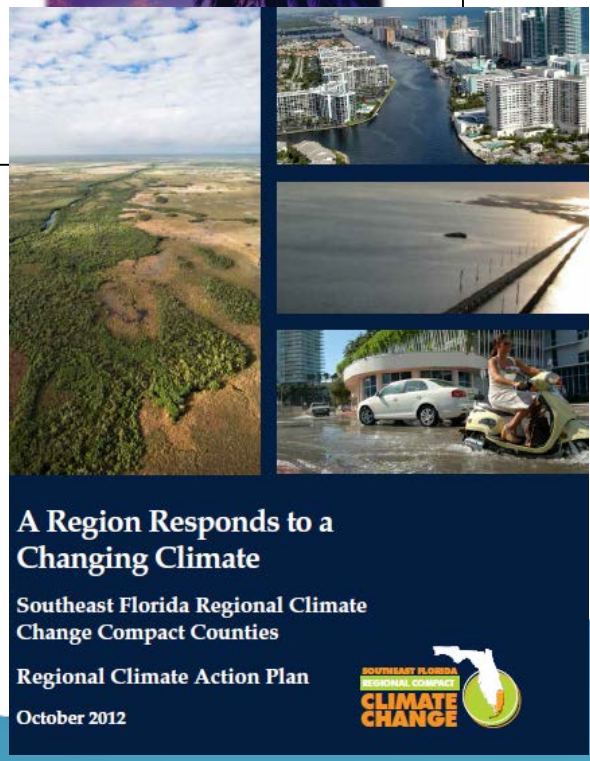
YEAR 2015

- Finalize GreenKeys! 5-year Sustainability Plan
- Begin implementation of Recommendations

PREVIOUS INITIATIVES ADDRESSING ENERGY AND CLIMATE







Monroe County 2010-2030 Comprehensive Plan

OVERVIEW OF GREENKEYS! PLANNING PROCESS

GreenKeys!

A Plan to Create a Sustainable Florida Keys

CLIMATE:
Forecasting Tools & Modeling

SUSTAINABILITY
ENERGY SAVINGS

County Assets
Infrastructure
Habitat

Community Impacts

Government Operations
Natural Systems
Built Environment
Health & Safety
Education, Arts & Community
Economy & Jobs
Equity & Empowerment

DUAL TRACK FOR PROJECT DEVELOPMENT

CLIMATE

- Data Collection
- Analyze Impacts
- Review, Recommend and Strategies

Public and Staff Involvement

SUSTAINABILITY

- GHG Data Collection & establish sustainability "baseline"
- Analyze Benefits
- Review, Recommend and Prioritize Strategies

Public and Staff Involvement

PRESENT PLAN AND RECOMMENDATIONS TO BOCC

GREENKEYS! A PLAN TO CREATE A SUSTAINABLE FLORIDA KEYS

THE PROJECT TEAM

Erin L. Deady, Esq., AICP, LEED AP

Jason Evans, PhD, Stetson University

Chris Bergh, The Nature Conservancy

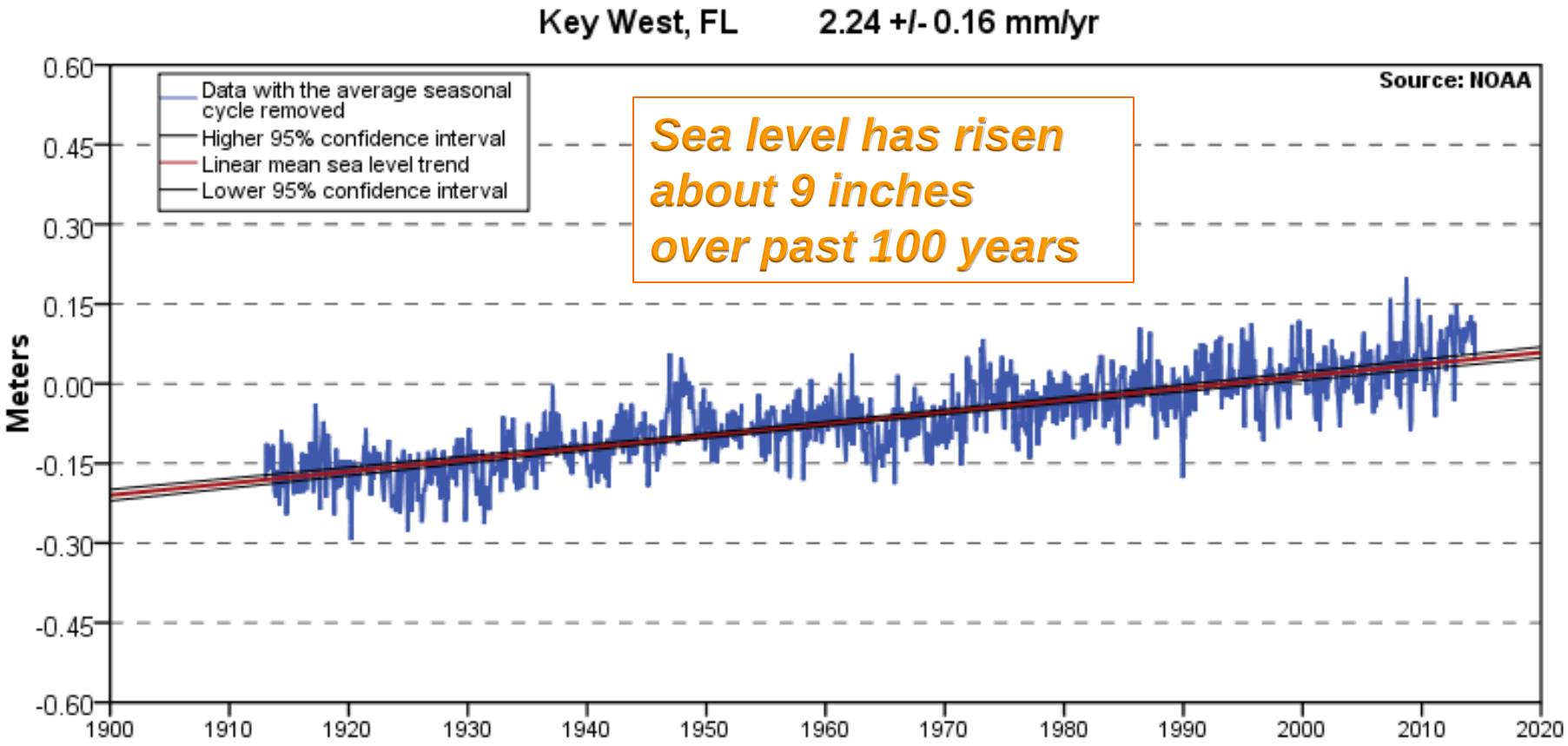
VHB/Miller Sellen

Catalysis Adaptation Partners

Quest Ecology

EcoSmart

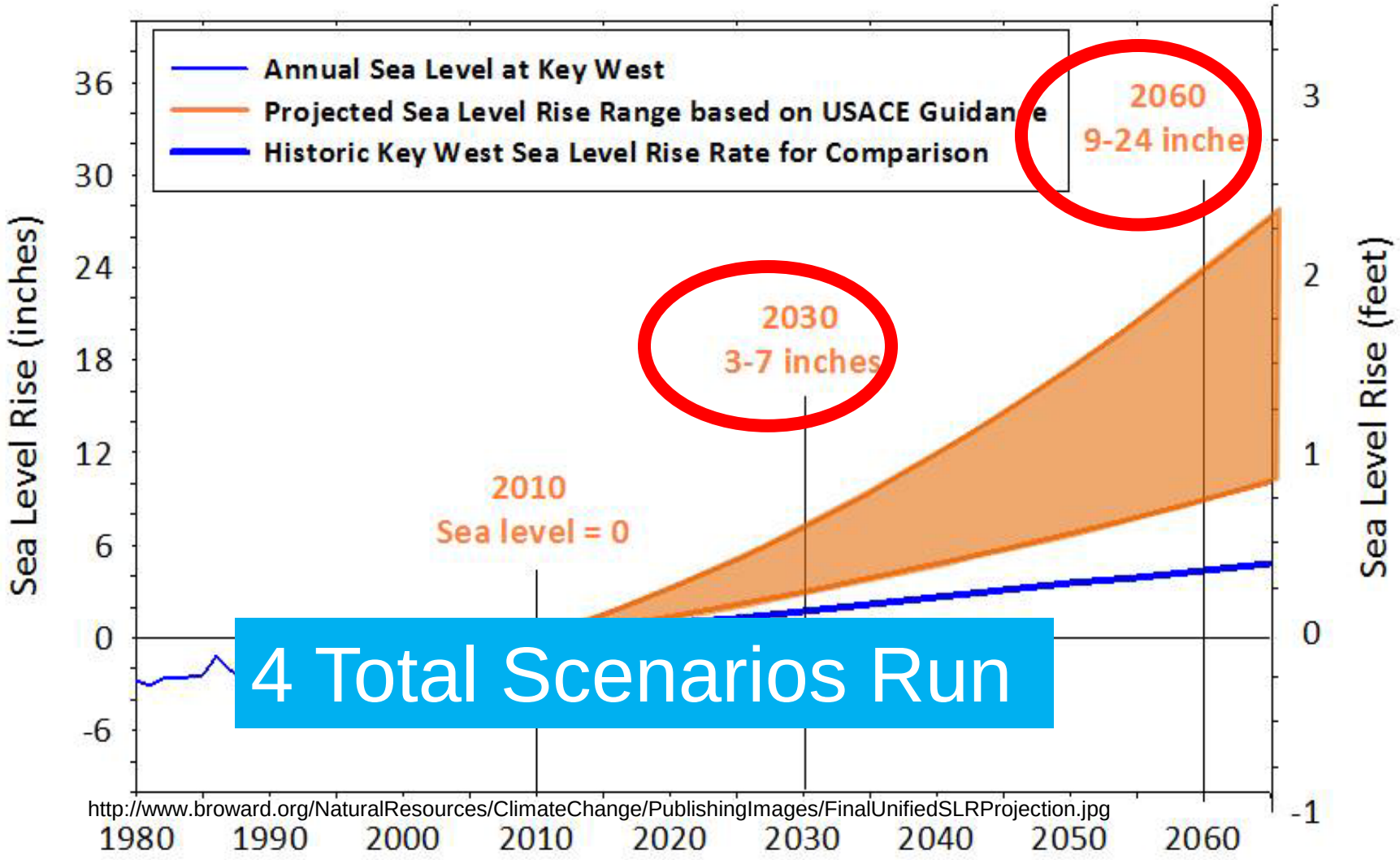
SEA LEVEL RISE IN MONROE COUNTY



NOAA KEY WEST TIDE GAUGE

SEA LEVEL RISE SCENARIOS

Adopted by Southeast Florida Regional Climate Compact



4 Total Scenarios Run

http://www.broward.org/NaturalResources/ClimateChange/PublishingImages/FinalUnifiedSLRProjection.jpg

THE BURNING QUESTIONS RELATED TO SEA LEVEL RISE

1. **What impacts to County assets, infrastructure and habitat will occur from sea level rise in 2030 (at 3” and 7”) and in 2060 (9” and 24”)?**
    - **Today’s presentation**
2. **How can the County address those impacts?**
    - **Next phase of analysis**

THE APPROACH TO THE ANALYSIS: WHAT SEA LEVEL RISE IMPACTS ARE EXPECTED WHEN?

Step 1

- Analyze what's been done & DETERMINE "GAPS"
- De
  ro

to

Step 2

- C
  w

Step 3

- A
- W
  M

No single analytical tool can determine individualized sea level rise impacts to Monroe County habitat and infrastructure. Team used multiple analytical tools and approaches

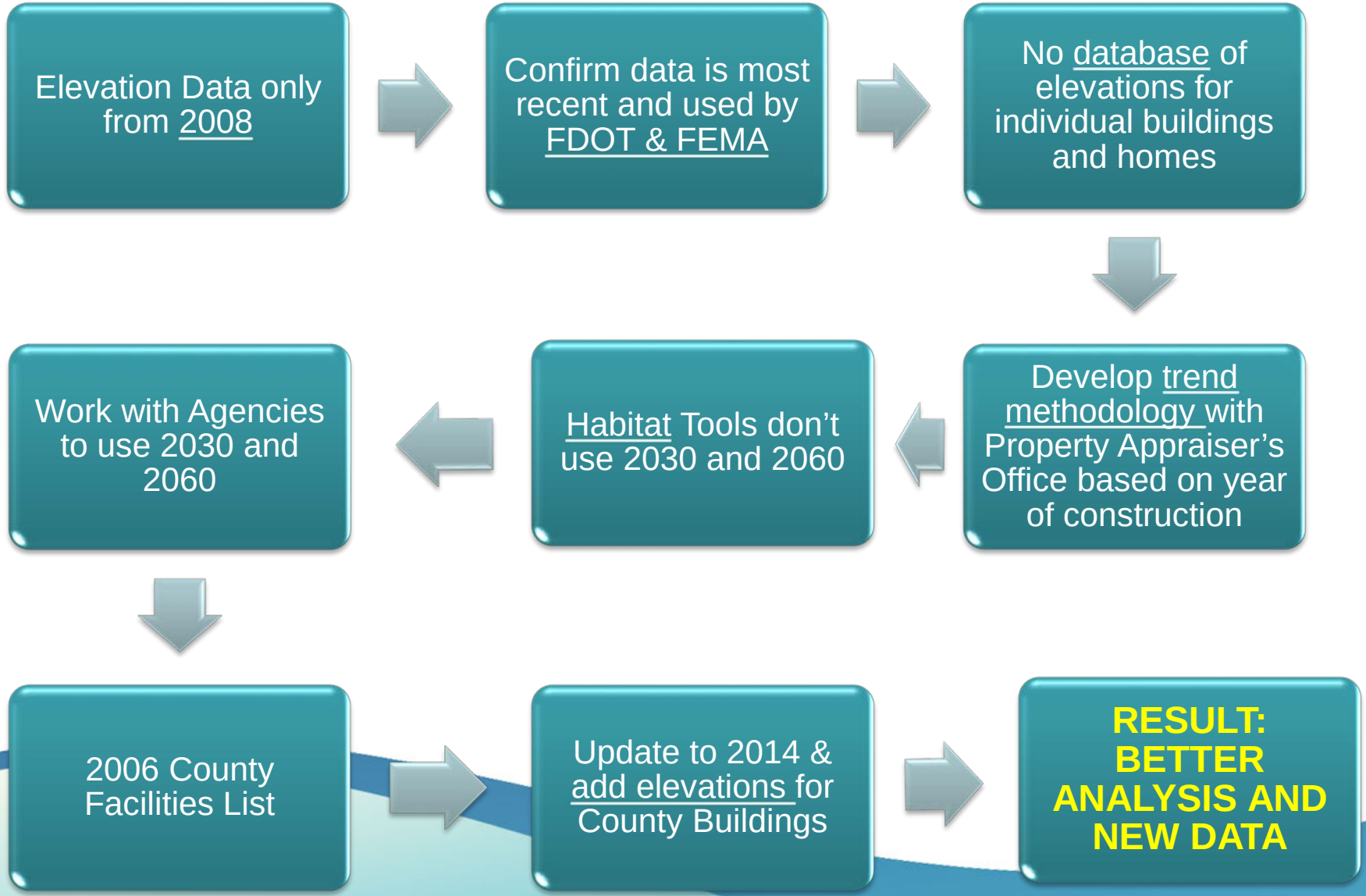
Step 4

- Confirm use of best tools to show COUNTY-SPECIFIC IMPACTS
- Use TOOLS that have support of agencies / organizations
- Provide feedback and IMPROVE TOOLS AND INPUTS

SOURCES OF DATA AND TOOLS TO ANSWER THE QUESTION: "WHAT SEA LEVEL RISE IMPACTS ARE EXPECTED WHEN?"

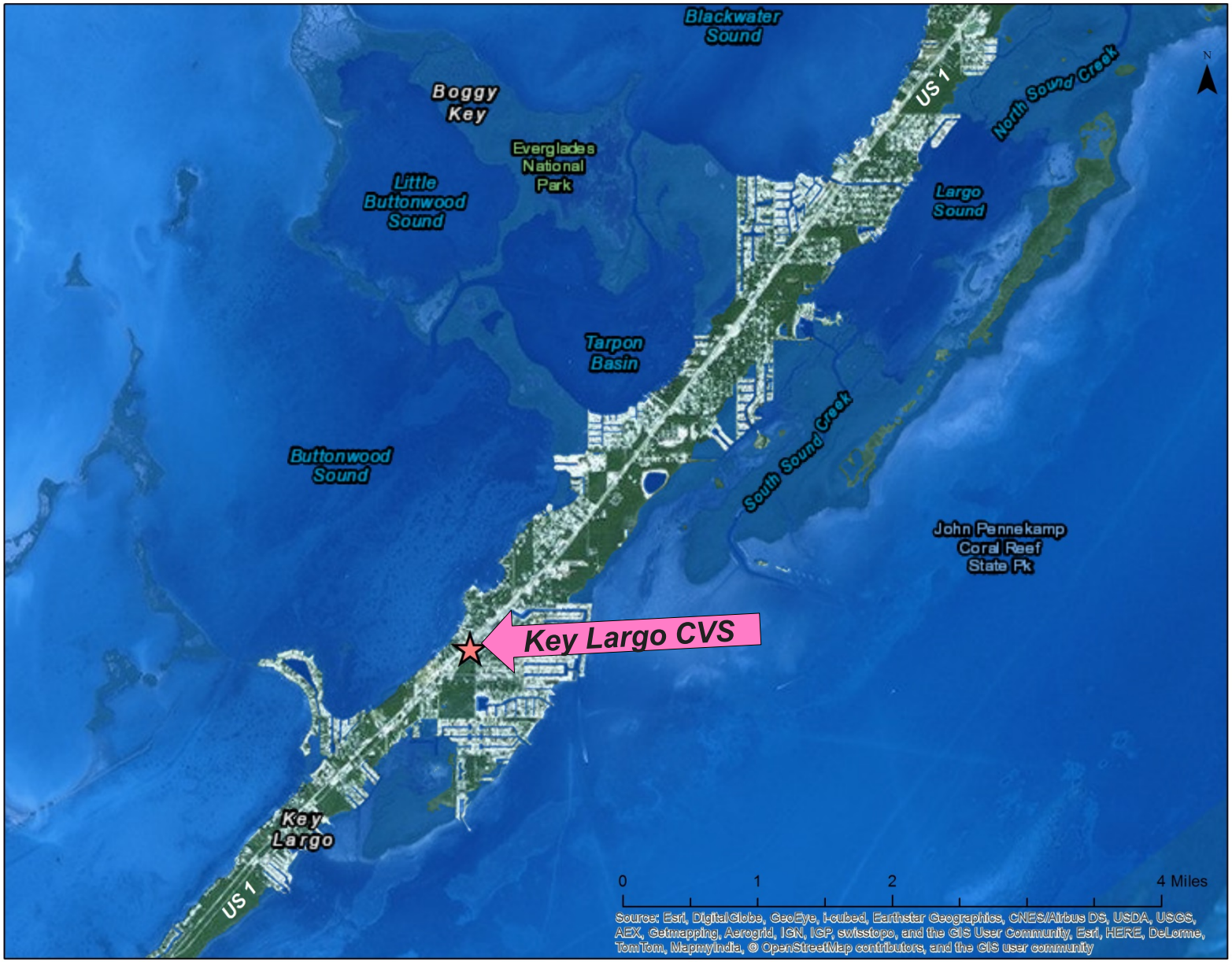
Nuisance Flooding	• NOAA Digital COAST 2030 and 2060 scenarios
Water/ Wastewater	• FKAA As Built Drawings and GIS 2030 and 2060 scenarios
Water Supply	• USGS Integrated surface - groundwater model to determine saltwater intrusion impacts for wellfields at 2030 and 2060
Roads	• FDOT Sketch Tool and County Pavement Condition Index (2014) 2030 and 2060 scenarios
Habitat	• Sea Level Affecting Marsh Model ("SLAMM"), the Florida Cooperative Land Cover Classification ("FCLCC"), the Critical Lands and Waters Identification Project ("CLIP"), Monroe County's "Habitat" shapefile and Strategic Habitat Conservation Area (SHCA).
Electric Utility	• FKEC and Keys Energy facilities data and GIS 2030 and 2060 scenarios
County Facilities	• Point locations of County-owned buildings (2006 GIS Mapping) 2030 and 2060 scenarios
Elevation Data	• 2008 Department of Emergency Management LiDAR (Light Detection and Ranging)

HOW THE TEAM FILLED THE GAPS: WHAT SEA LEVEL RISE IMPACTS ARE EXPECTED WHEN?

