Eastern Shore Drive Drainage Improvements Project Briefing Part II

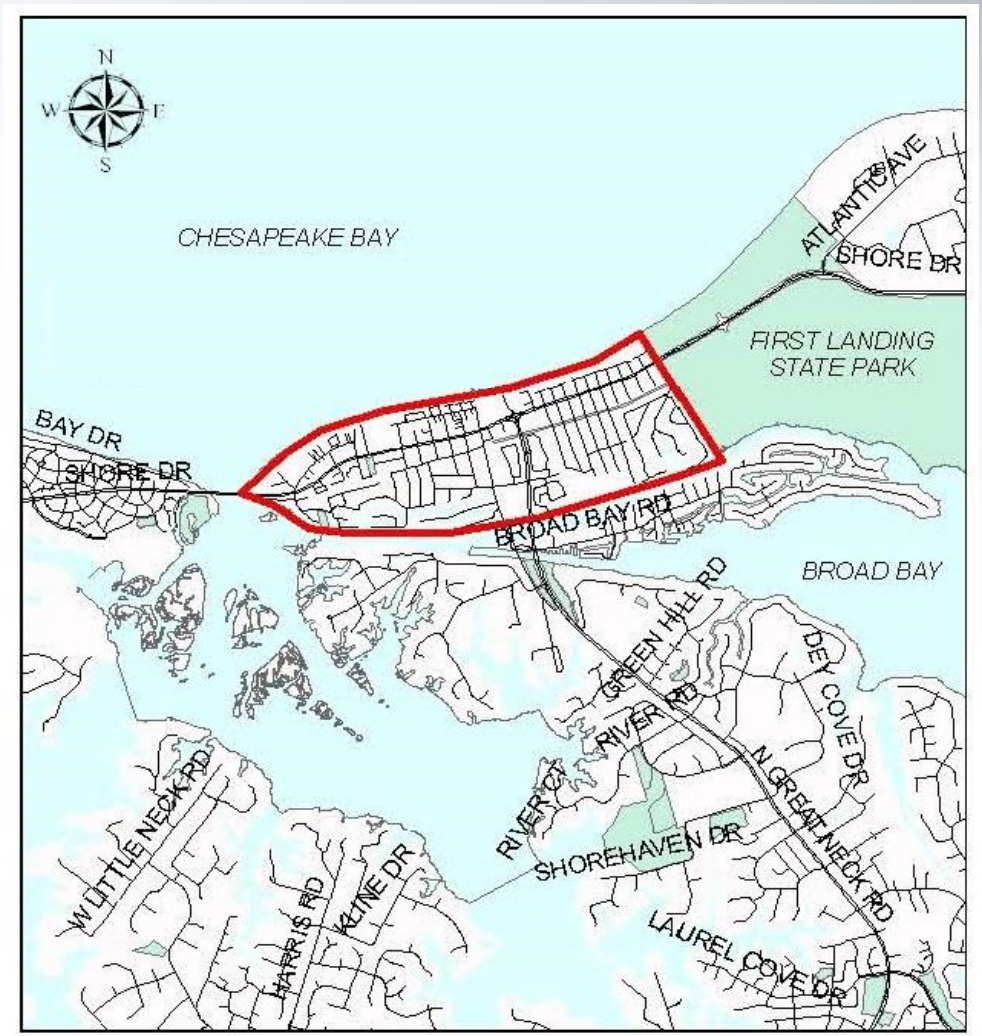
PW/Engineering April 22, 2014

Public Works.....Delivering Excellence, Serving with Pride

Today's Presentation

- What is the Eastern Shore Drive Area?
- What Actions Have Been Taken to Date?
- Why is the Eastern Shore Drive Drainage Area Experiencing Recurrent Flooding?
- What In General Can Be Done About It?
- What Specific Measures Are Being Considered?