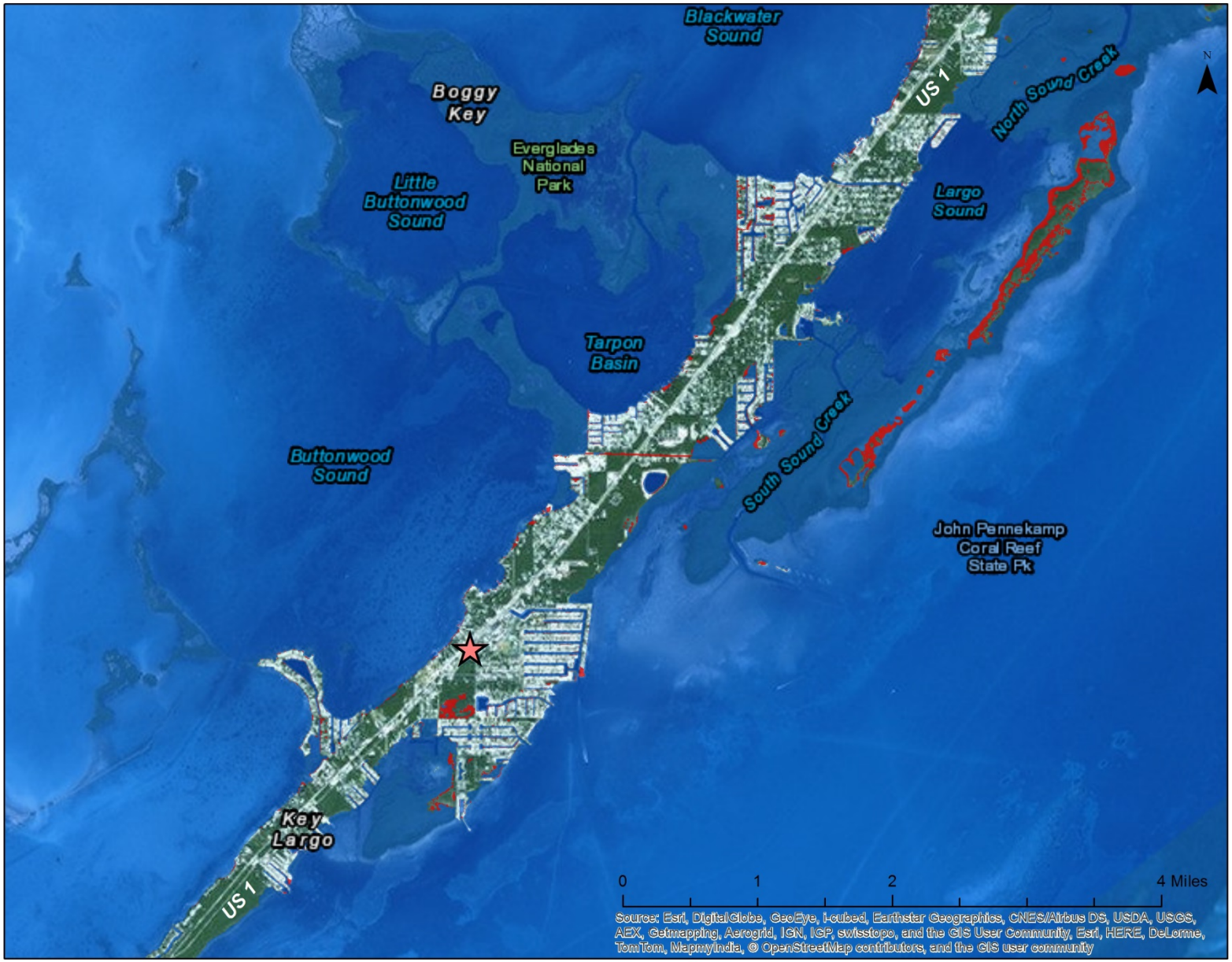


INUNDATION

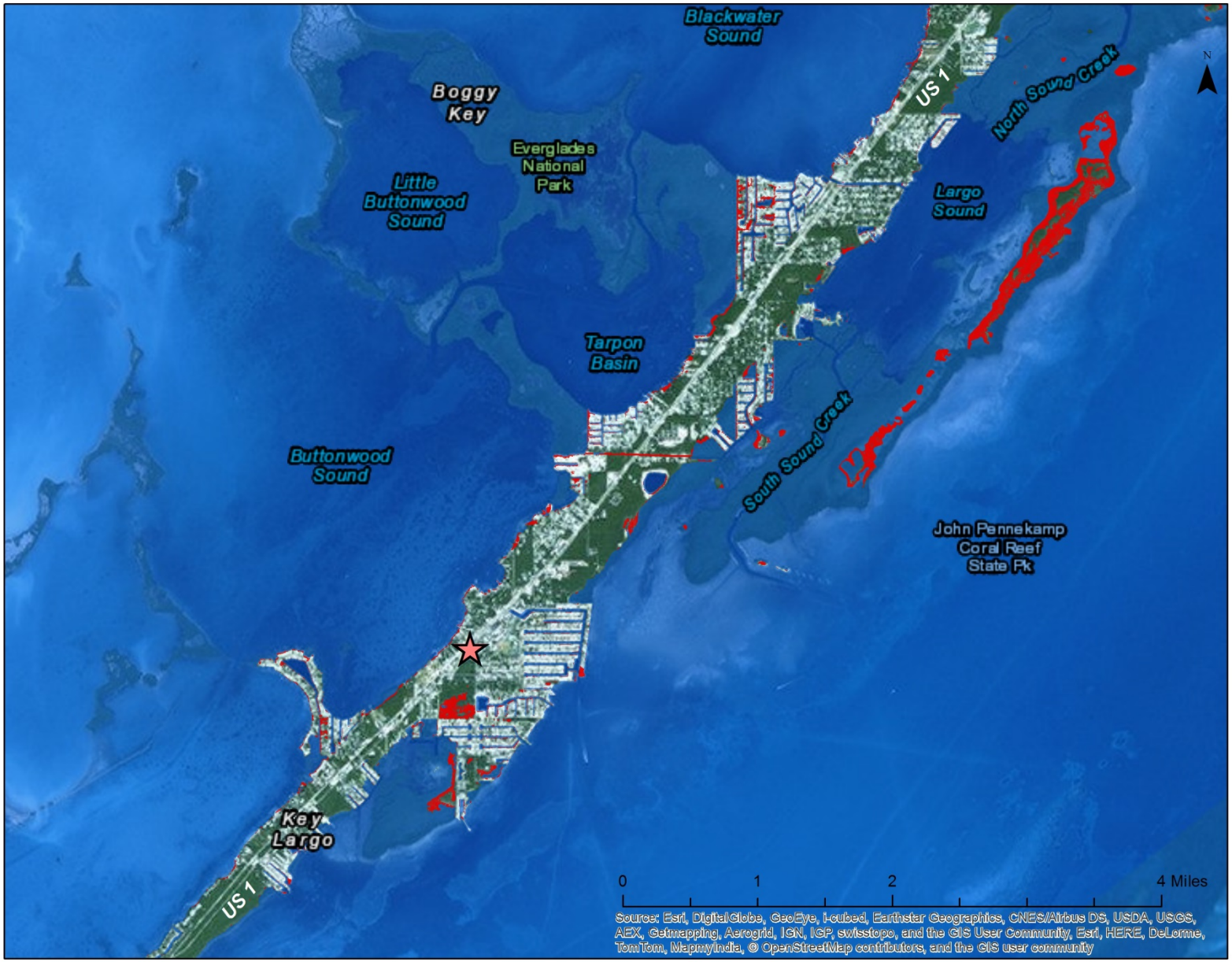
Key Largo, Present Day



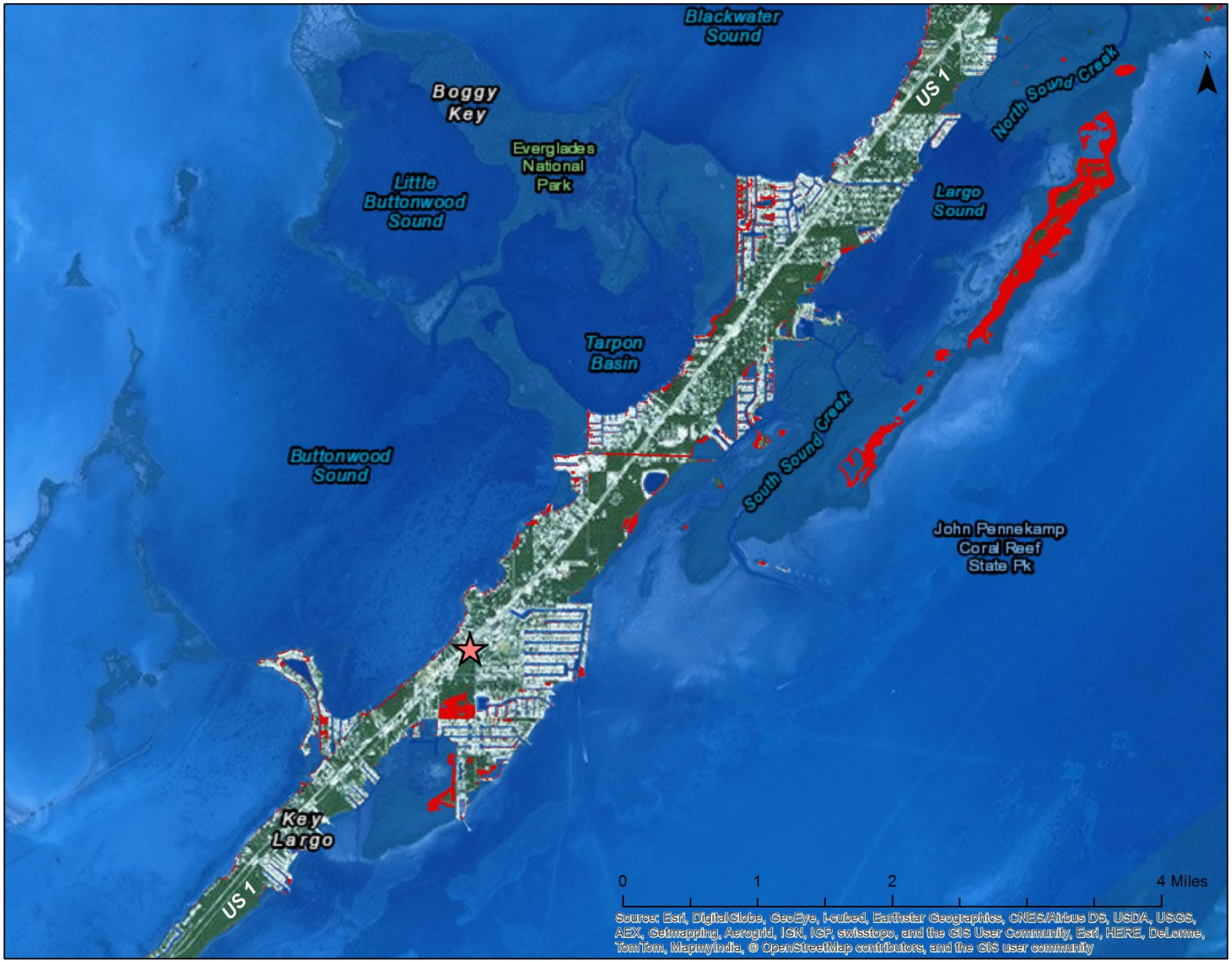
Key Largo, 3 inches Sea Level Rise (2030, Low Scenario)



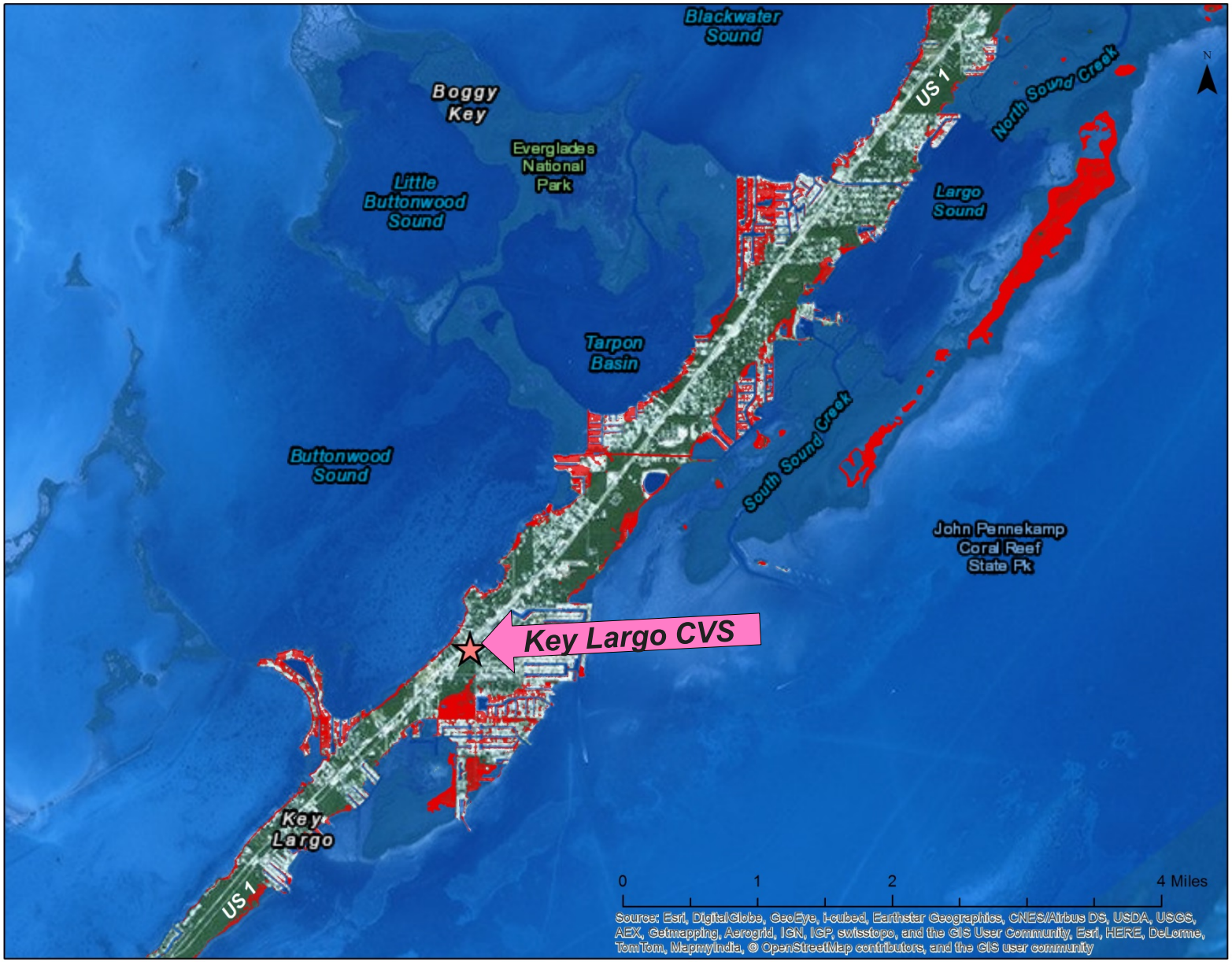
Key Largo, 7 inches Sea Level Rise (2030, High Scenario)



Key Largo, 9 inches Sea Level Rise (2060, Low Scenario)

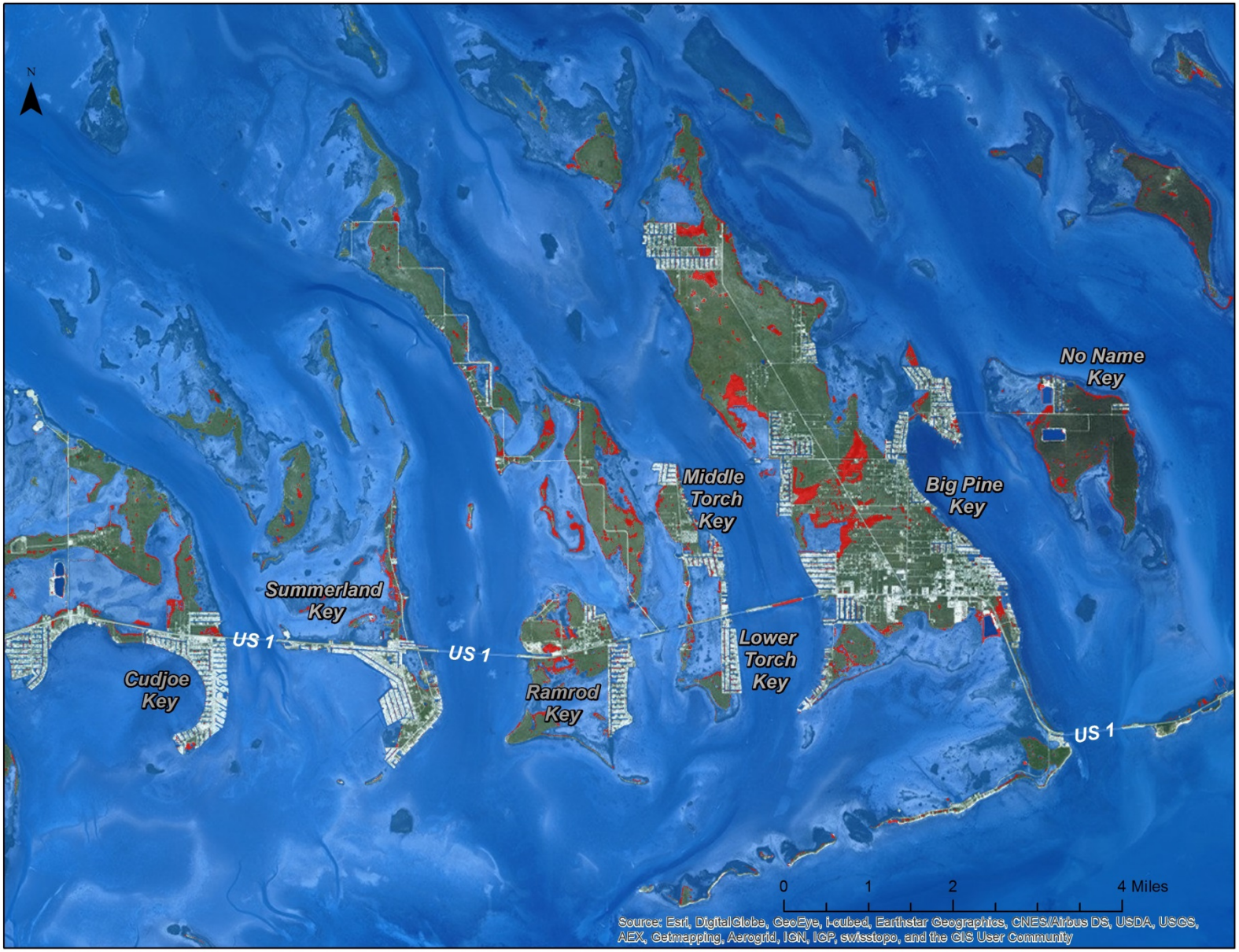


Key Largo, 24 inches Sea Level Rise (2060, High Scenario)

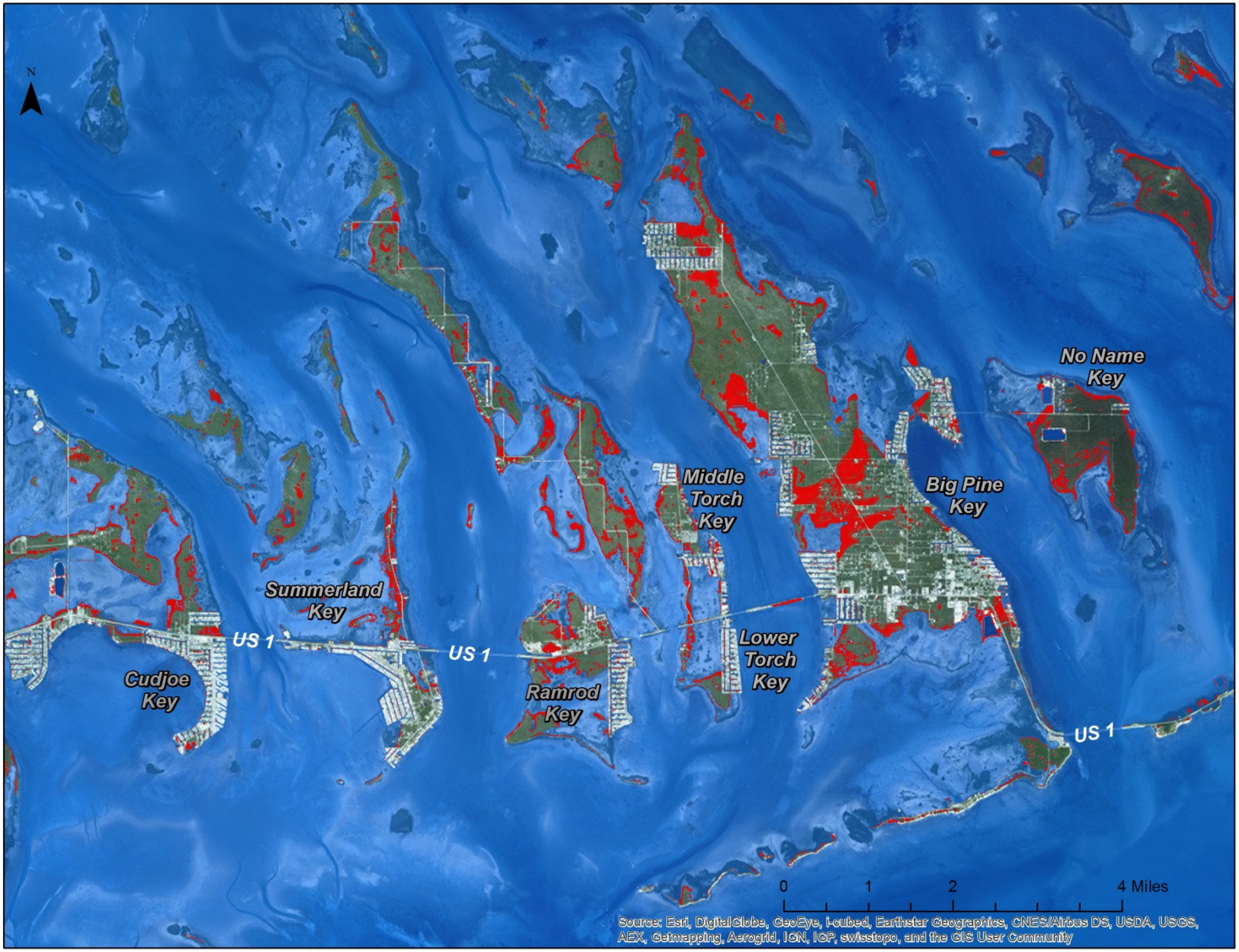


BIG PINE KEY AND VICINITY, PRESENT DAY

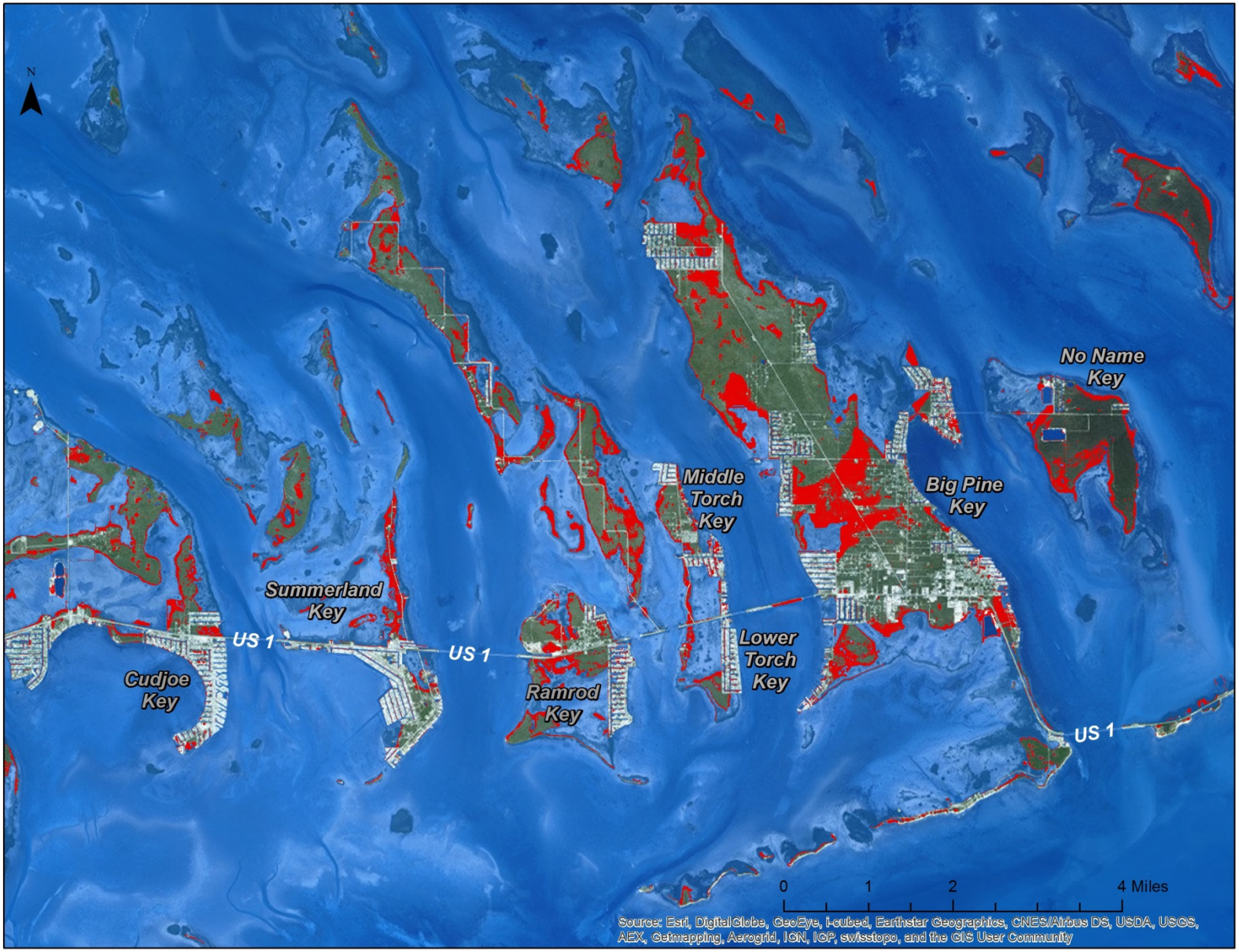
Big Pine Key and vicinity, 3 inches Sea Level Rise (2030, Low Scenario)



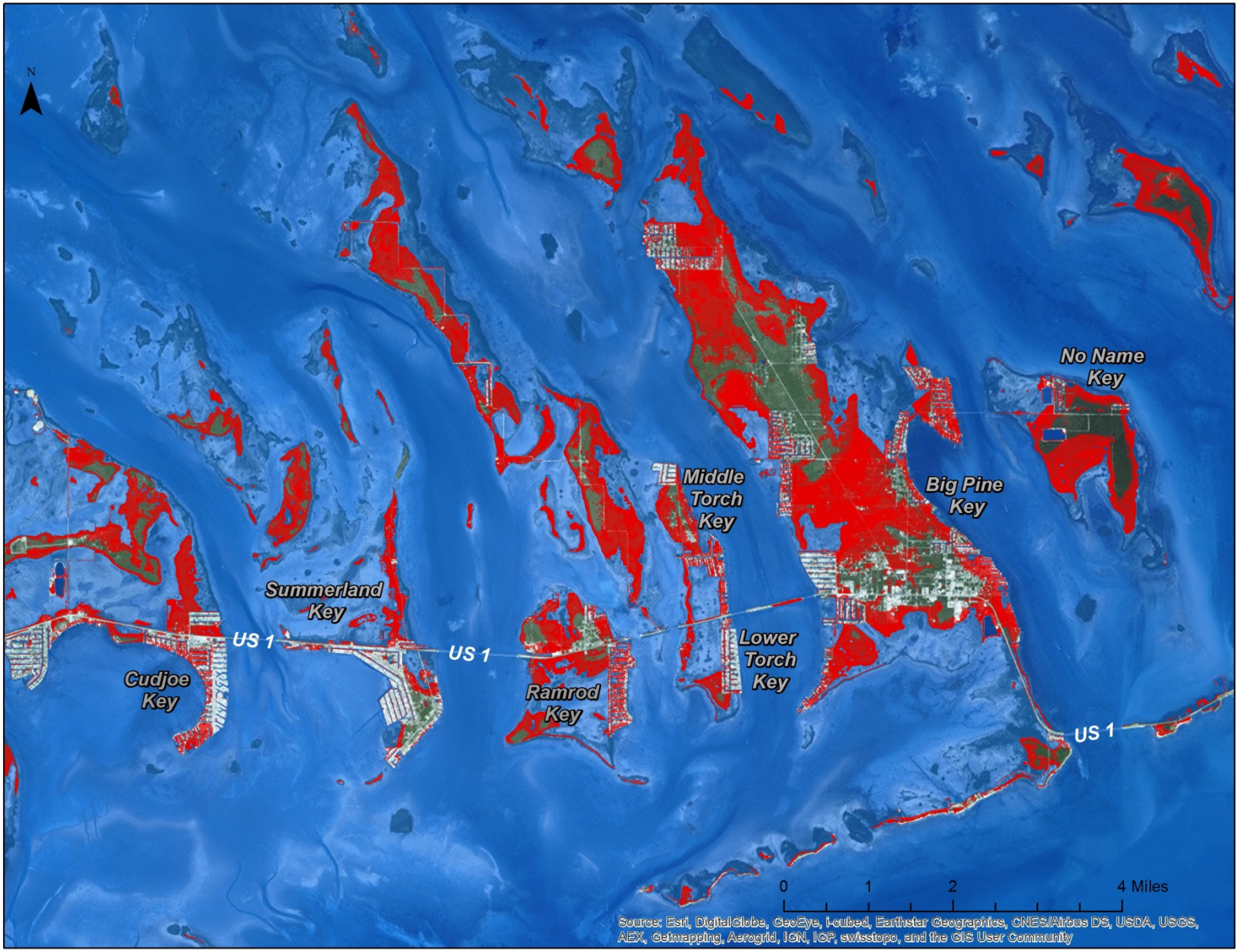
Big Pine Key and vicinity, 7 inches Sea Level Rise (2030, High Scenario)



Big Pine Key and Vicinity, 9 inches Sea Level Rise (2060, Low Scenario)



Big Pine Key and vicinity, 24 inches Sea Level Rise (2060, High Scenario)



KEY WEST, PRESENT DAY

Key West, 3 inches Sea Level Rise (2030, Low Scenario)

Key West, 7 inches Sea Level Rise (2030, High Scenario)

Key West, 9 inches Sea Level Rise (2060, Low Scenario)

Key West, 24 inches Sea Level Rise (2060, High Scenario)

NUISANCE FLOODING - 300-925% Increase Since 1960's

NOAA HOME WEATHER OCEANS FISHERIES CHARTING SATELLITES CLIMATE RESEARCH COASTS CAREERS

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

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- » Emergency Information for NOAA Employees

Media Contact

» Ben Sherman, NOAA, 301-713-3066

» Linda Austin, NOAA CO-OPS, 301-713-2981 ext.126, 301-802-9710 (cell)

NOAA: 'Nuisance flooding' an increasing problem as coastal sea levels rise

Study looks at more than 60 years of coastal water level and local elevation data changes

July 28, 2014

Eight of the top 10 U.S. cities that have seen an increase in so-called "nuisance flooding"--which causes such public inconveniences as frequent road closures, overwhelmed storm drains and compromised infrastructure--are on the East Coast, according to a new NOAA technical report.

This nuisance flooding, caused by rising sea levels, has increased on all three U.S. coasts, between 300 and 925 percent since the 1960s.

The report, Sea Level Rise and Nuisance Flood Frequency Changes around the United States, also finds Annapolis and Baltimore, Maryland, lead the list with an increase in number of flood

Annapolis, Maryland, pictured here in 2012, saw the greatest increase in nuisance flooding in a recent NOAA study. (Credit: With permission from Amy McGovern.)

NEWS RELEASE ON JULY 28, 2014

Facebook
Google
StumbleUpon
Digg
More Destinations

"As relative sea level increases, it no longer takes a strong storm or a hurricane to cause flooding," said William Sweet, Ph.D., oceanographer at NOAA's Center for Operational Oceanographic Products and Services (CO-OPS) and the report's lead author. "Flooding now occurs with high tides in many locations due to climate-related sea level rise, land subsidence and the loss of natural barriers. The effects of rising sea levels along most of the continental U.S. coastline are only going to become more noticeable and much more severe in the coming decades, probably more so than any other climate-change related factor."

The study was conducted by scientists at CO-OPS, who looked at data from 45 NOAA water level gauges with long data records around the country and compared that to reports of number of days of nuisance floods.

WHAT IS NUISANCE FLOODING?

High-tide flooded road on Big Pine Key

Duval Street high tide flooding

Defined by NOAA as 1.08 feet above Mean Higher High Water (MHHW) at the Key West tide gauge

NUISANCE VS. WILMA AT KEY WEST

Duval Street high tide flooding

http://cdn1.vtourist.com/4/2436059-Pics_of_Key_West_Hurricane_Wilma_Key_West.jpg

INCREASE IN “NUISANCE FLOODING”

1980-1982

.67 per year

2010-2012

2.3 per year

2030 at 3”

20 per year

2030 at 7”

78 per year

2060 at 9”

139 per year

2060 at 24”

672 per year

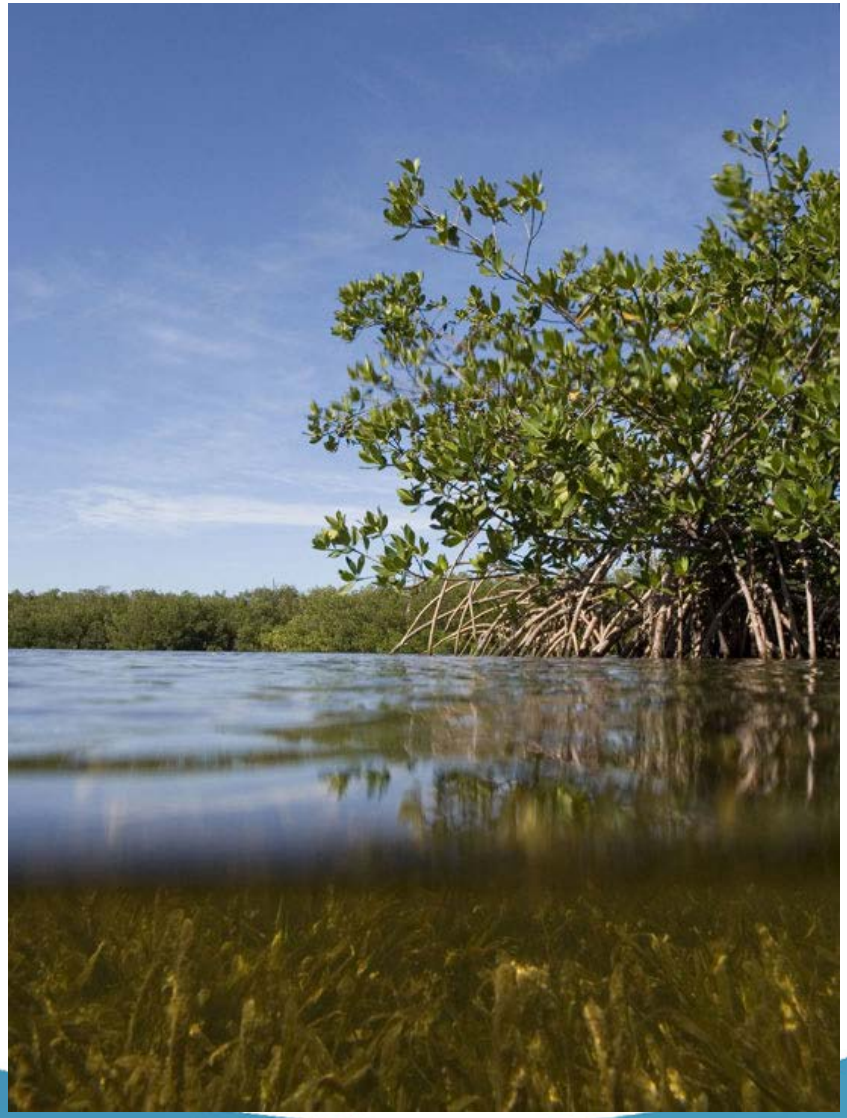
Flooding More Than 1x Per Day

FREQUENCY OF WILMA-LIKE TIDES

With 24 inches of sea level rise, a tide as high as recorded by NOAA during Wilma can be expected to occur at Key West about <u>two times a year</u>

HABITAT


Download from
Dreamstime.com
2711076
Brandi Pierce | Dreamstime.com



HABITAT CHANGE

3 inches of sea level rise (2030, Low Scenario) could bring *daily* saltwater tides into 19% of Monroe County's Freshwater Wetland Areas*

Analysis based on Monroe County Habitat dataset (2009)

Freshwater pond on Big Pine Key

http://rcrackliffe.com/images/FloridaVacation/2004-12-28-14.jpg

HABITAT CHANGE

24 inches of sea level rise (2060, High Scenario) could bring *daily* saltwater tides into 94% of Monroe County's Freshwater Wetland Areas*

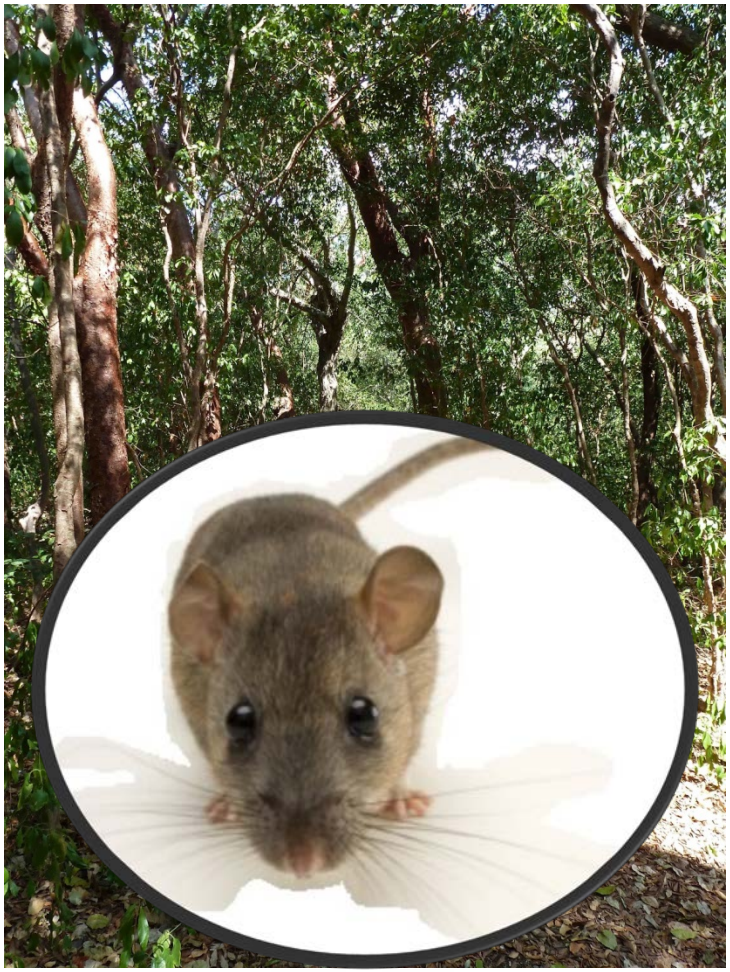
Key deer on Big Pine Key
http://s3.amazonaws.com/trazzler-images/af/1505/00.jpg