Eastern Shore Drive Area

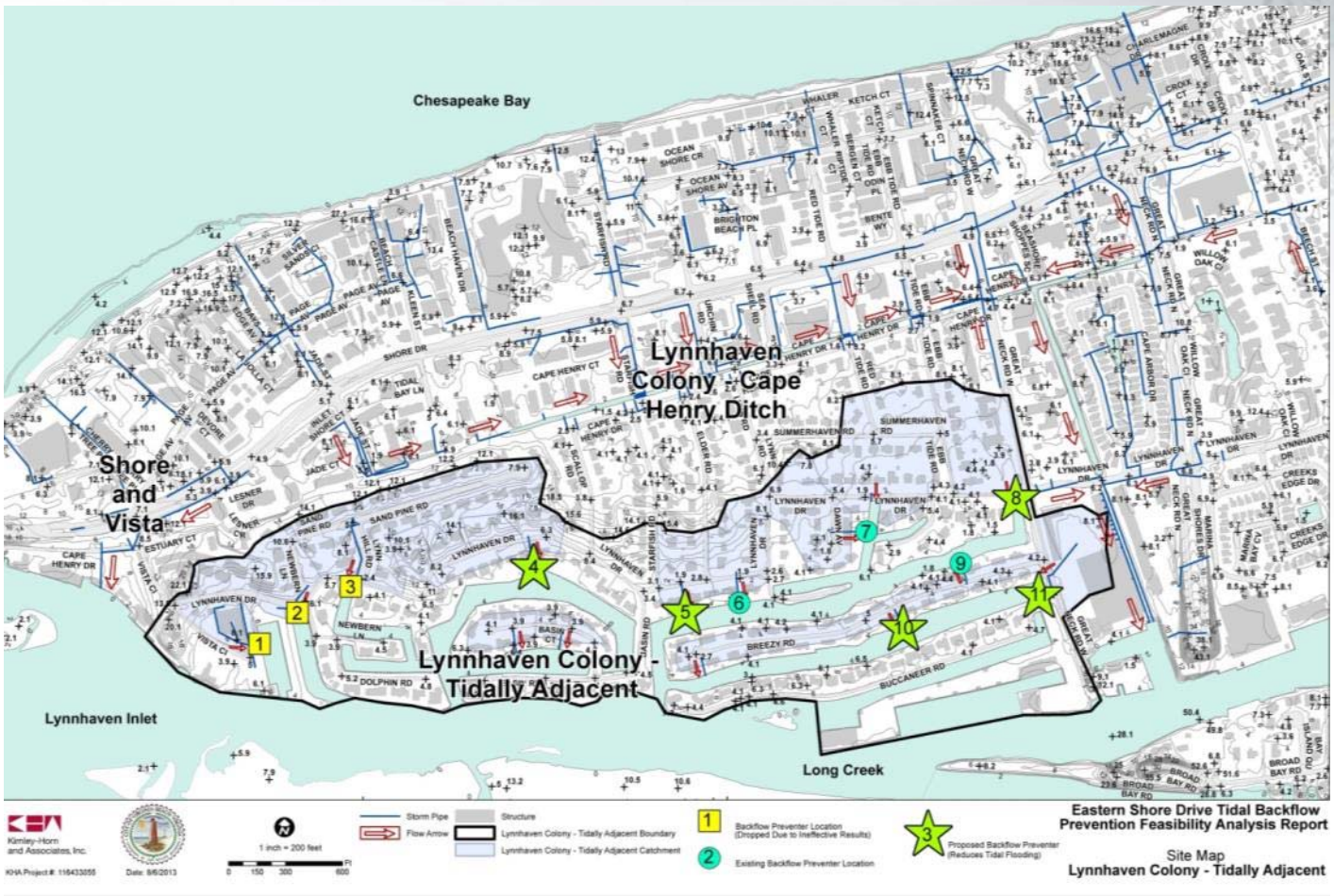


Actions to Date

- Previously Briefed Council on September 3, 2013
- Focus of the September 3, 2013 Briefing:
  - Interim Improvements
- Authorized Package of Interim Improvements
  - $1.5 M budget
  - 5 Check Valves (Completed January 2014)
  - 3 Sluice Gates (Under Design, Construct late 2014))
  - Reduces Flood Frequency
    - 40 Houses
    - 48 Garages
    - 7,450 Feet of Roadway