**Analysis based on Monroe County Habitat dataset (2009)*

HABITAT CHANGE

3 inches of sea level rise (2030, Low Scenario) could bring *daily* saltwater tides into 2.3% of Monroe County's remaining Tropical Hardwood Hammock*

Analysis based on Monroe County Habitat dataset (2009)



Tropical hardwood hammock
Lignumvitae State Park

http://3.bp.blogspot.com/-I6rkce85yqI/T5QYIYE2dZI/AAAAAAAAFDk/7BHEUgYDDMY/s1600/LignumTrail.jpg

HABITAT CHANGE

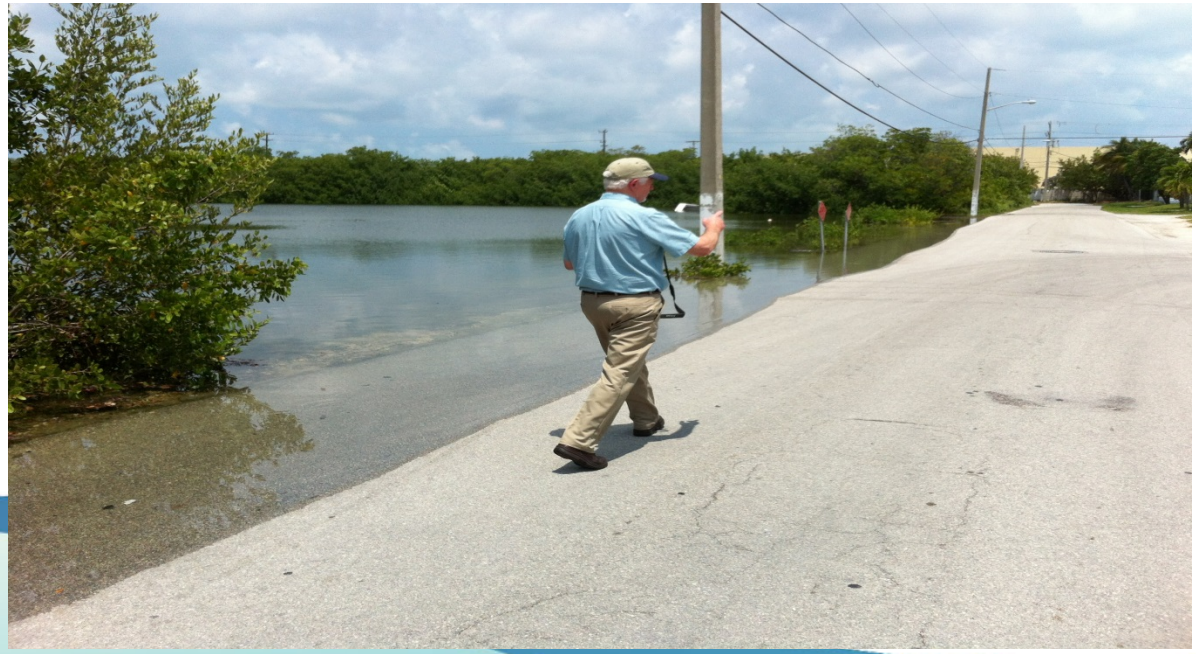
24 inches of sea level rise 2060, High Scenario) could bring *daily* saltwater tides into 42% of Monroe County's remaining Tropical Hardwood Hammock*

Trees killed by saltwater intrusion (Big Pine)
http://www.worldviewofglobalwarming.org/risingseas/FLKeysPinesKilledSaltSLRWeb.jpg

****Analysis based on Monroe County Habitat dataset (2009)***

ROADS

County-Maintained and All Roads

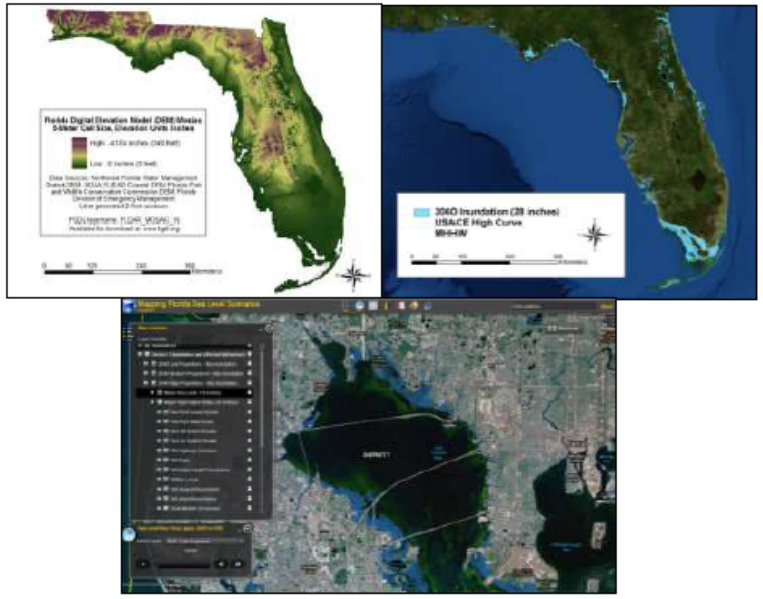


ROADS ANALYSIS

Based on FDOT Sea Level Rise Sketch Tool*

Developed by University of Florida

DEVELOPMENT OF A GEOGRAPHIC INFORMATION SYSTEM (GIS) TOOL FOR THE PRELIMINARY ASSESSMENT OF THE EFFECTS OF PREDICTED SEA LEVEL AND TIDAL CHANGE ON TRANSPORTATION INFRASTRUCTURE



FDOT Contract# BDK75 977-63
September 2013
Final Report

Prepared by
Alexis Thomas
Dr. Russell Watkins
The GeoPlan Center
Department of Urban & Regional Planning
University of Florida

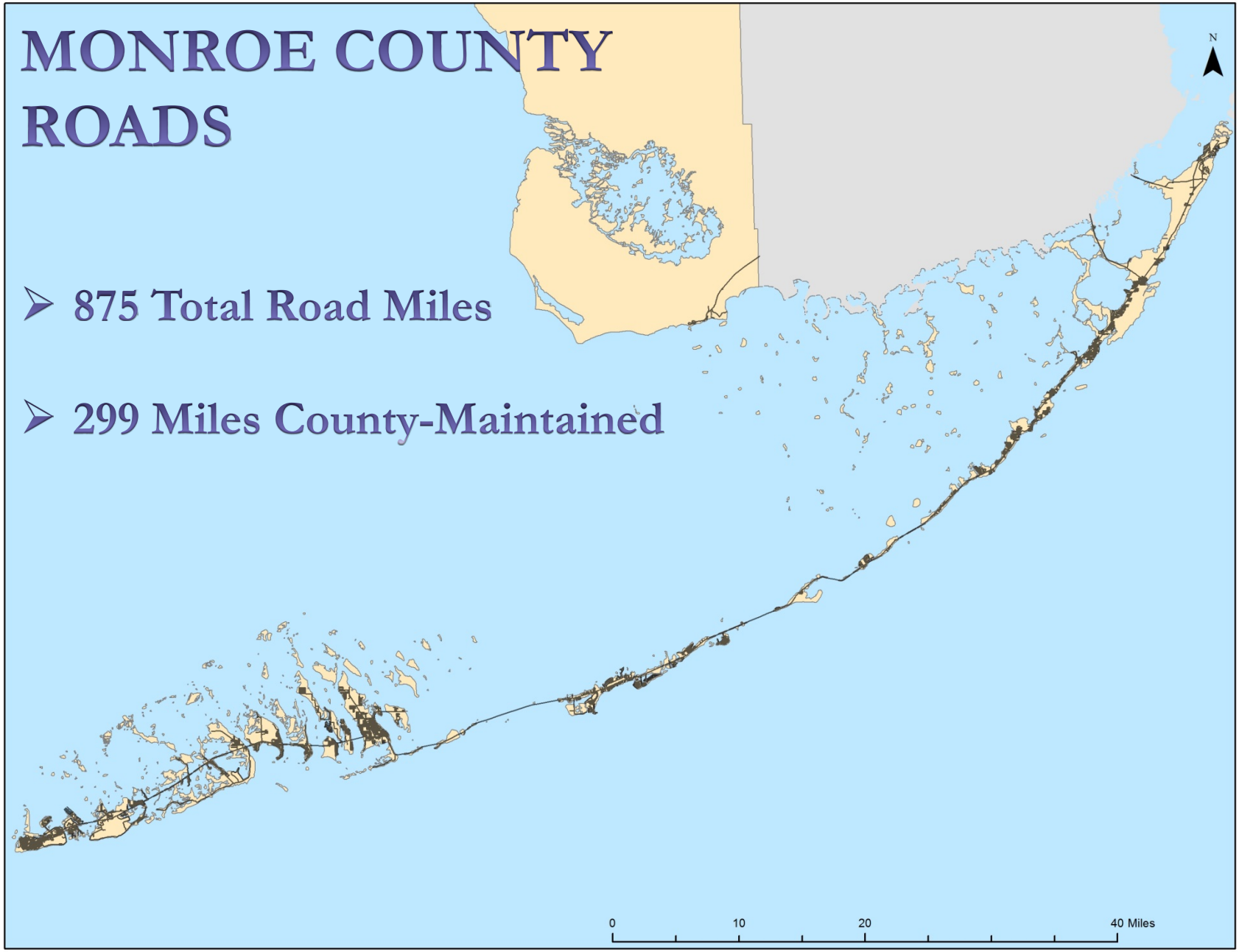
Funded by
Florida Department of Transportation

http://fsls.geoplan.ufl.edu/documents-links/

**General planning assessment tool requires additional data for use in site-level decisions*

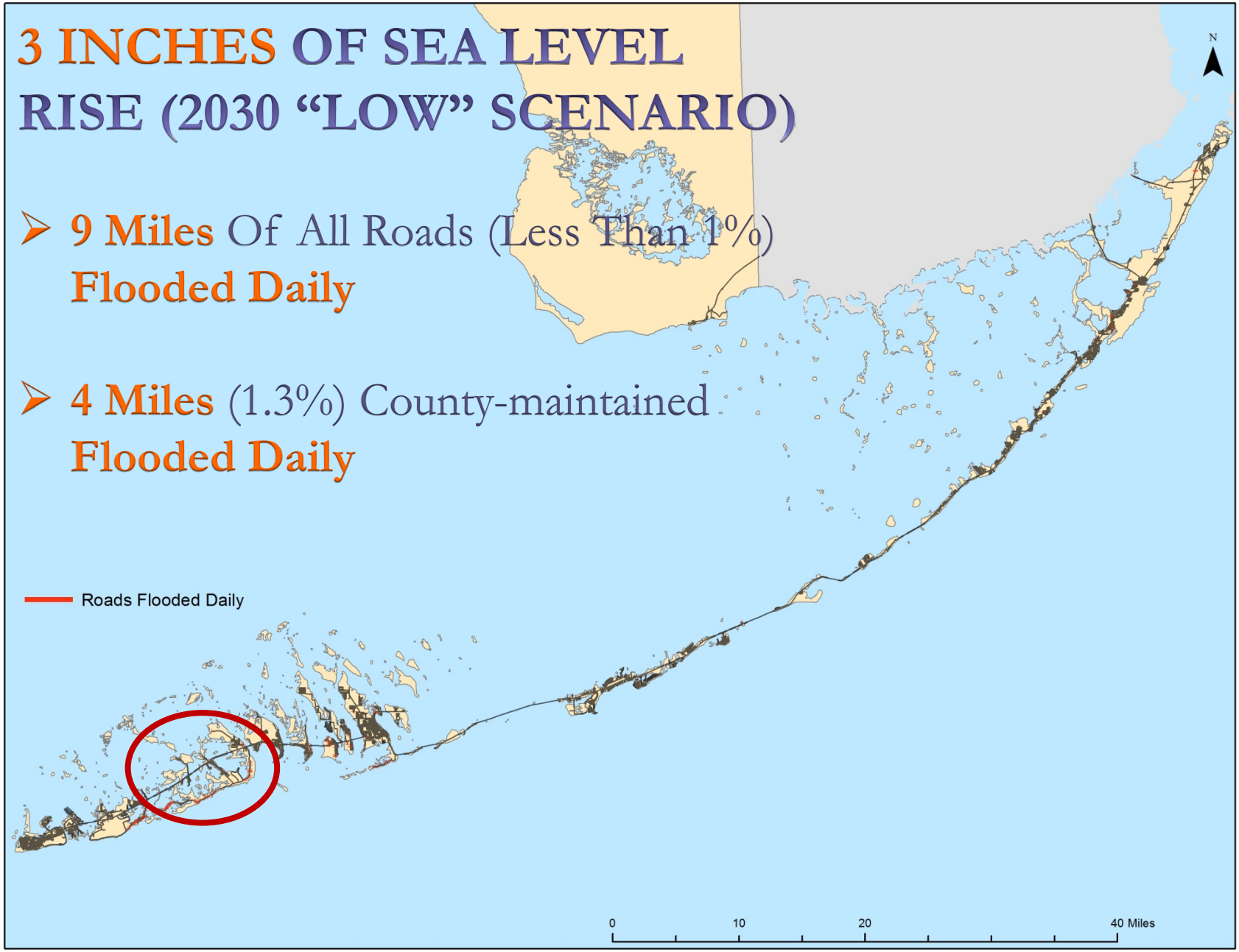
MONROE COUNTY ROADS

- 875 Total Road Miles
- 299 Miles County-Maintained



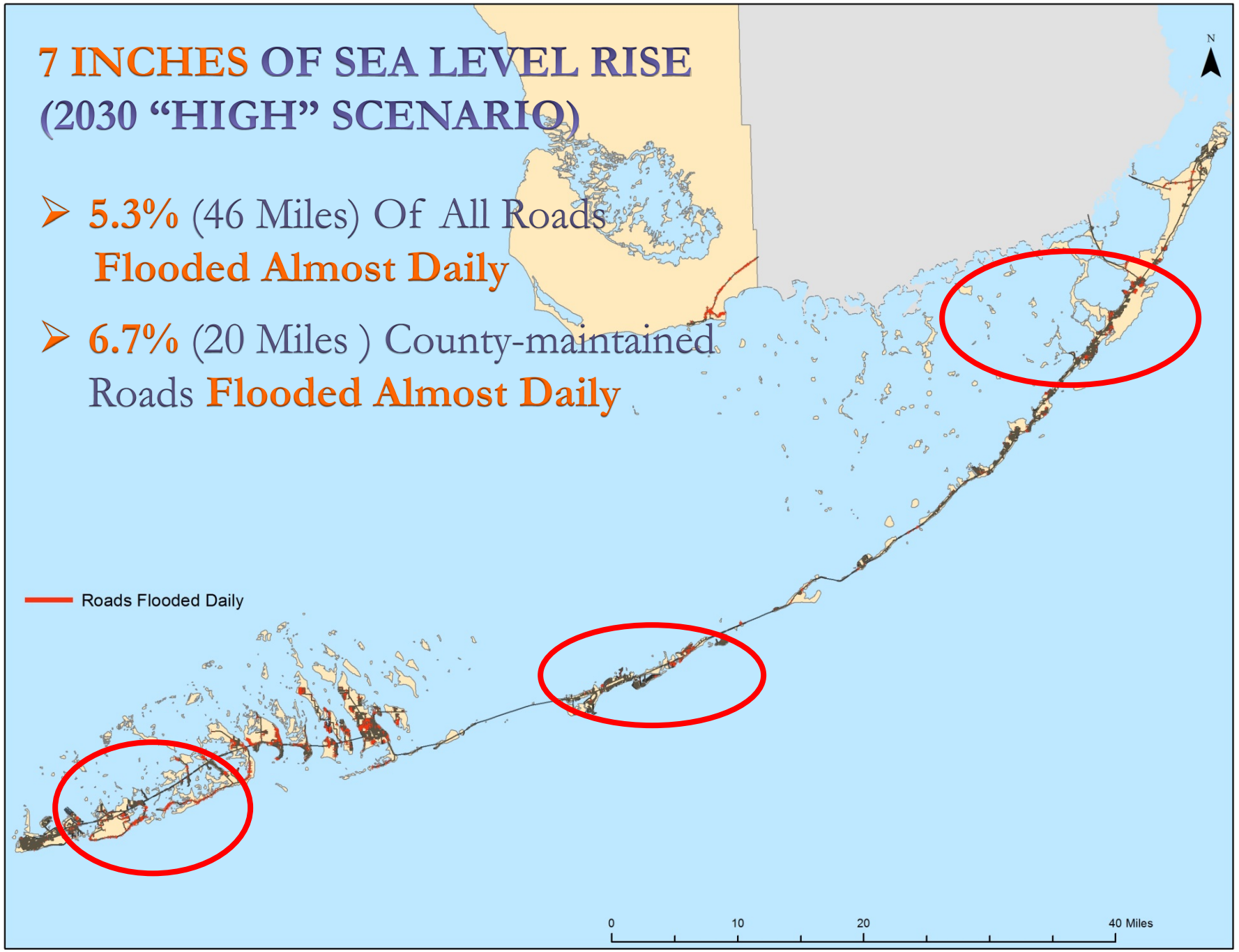
3 INCHES OF SEA LEVEL RISE (2030 "LOW" SCENARIO)

- **9 Miles** Of All Roads (Less Than 1%) **Flooded Daily**
- **4 Miles** (1.3%) County-maintained **Flooded Daily**



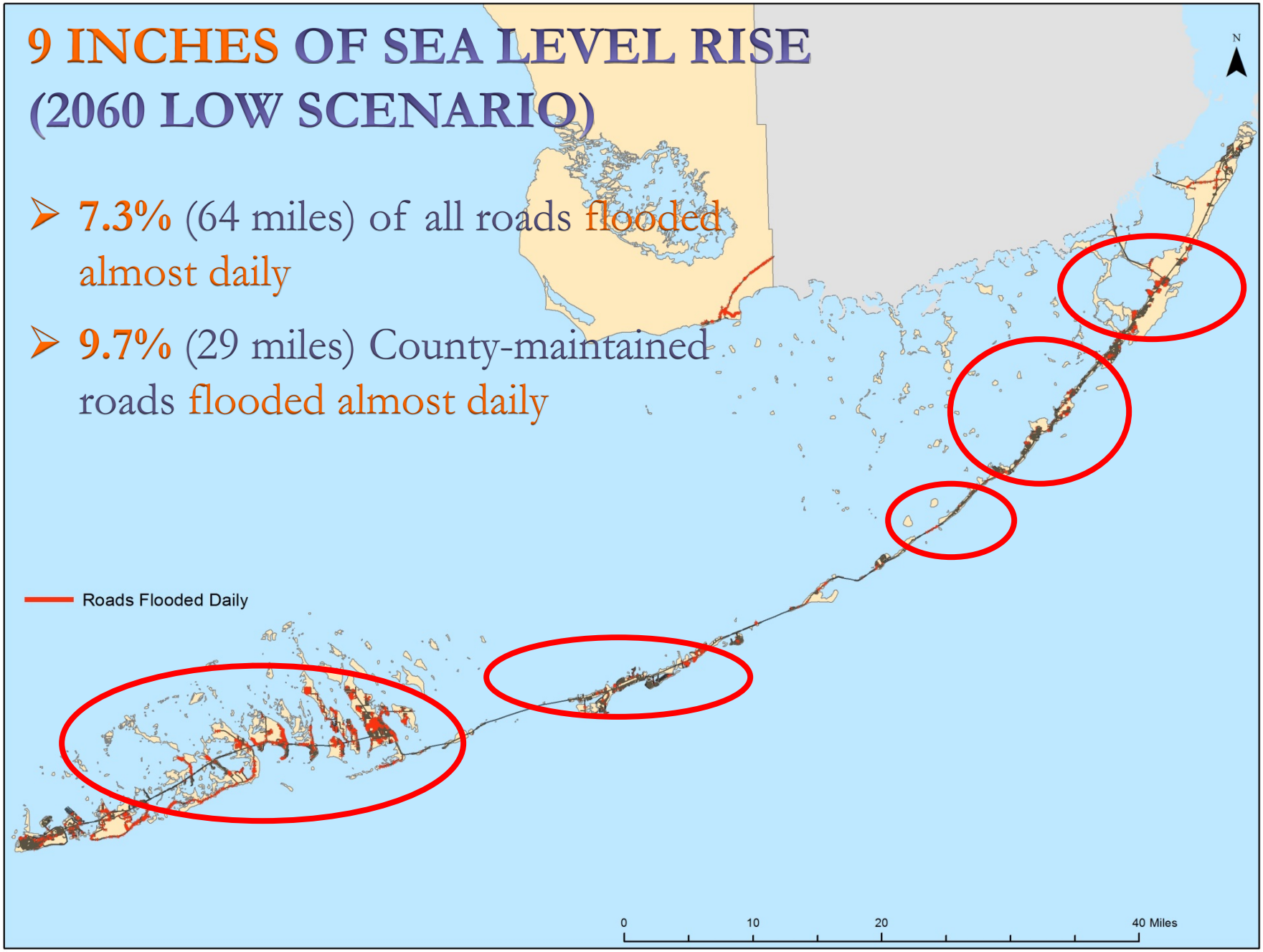
7 INCHES OF SEA LEVEL RISE (2030 "HIGH" SCENARIO)

- **5.3%** (46 Miles) Of All Roads **Flooded Almost Daily**
- **6.7%** (20 Miles) County-maintained Roads **Flooded Almost Daily**



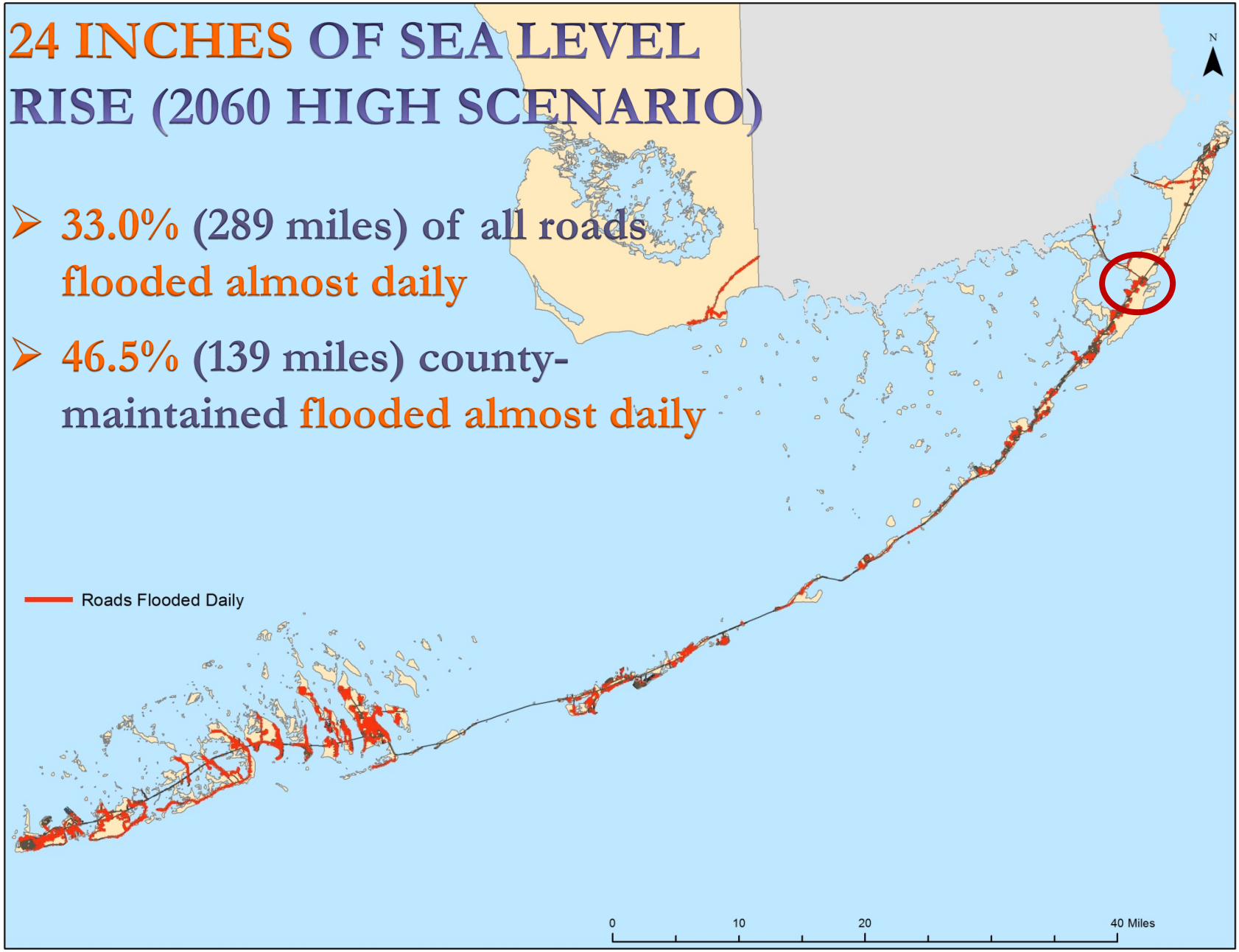
9 INCHES OF SEA LEVEL RISE (2060 LOW SCENARIO)

- **7.3%** (64 miles) of all roads flooded almost daily
- **9.7%** (29 miles) County-maintained roads flooded almost daily



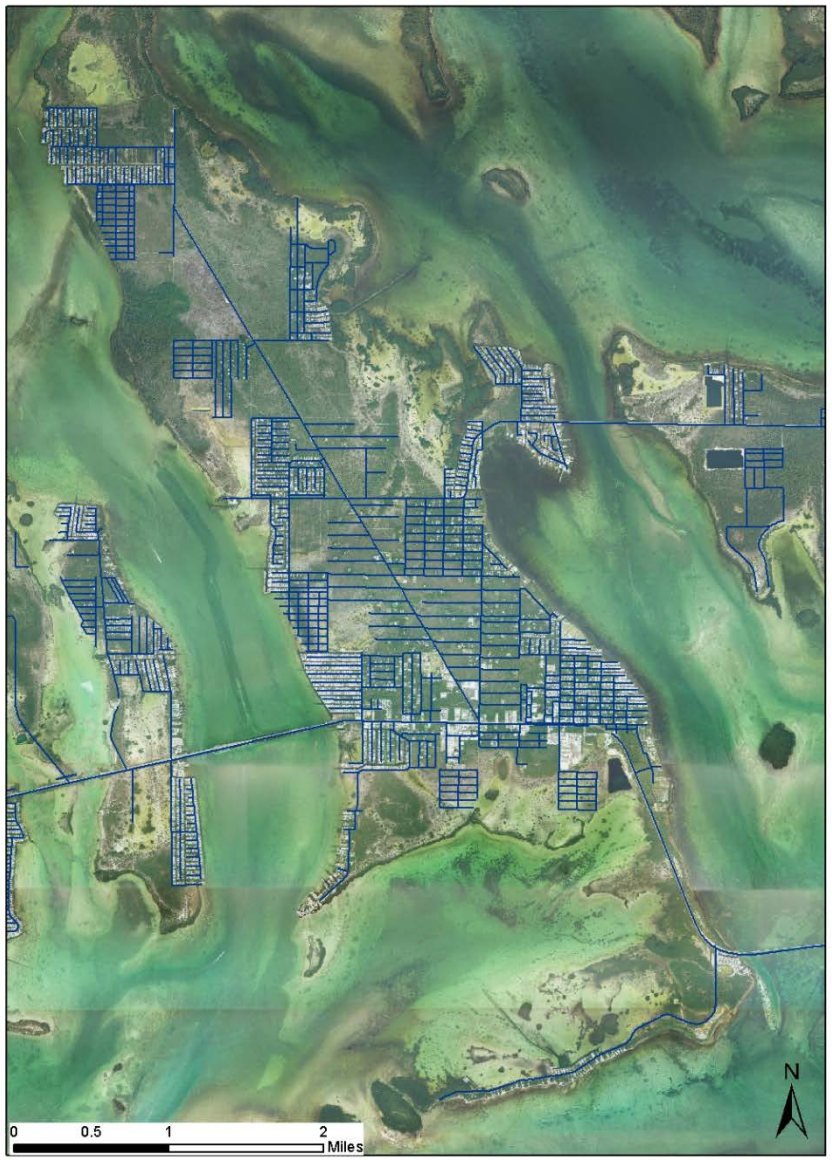
24 INCHES OF SEA LEVEL RISE (2060 HIGH SCENARIO)

- 33.0% (289 miles) of all roads flooded almost daily
- 46.5% (139 miles) county-maintained flooded almost daily



PRESENT DAY ROADS

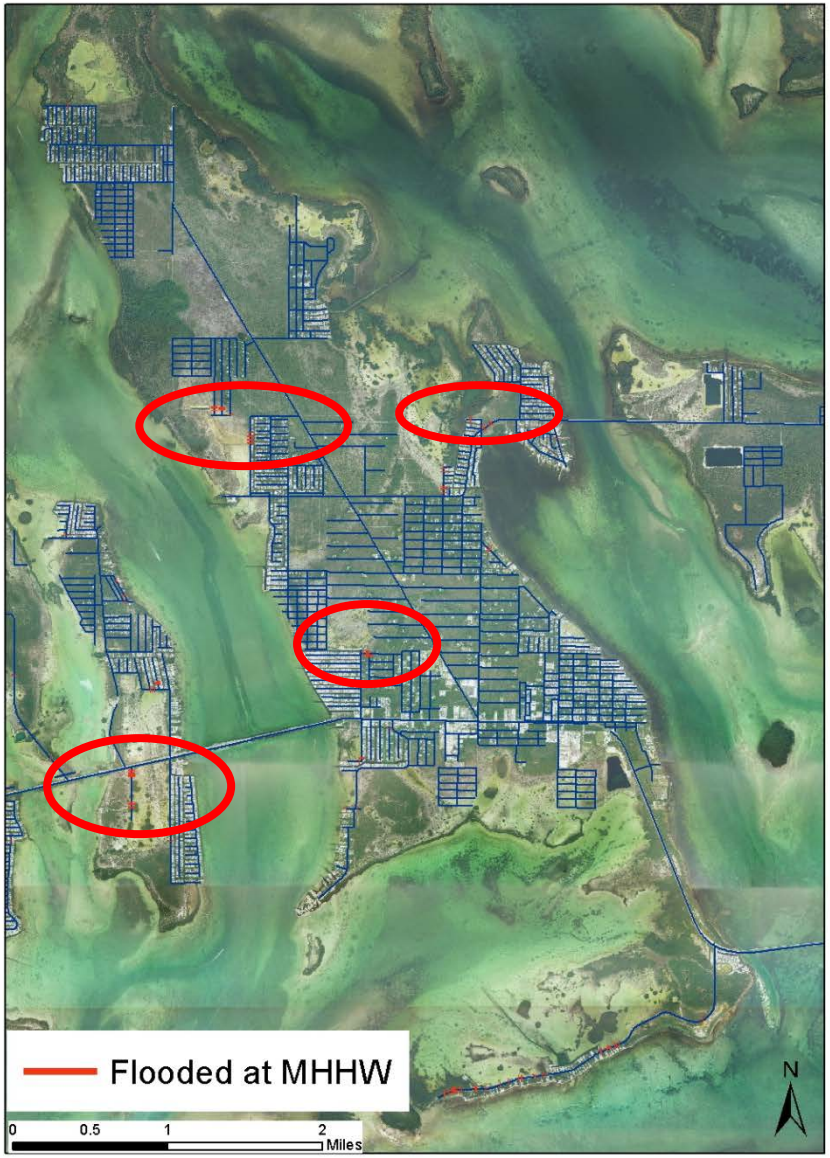
Road centerlines and aerial imagery: Monroe County Property Appraiser's Office



2030 LOW SCENARIO
3 INCHES SEA LEVEL RISE

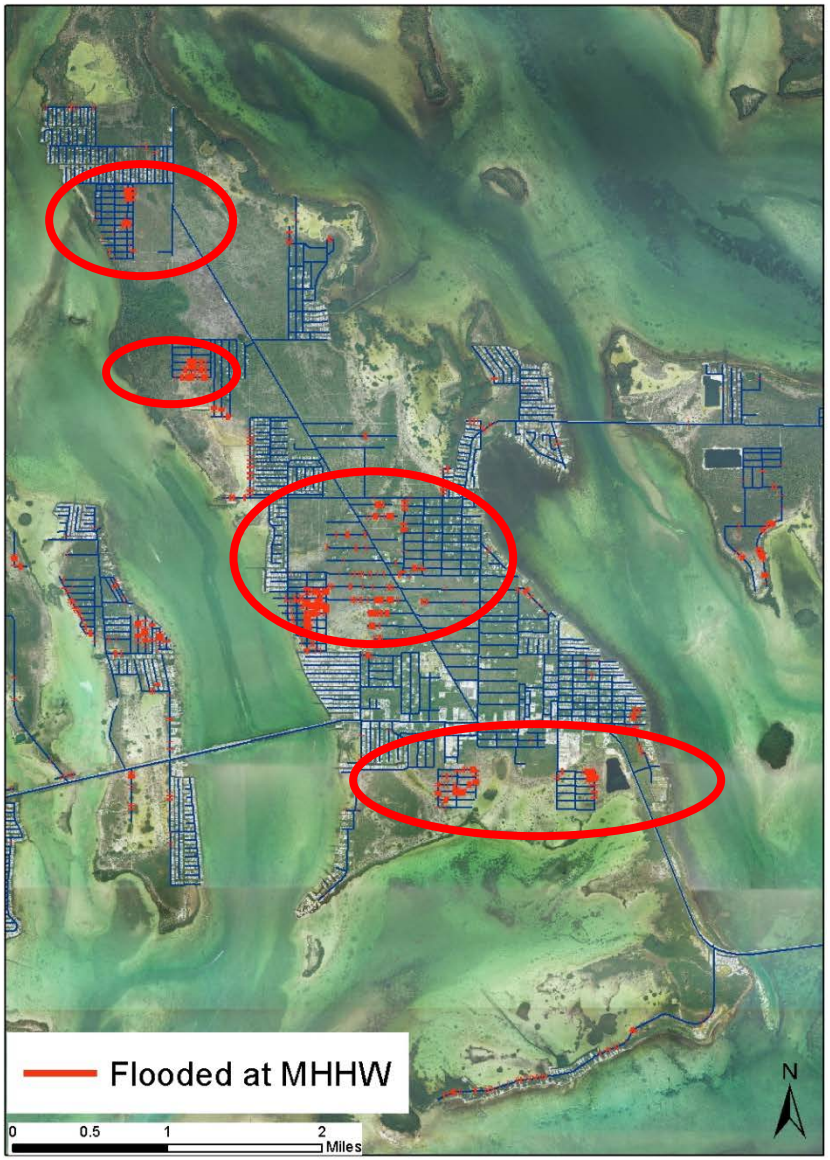
Road centerlines and aerial imagery: Monroe County Property Appraiser's Office

Big Pine Key



2030 HIGH SCENARIO
7 INCHES SEA LEVEL RISE

Big Pine Key

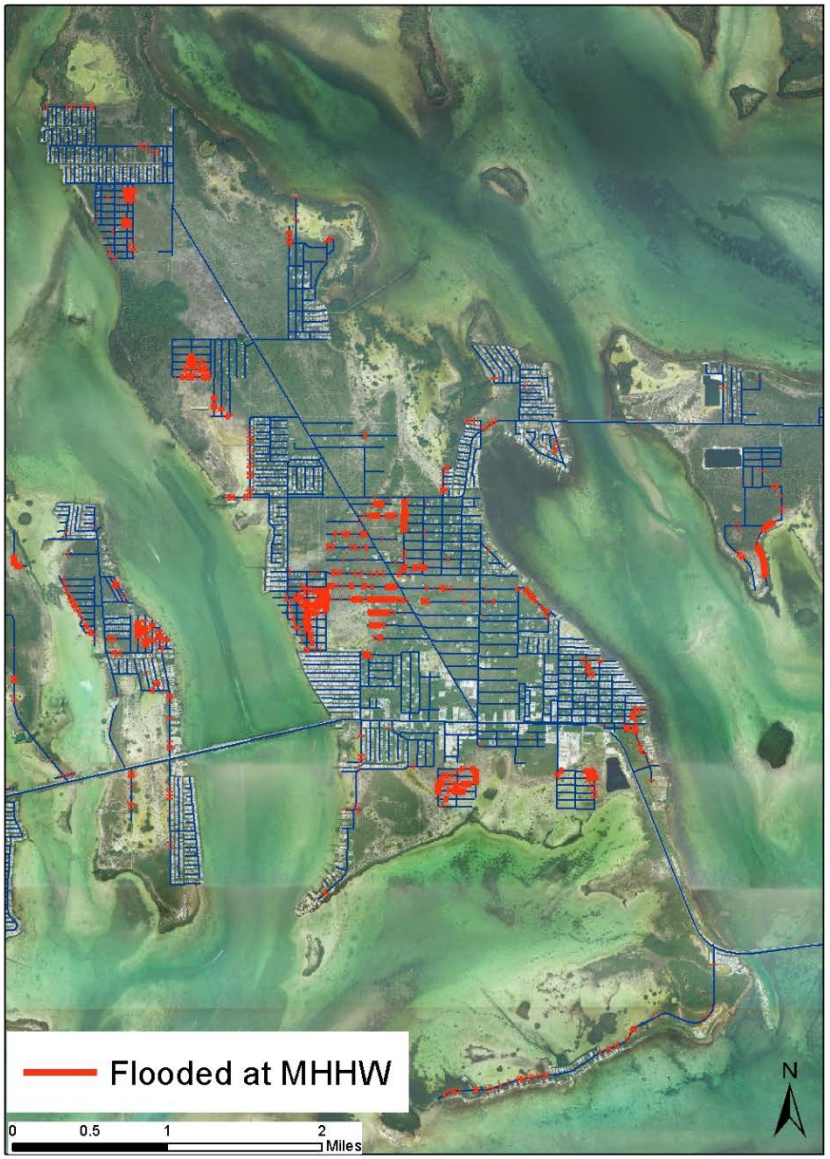


Road centerlines and aerial imagery: Monroe County Property Appraiser's Office

2060 LOW SCENARIO
9 INCHES SEA LEVEL RISE

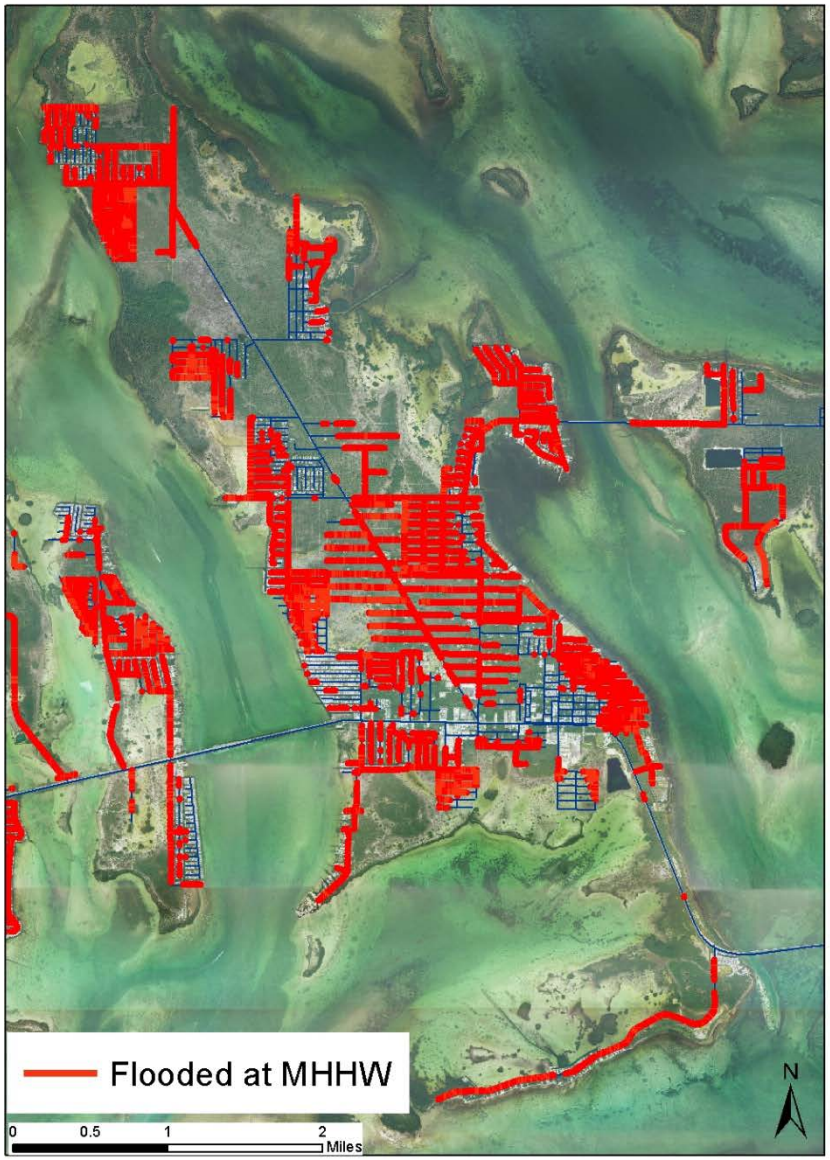
Road centerlines and aerial imagery: Monroe County Property Appraiser's Office