Interim Flood Control Measures

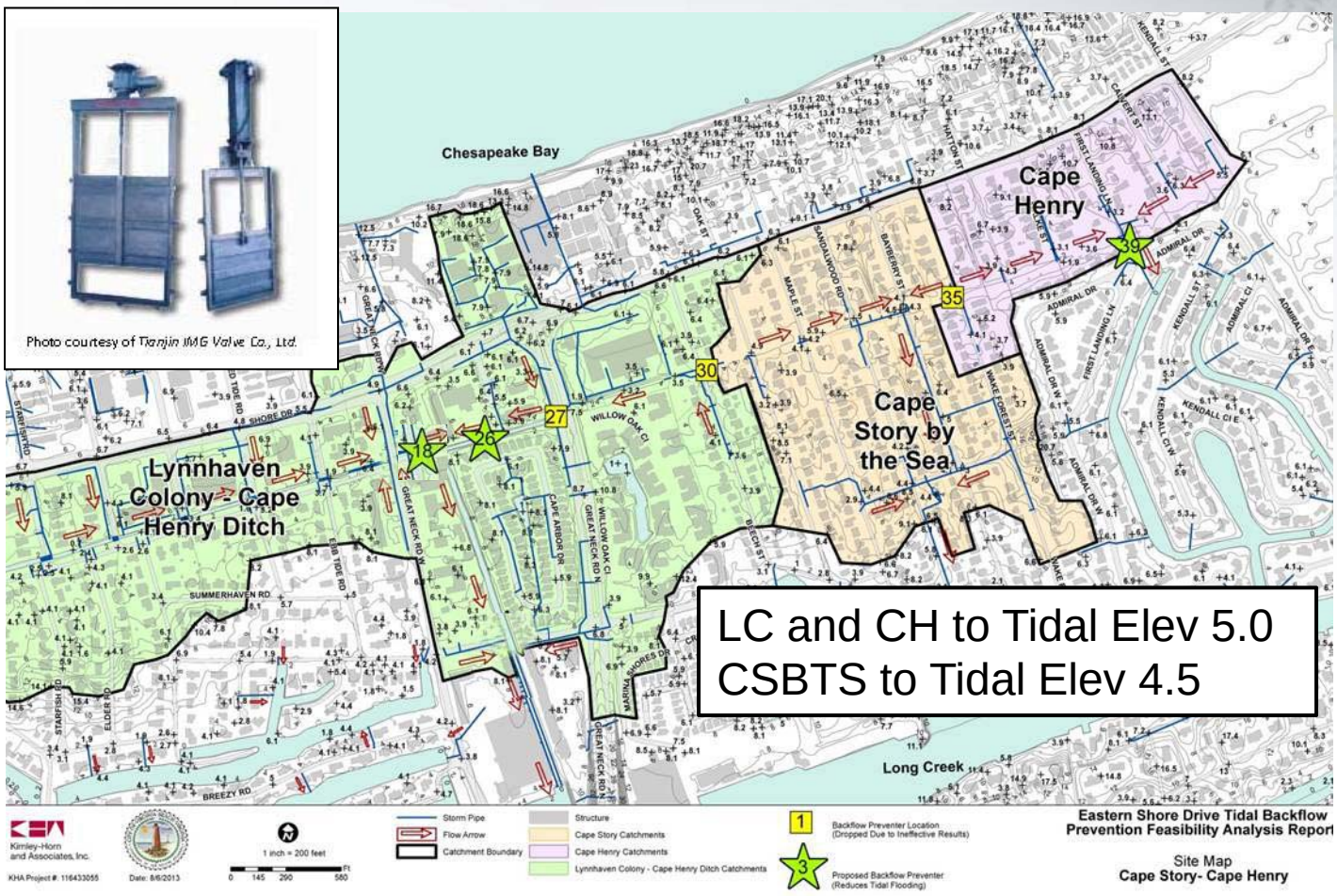
Lynnhaven Colony – 5 Tide Valves



Check Valves

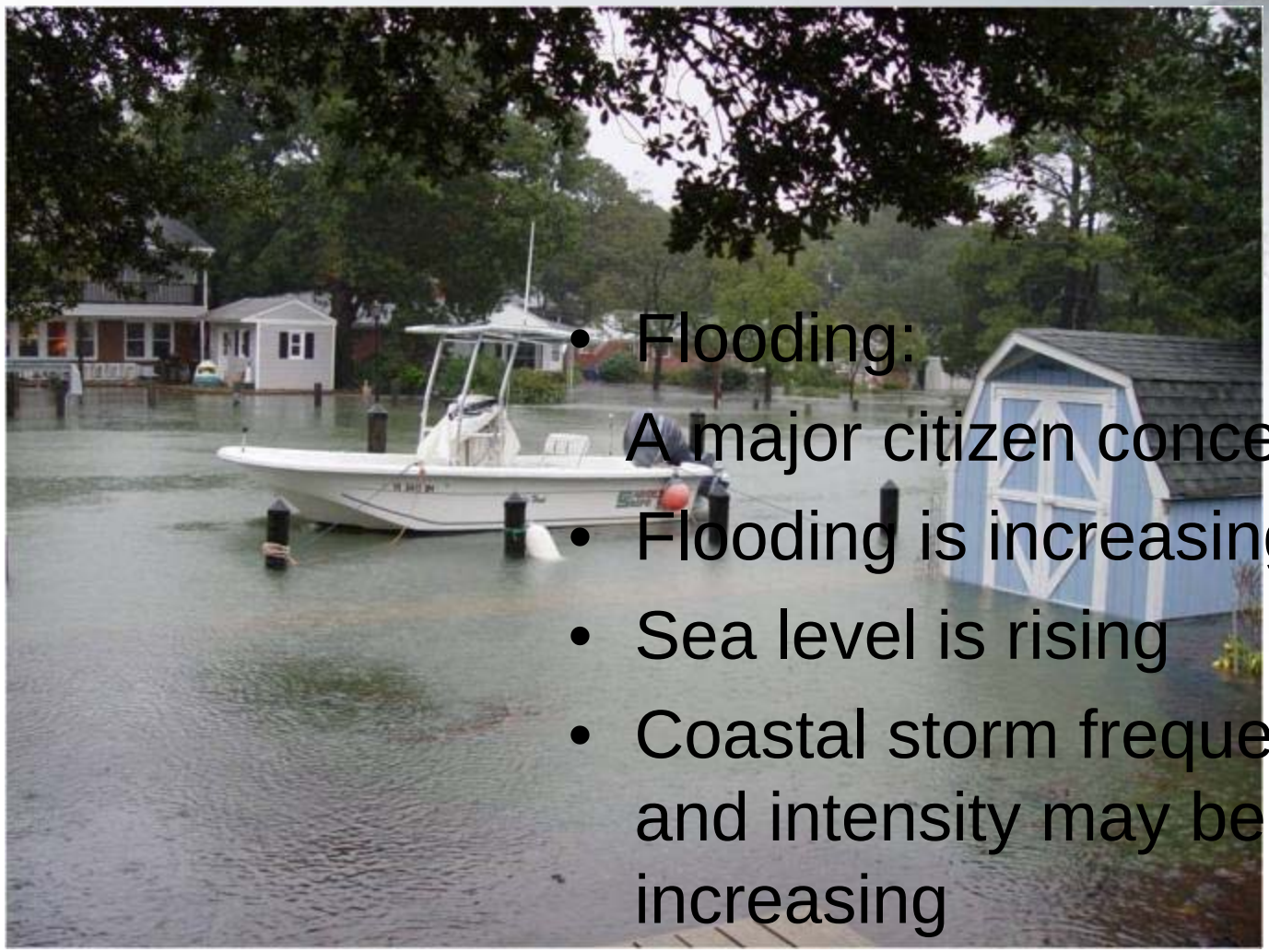
Interim Flood Control Measures

3 Flood Gates On Cape Henry Ditch



Why is the Eastern Shore Drive Drainage Area Experiencing Recurrent Flooding?

Recurrent Flooding, Sea Level Rise, & Coastal Storms



- Flooding:
  - A major citizen concern
- Flooding is increasing
- Sea level is rising
- Coastal storm frequency and intensity may be increasing

Sea Level Rise Information

- Sewell's Point: + 0.18 in/yr
- CBBT: + 0.24 in/yr
- Rise last 50 years: ~ 1 ft
- Projected rise next 50 years: 1.5 – 3 ft*

* VIMS Recurrent Flooding Study for Tidewater Virginia, Jan. 2013

Coastal Storms Information

Sewell's Point Storm Tide Info

Benchmarks and Events	MLLW (FT)
Category 4 - (13-19 Feet Surge at High Tide)	21.56
Category 3 - (9-12 Feet Surge at High Tide)	14.56
Category 2 - (6-8 Feet Surge at High Tide)	10.56
1933 Hurricane 8.02' Above MLLW	8.02
8.0 FT OCCURS ONCE EVERY 80 YEARS (EXTREME)	8.00
Hurricane Isabel 9/18/2003 7.89' Above MLLW	7.89