Big Pine Key



2060 High Scenario
24 inches sea level rise

Big Pine Key



Road centerlines and aerial imagery: Monroe County Property Appraiser's Office

ISLAMORADA: US1 near White Marlin Blvd. Lower Matecumbe Key

ISLAMORADA:
US1 Lower Matecumbe Key

2030 Low Scenario
3 inches sea level rise

ISLAMORDAD:
US1 Lower Matecumbe Key

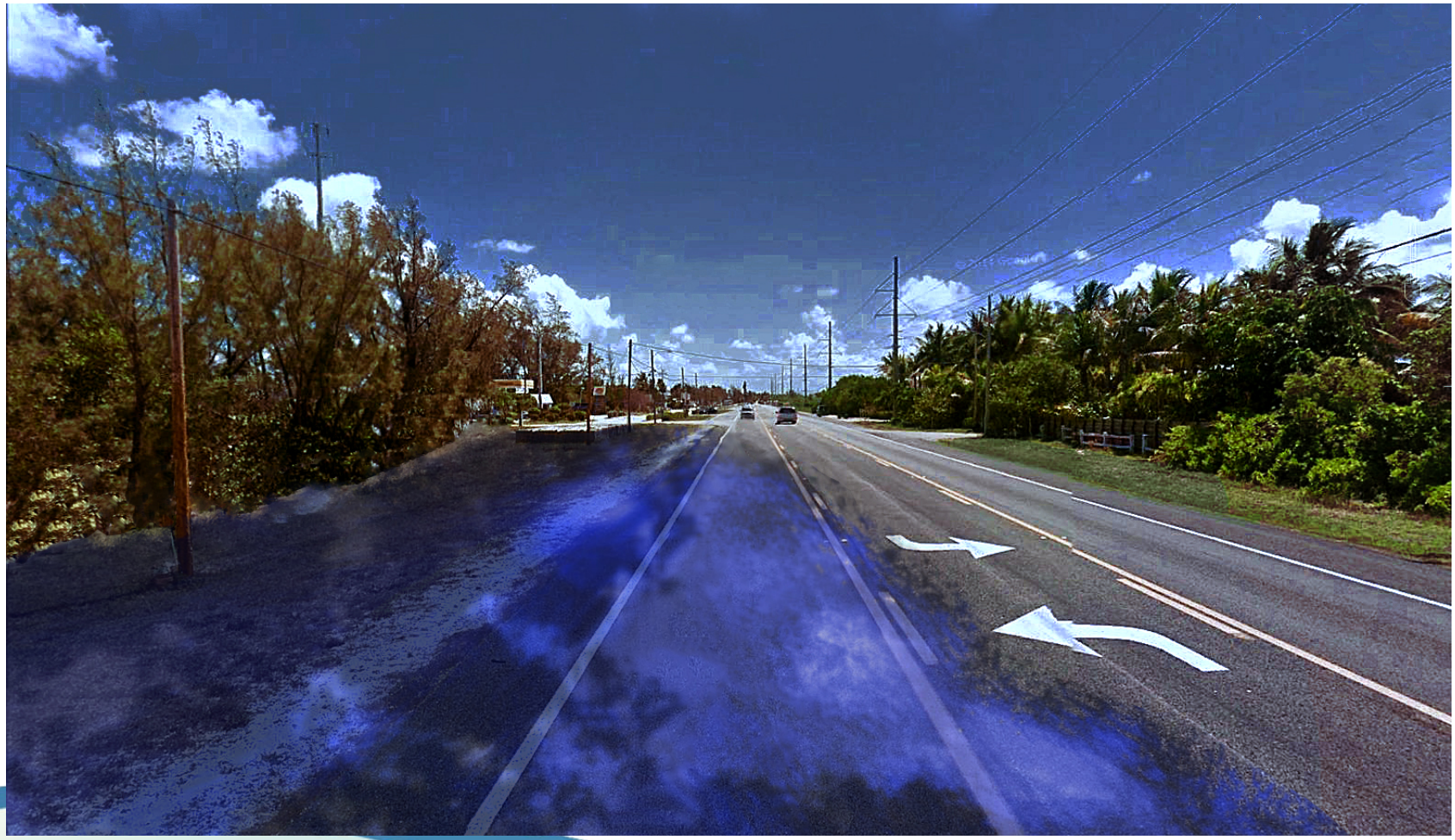
2030 High Scenario
7 inches sea level rise

US1 near White Marlin Blvd. Lower Matecumbe Key

2060 Low Scenario
9 inches sea level rise

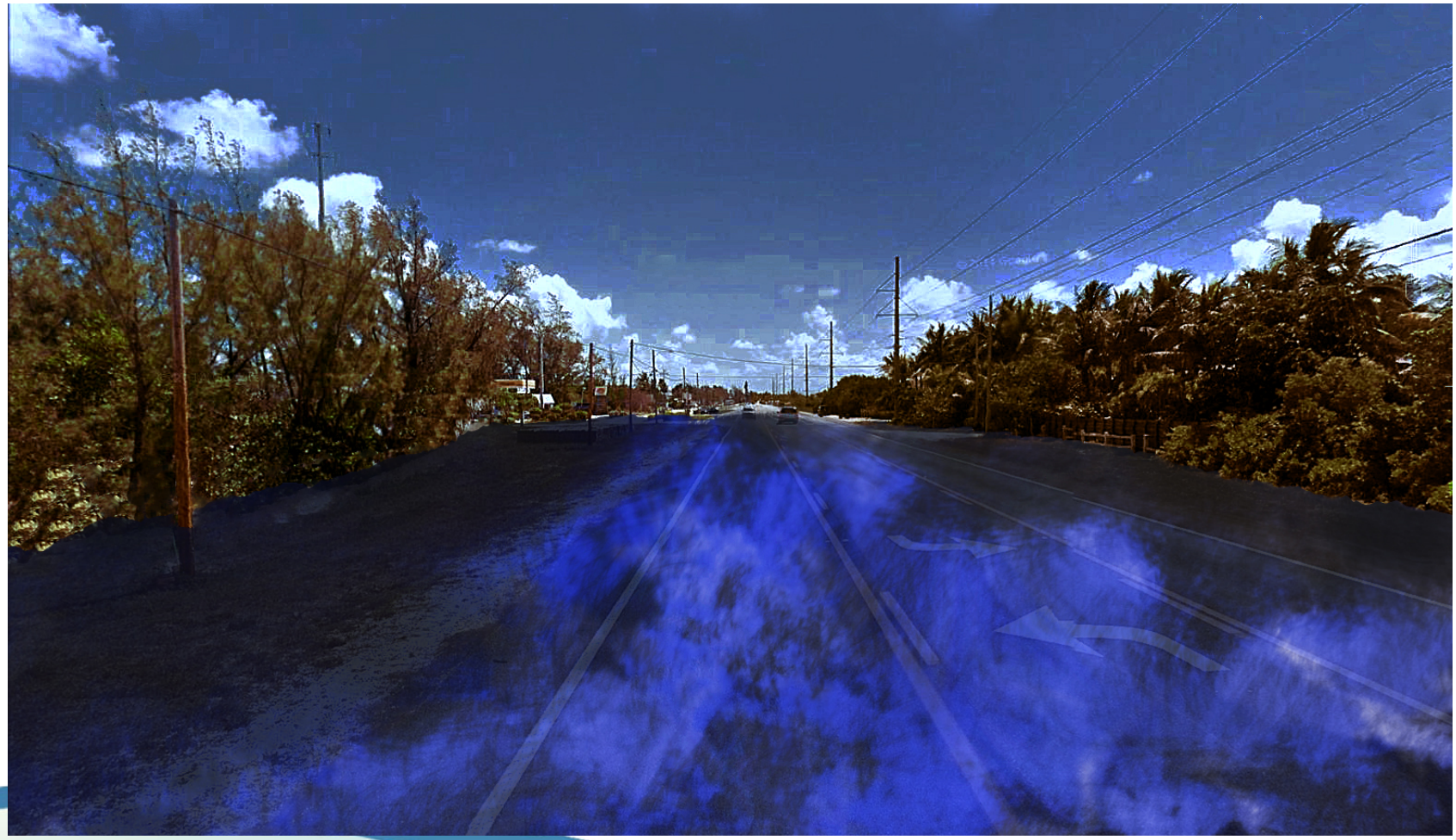
ISLAMORADA:
US1 Lower Matecumbe Key

2060 High Scenario
24 inches sea level rise



ISLAMORADA:
US1 Lower Matecumbe Key

Wilma-sized event
(Key West record)



RECOMMENDATIONS FOR ROADS

1. Use results from this analysis to inform flood mitigation for near-term paving projects

2. Systematically document locations and dates for nuisance flood events

3. Develop survey-grade digital elevation data for road surfaces

Wastewater Facilities

Key Haven Wastewater Treatment Plant

Key Haven Wastewater Treatment Plant
2030 Low SLR (3 inches)

Key Haven Wastewater Treatment Plant
2030 High SLR (7 inches)

Key Haven Wastewater Treatment Plant
2060 High SLR (24 inches)

Key Haven Wastewater Treatment Plant
Wilma-sized event (Key West record)

PRIORITIZATION FOR WASTEWATER FLOOD ADAPTATION

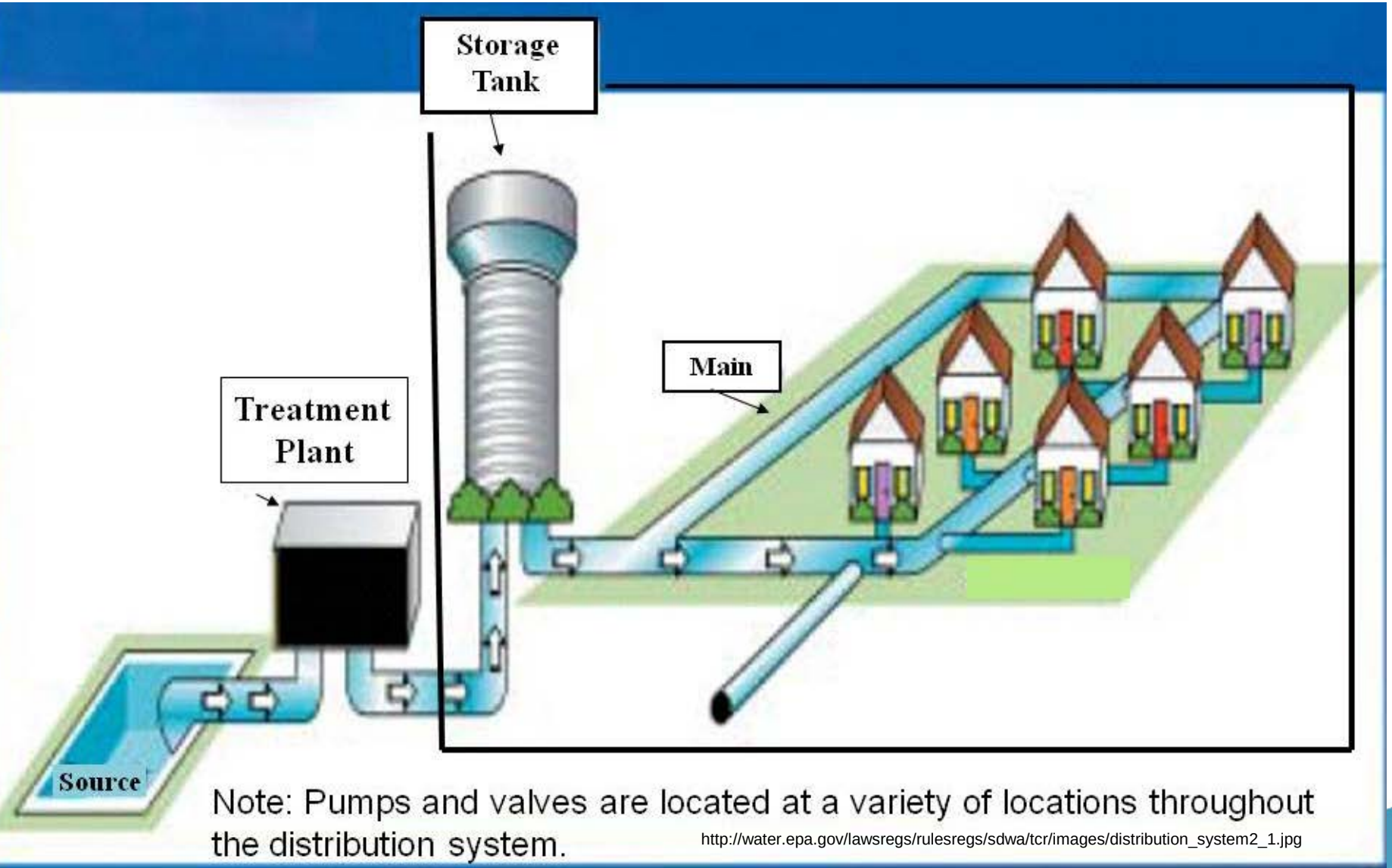
1. Near term (2030): Key Haven & Bay Point

   Key Haven decommission scheduled in 2015

2. Medium term (2045): Duck Key

3. Longer term (2060): Cudjoe, Big Coppitt, Layton, and Key Largo

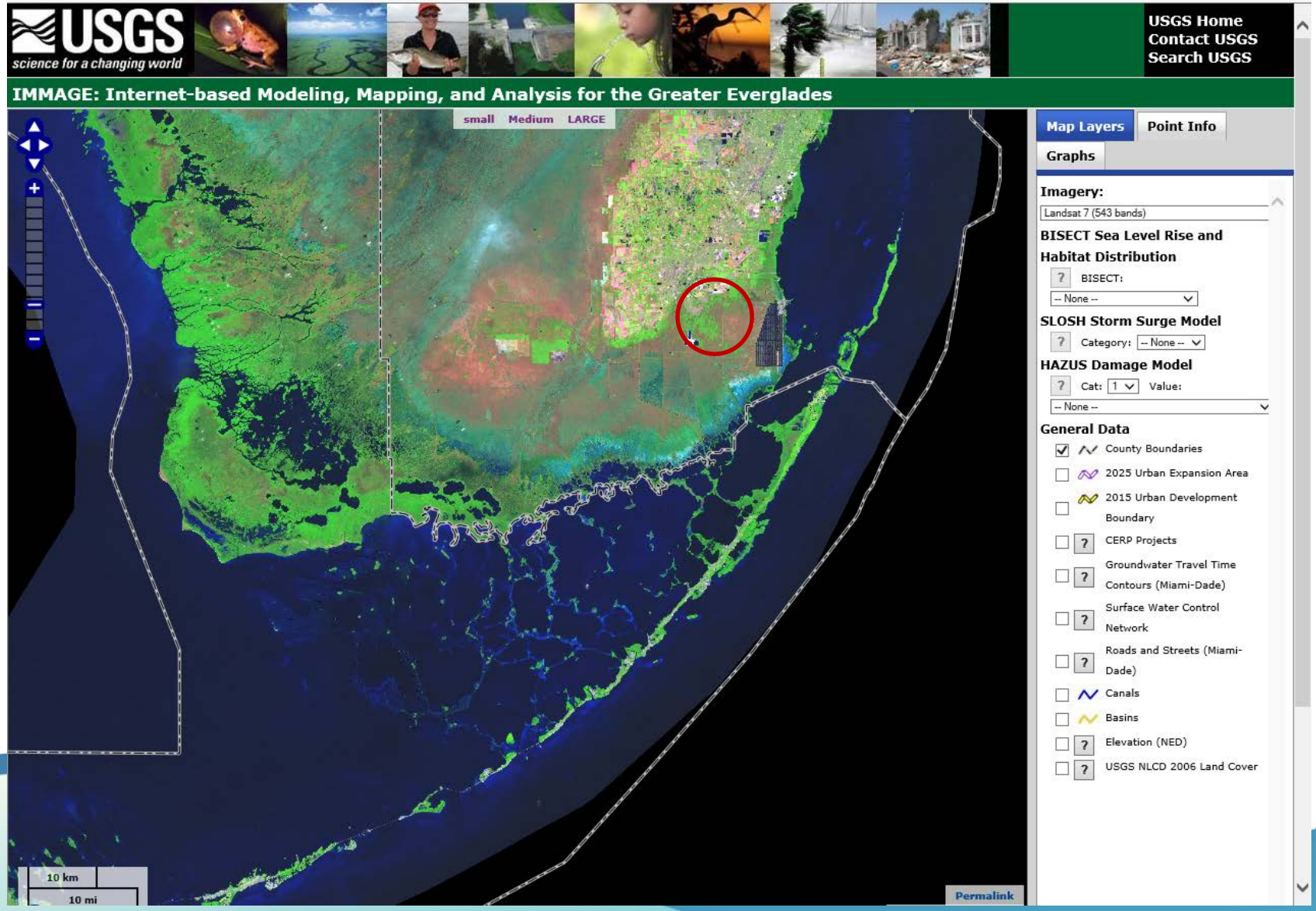
WATER SUPPLY AND DISTRIBUTION (FKAA)



Note: Pumps and valves are located at a variety of locations throughout the distribution system.

http://water.epa.gov/lawsregs/rulesregs/sdwa/tcr/images/distribution_system2_1.jpg

FKAA Groundwater Wells



http://lcat.usgs.gov/immage/immage.html

FKAA GROUNDWATER WELLS

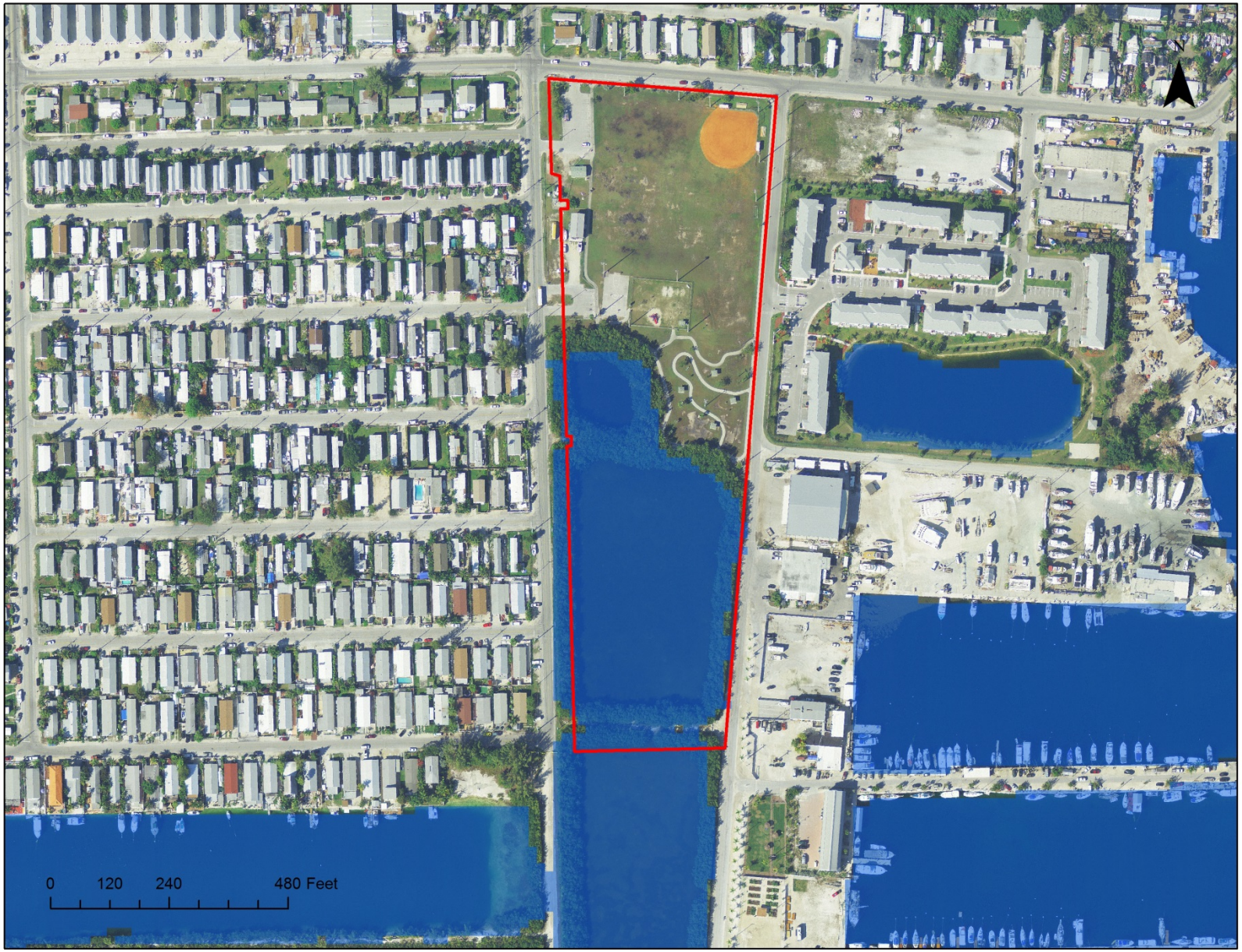
1. *Model results supplied by USGS do not show saltwater contamination to FKAA well field by any 2030 or 2060 sea level rise scenario*

2. *Potential for development of new wells in west Dade and increased severity of drought episodes not factored into these models*

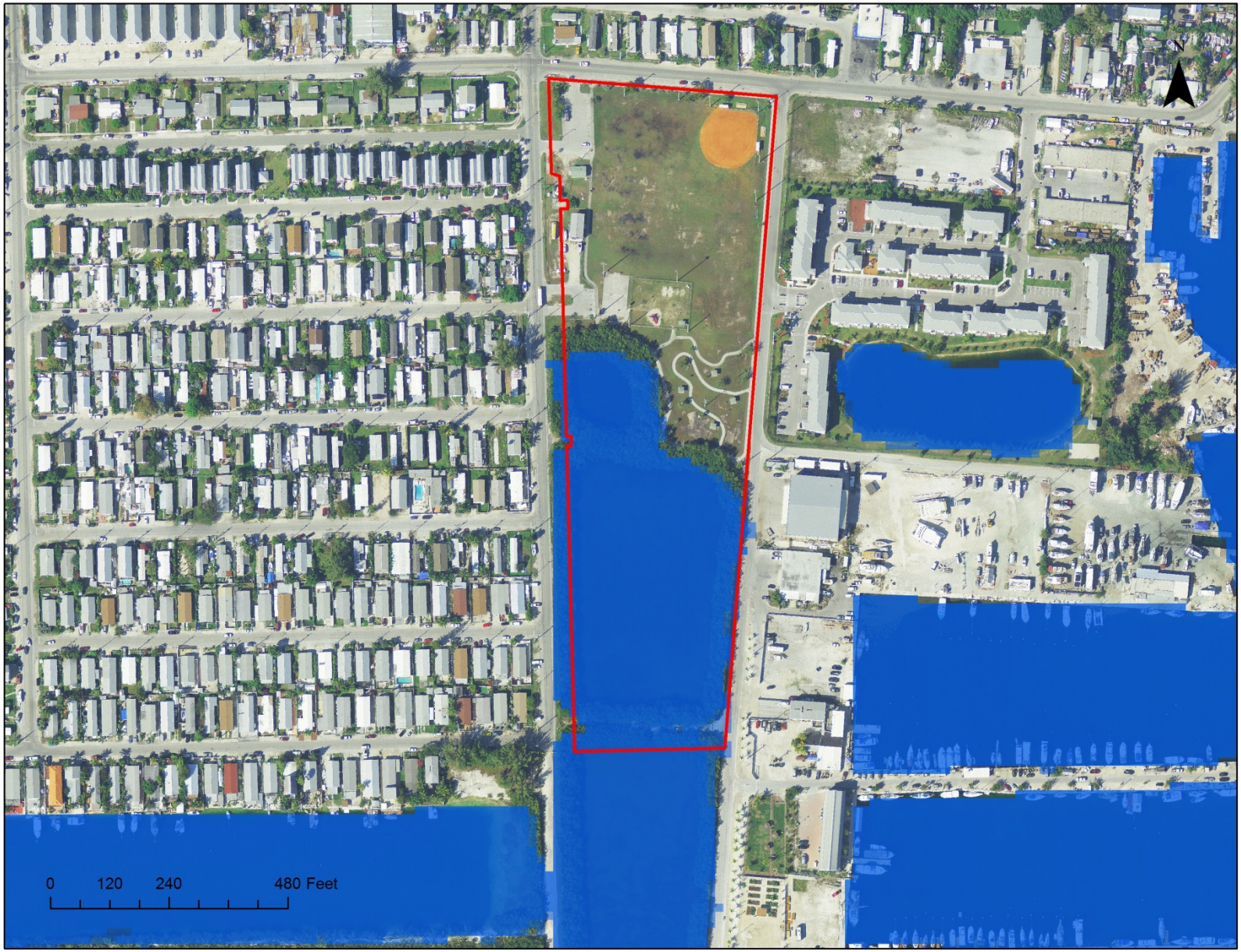
COUNTY FACILITIES AND BUILDINGS

1. Evaluated 74 parcels with County-owned buildings and facilities
2. 41% (26 parcels) show flooding encroachment at 3 inches of sea level rise
3. 53% (36 parcels) show flooding encroachment at 24 inches sea level rise
4. Overlays with aerial photos show buildings generally located on highest ground

BERNSTEIN PARK - STOCK ISLAND

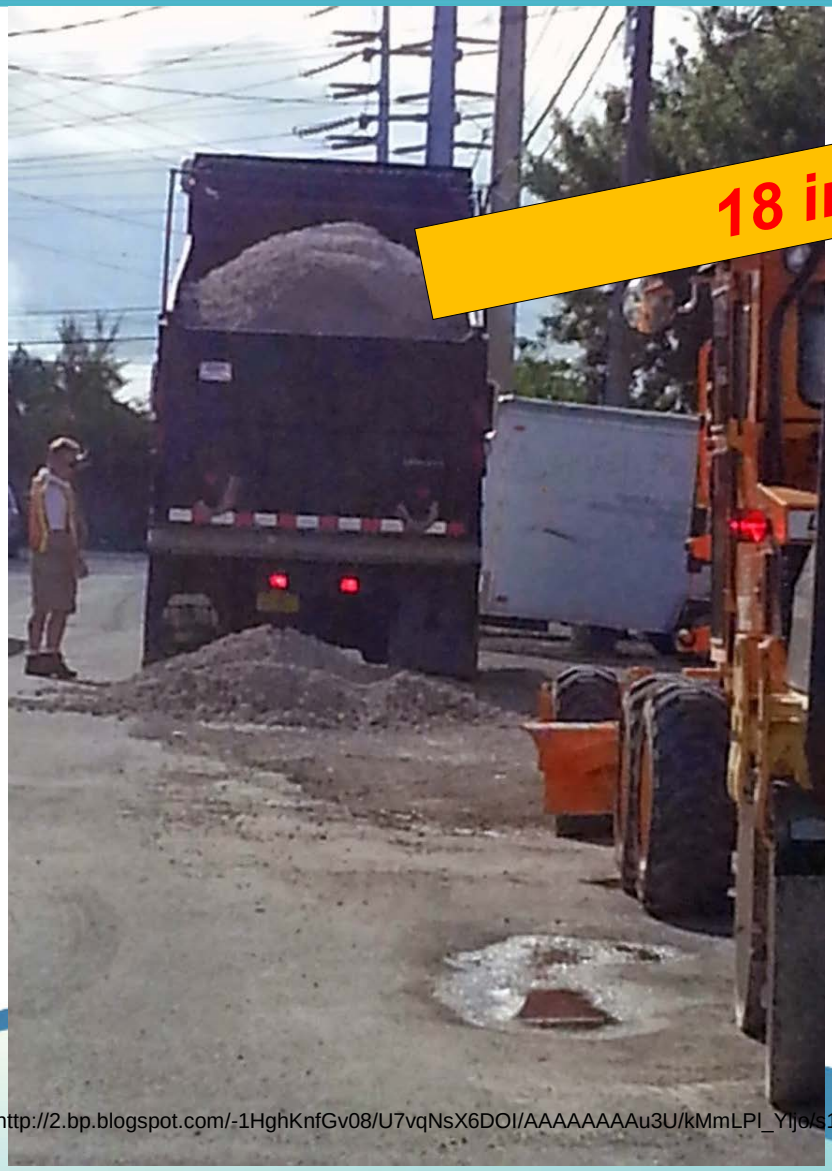


Bernstein Park, 3 inches sea level rise (2030 Low Scenario)

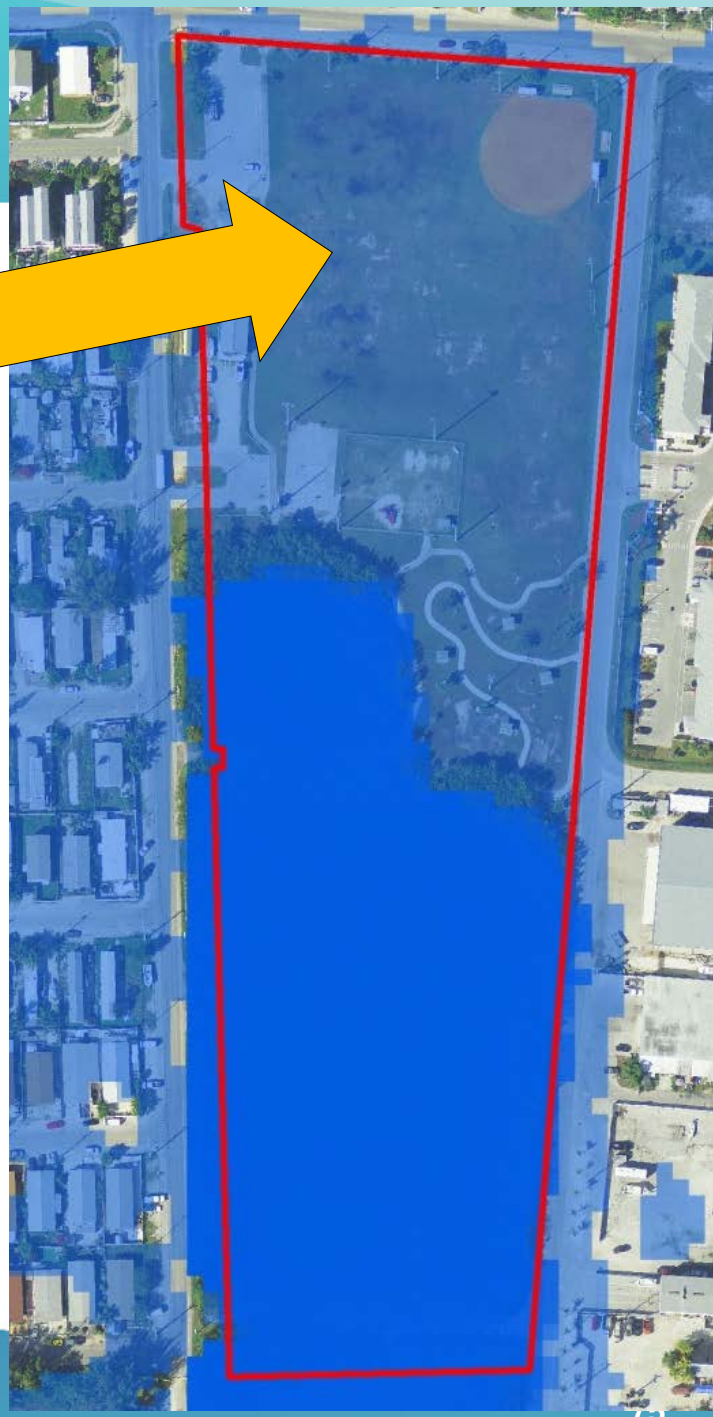


Bernstein Park, 24 inches sea level rise (2060 High Scenario)

Public Works project

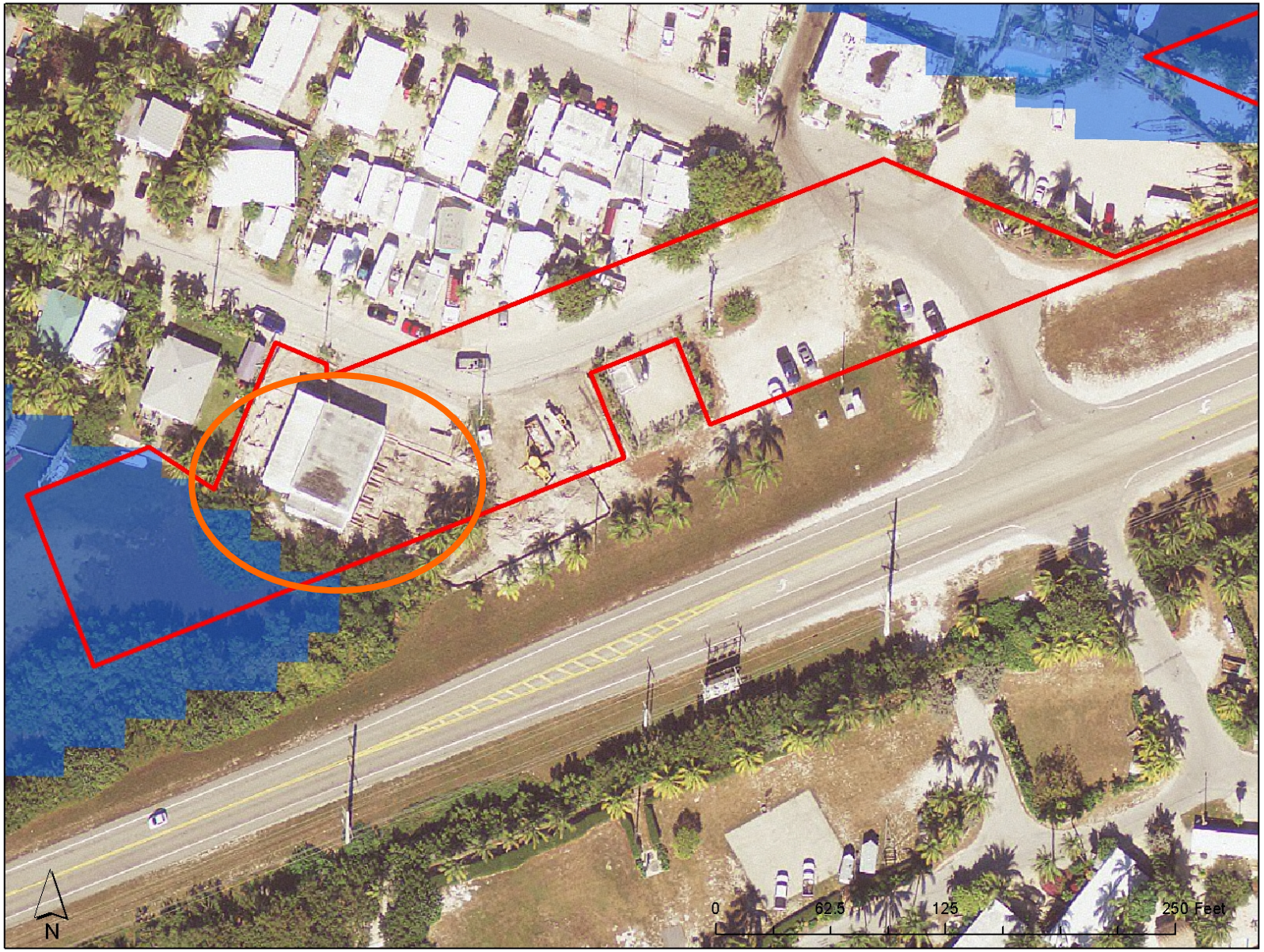


http://2.bp.blogspot.com/-1HghKnfGv08/U7vqNsX6DOI/AAAAAAAAAu3U/kMmLPl_Yljo/s1600/20140626_091001.jpg

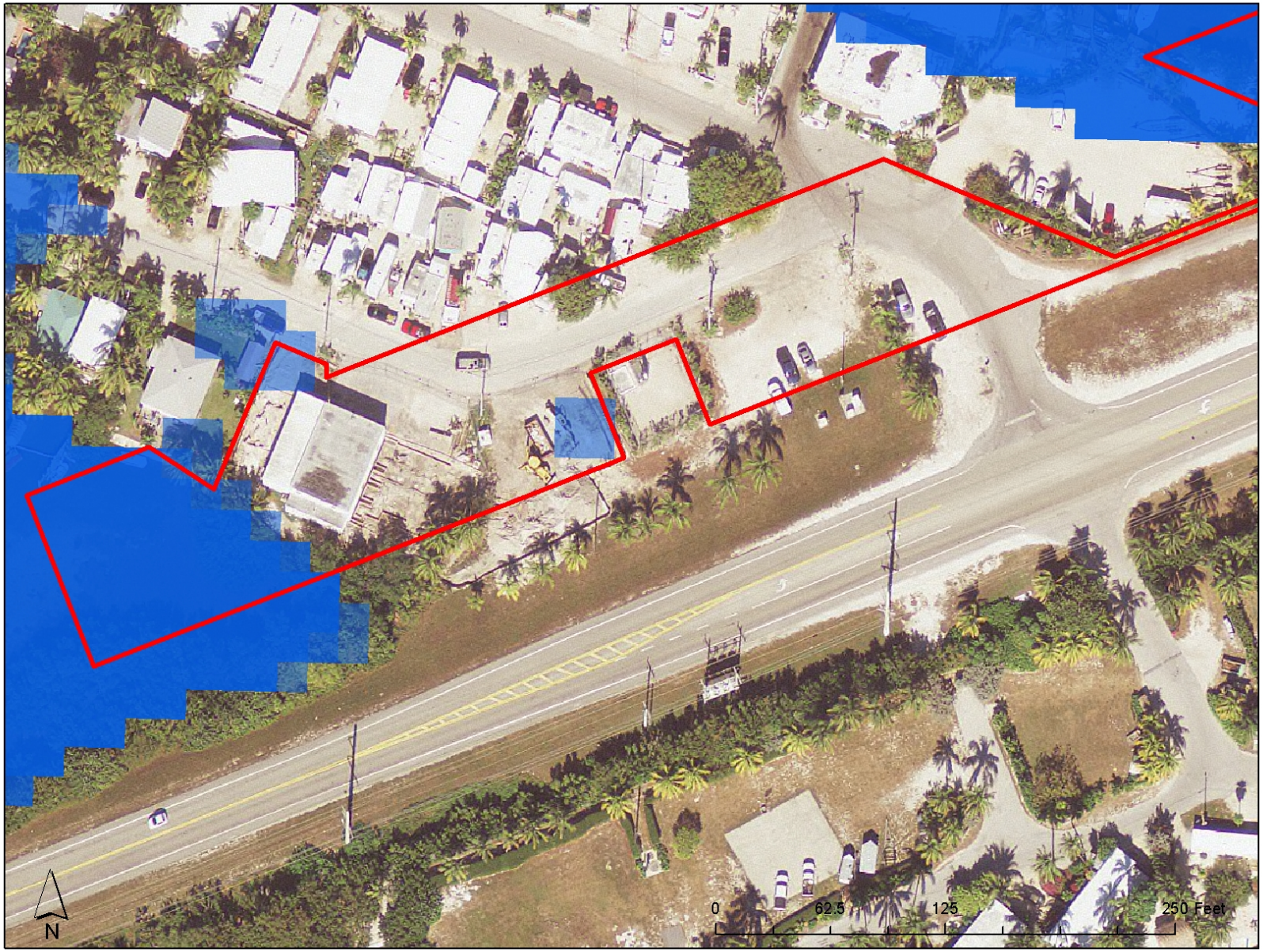


Bernstein Park, 24 inches sea level rise (2060 High Scenario, after fill elevation)

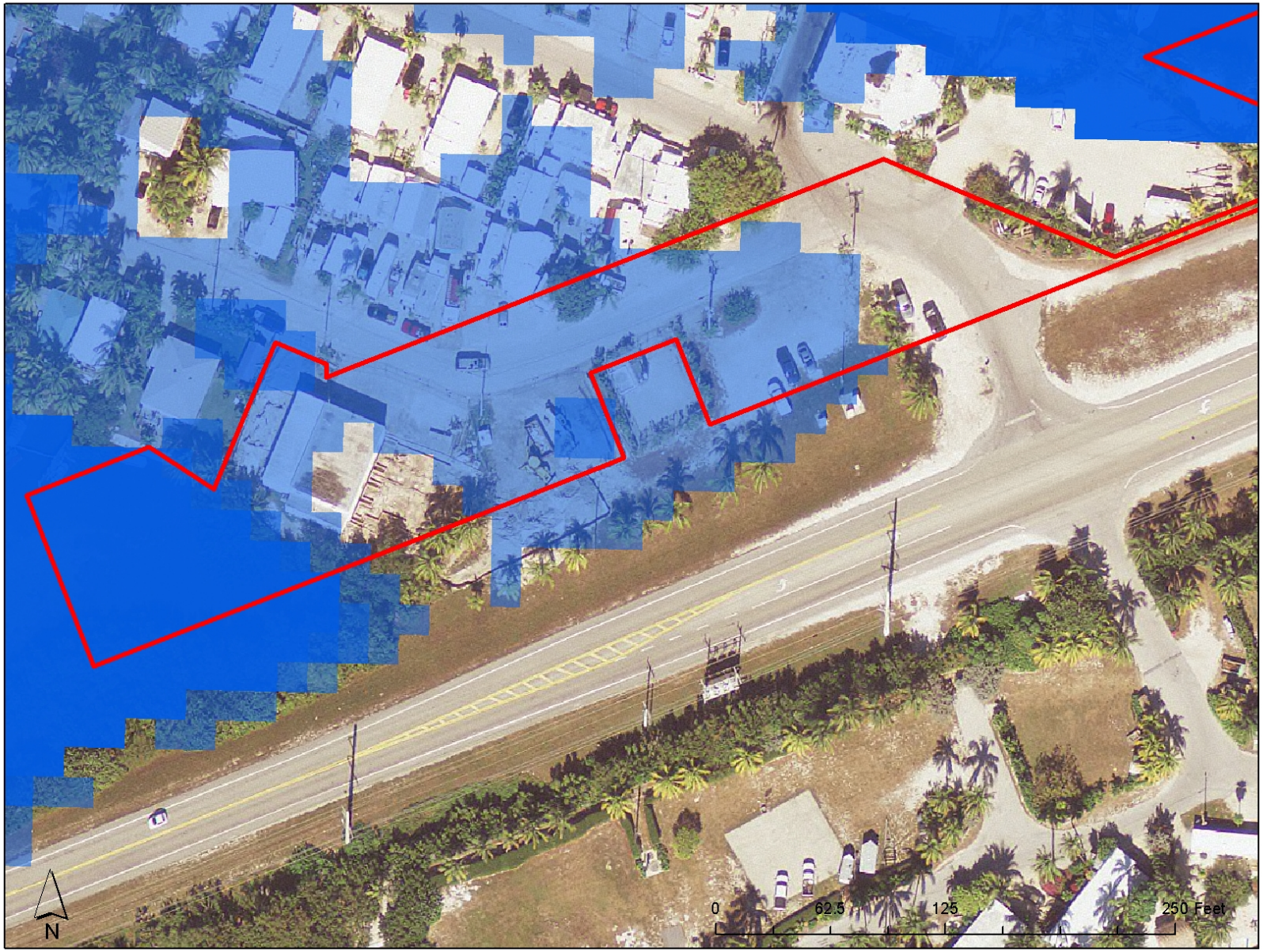
Conch Key Fire Station, 3 inches sea level rise (2030 Low Scenario)



Conch Key Fire Station, 9 inches sea level rise (2060 Low Scenario)

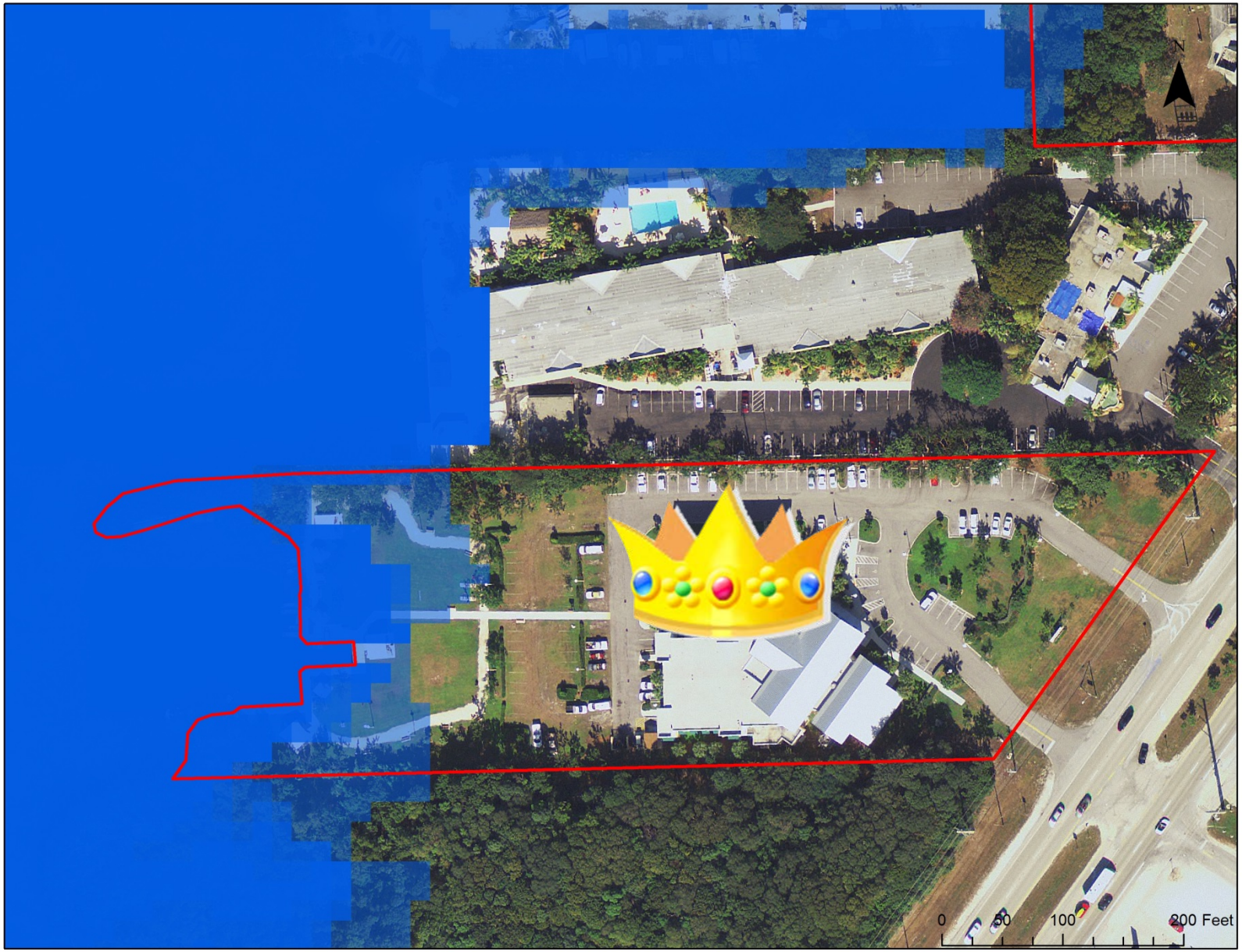


Conch Key Fire Station, 24 inches sea level rise (2060 High Scenario)



Key Largo Government Center, 3 inches sea level rise (2030 Low Scenario)

KEY LARGO GOVT CENTER, 24 inches sea level rise (2060 High Scenario)



ELECTRICAL INFRASTRUCTURE

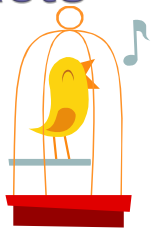
Flooded electrical substation
Tewkesbury, England

ELECTRICAL INFRASTRUCTURE

1. Evaluated 12 electrical facility locations and support infrastructure
   a) 6 Keys Energy Services
   b) 6 Florida Keys Electrical Cooperative
2. Good News!

TECHNICAL RECAP

1. The Florida Keys are clearly vulnerable to impacts from long-term sea level rise
2. Roads will be the "canary in the coal mine"
3. Lower and Middle Keys will feel earlier and more widespread effects as compared to the Upper Keys
4. Impacts to other infrastructure will gradually increase through 2030 scenarios
5. High sea level rise scenario brings a *Wilma-like event* to Key West twice *a year by 2060*
6. Effective adaptation planning requires continuous development and enhancement of information



Human Habitat

Human living areas impacted by tidal flooding 2 feet of sea level rise, 2060*

Rank	County	County population displaced
1.	Tyrell, NC	45%
2.	Hyde, NC	42%
3.	**Monroe, FL**	**36%**
4.	Dare, NC	21%
5.	Currituck, NC	20%

Land that's dry now that will go under water by 2060 in relation to the number of people living there

**National-scale analysis of over 300 coastal counties*
Matthew Hauer, Applied Demography Program, University of Georgia

WHAT COULD THIS MEAN?

http://activerain.trulia.com/image_store/uploads/3/9/8/6/1/ar117798897116893.jpg

"STILTSVILLE", NEAR MIAMI

DECISION MAKING PARADIGM SHIFT

LAND- ACQUISITION / MANAGEMENT

Species, Habitat and Adaptation/Mitigation

POLICY IMPLEMENTATION-

Departmental Collaboration,

Comp Plan, Code, Legal Issues

PROJECT PLANNING-

Addressing Priority Vulnerabilities,

Budget Implications (New Cost Considerations),

Departmental Collaboration

NEAR TERM ACTION: ENHANCED INFORMATION

1. **Create database** for localized tide/flood events (if not centralized)
2. **Digital building footprints** and ground floor elevations for all structures
   a) Appraiser's aerial photography
   b) Elevation certificates
   c) "Easy" to do, but labor and time-intensive
   d) Beginning with County-owned buildings and facilities

NEAR TERM ACTIONS:
SUGGESTIONS FOR ENHANCED INFORMATION

3. **Existing aerial LiDAR from Florida Department of Eme**

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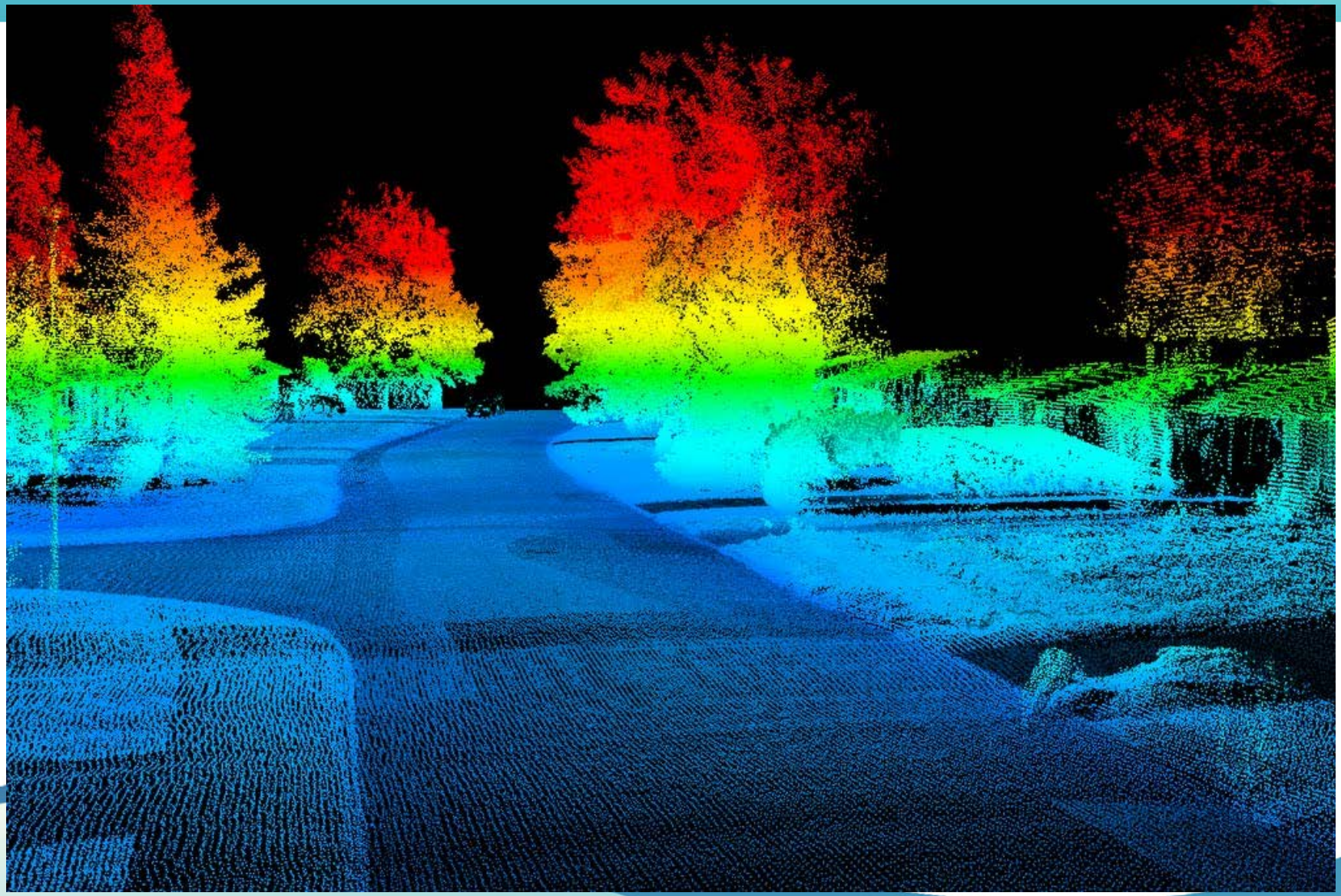
MOBILE LIDAR “POINT CLOUD”



http://static.panoramio.com/photos/large/54282010.jpg

WHAT HAS THE COUNTY DONE TO BEGIN PREPARING?

STOCK ISLAND FIRE STATION (KEY WEST)

Station Floor Located Here

2/13/13

Under Construction, Elevation 1.5 ft. above Code

STOCK ISLAND FIRE STATION (KEY WEST)

- **Cost To Elevate: $100,000.**
  - More fill
  - Longer drive for the garage area
  - More concrete to raise the elevated floor of the other part of the building (living areas)
  - Longer stairs and ramps.
  - Equipment (a/c condensers and generator) needed to be elevated more.
  - More labor on the plumbing
- **TOTAL COST $3.2 Million**

KEY WEST AIRPORT

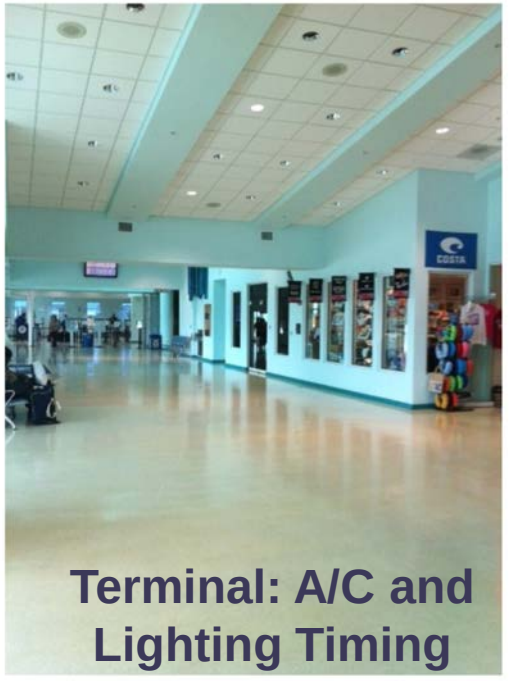
- End-of-Runway flooding from extreme high tide May 2012

- Area is designed to flood during rain events
  - Now gets wet during extreme high tides

KEY WEST AIRPORT

- **Lighting Upgrade Completed 7/2/14**
  - Original bulbs 75.9 kw/day
    - $3044 cost – 10 years
  - LED bulbs 12.65 kw/day
    - $507 cost – 10 years
  - Total Savings 10 years $19,238
- **October 2014 Taxiway Lighting to be installed**
  - **72%** energy savings
- **November 2014 Ph. 2 of airfield signage begins**
  - **68%** energy savings

Security Checkpoint Lighting



Terminal: A/C and Lighting Timing

Key West Sustainability Award

LED Runway Lights

PUBLIC OUTREACH AND EDUCATION

KEY WEST CITIZEN

Keys' Only Daily Newspaper. Est. 1876

Red Shirt run photos and results — Page 2B, 3B

Insurance available for costly life flights

Trauma Star vs. LifeNet: Confusion still lingers in Keys

Flooded memories could be the future

vs. "Nuisance Flood"

Tide Chart Prediction

Individual solutions to a global problem

Wetter lands forecast by 2060

Talk is cheaper than ever

EVENTS

1. Commission Sea Level Rise Workshop 9/3/14
2. Planning And Legal Sea Level Rise Issues Workshop 9/12/14

COMMUNITY MODELING – see next slide

- October 9th Community Modeling Workshop #1- KEY LARGO
- November 5th Community Modeling Workshop #2-KEY LARGO
- December 9th Community Modeling Workshop #3- KEY LARGO

SUSTAINABILITY GOAL DEVELOPMENT WORKSHOPS

Additional Community Modeling Workshops

Draft Plan Presentation To Public And Bocc Early Winter

HOW TO ENGAGE:

- Greenkeys.info
- http://greenkeys.mindmixer.com/

KEY LARGO WORKSHOPS

WORKSHOP SERIES FOR RESIDENTS AND BUSINESSES

PREPARING FOR SEA LEVEL RISE IN KEY LARGO

Murray Nelson Government Center, 102050 Overseas Highway, Key Largo

Date	Topic
THURSDAY OCTOBER 9TH 5:30 p.m. – 8:30 p.m.	#1. Identifying Sea Level Rise Risks to Homes & Businesses in Key Largo
WEDNESDAY NOVEMBER 5TH 5:30 p.m. – 8:30 p.m.	#2. What We Can Do to Prepare our Homes & Businesses in Key Largo
TUESDAY DECEMBER 9TH 5:30 p.m. – 8:30 p.m.	#3. What Will It Cost to Prepare? What are the Benefits?

The map to the right shows the projected effects of sea level rise at 24" in Key Largo. Come to the workshop series and learn what is predicted for your street and neighborhood, what you can do to prepare, and what are the costs versus benefits.

QUESTIONS?

RHONDA (305) 453-8774

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