November Nor'easter 11/12/2009 7.75' Above MLLW	7.75
Category 1 - (3-5 Feet Surge at High Tide)	7.56
Hurricane Irene 8/27/2011 7.55 Above MLLW	7.55
Ash Wednesday Storm 3/7/1962 7.22 ' Above MLLW	7.22
7.0 FT OCCURS ONCE EVERY 20 YEARS (SEVERE)	7.00
Hurricane Sandy 10/29/2012 6.81' Above MLLW	6.81
Hurricane 1936 6.2' Above MLLW	6.72
Thanksgiving Nor'easter 2006 6.63' Above MLLW	6.63
Twin Nor'easter #2 1998 6.58' Above MLLW	6.58
Columbus Day Nor'easter 6.52' Above MLLW	6.52
Nor'easter 1956 6.12' Above MLLW	6.12
6.0 FT OCCURS ONCE EVERY 7 YEARS (MODERATE)	5.00
Twin Nor'easter 1998 6.04' Above MLLW	6.04
Hurricane Floyd 1999 5.97' Above MLLW	5.97
Hurricane Flossy 1956 5.92' Above MLLW	5.92
Hurricane Donna 1960 5.92' Above MLLS	5.92
4.5 FT OCCURS 3 TIMES PER YEAR (MINOR)	4.50
2.56 OCCURS 3 TIMES PER YEAR	2.56
MEAN HIGH HIGH WATER- MHW (Average all High Tides)	2.56
MEAN SEA LEVEL	1.35
MEAN LOWER LOW WATER- MLLW (Average all Low Tides)	0.00
Lowest Tide of Record 1/31/1996	-3.58

- Oldest tide gauge in the area – 1927
- 15 storms of record
- 9 within the last 16 years

Coastal Storms Since 1998

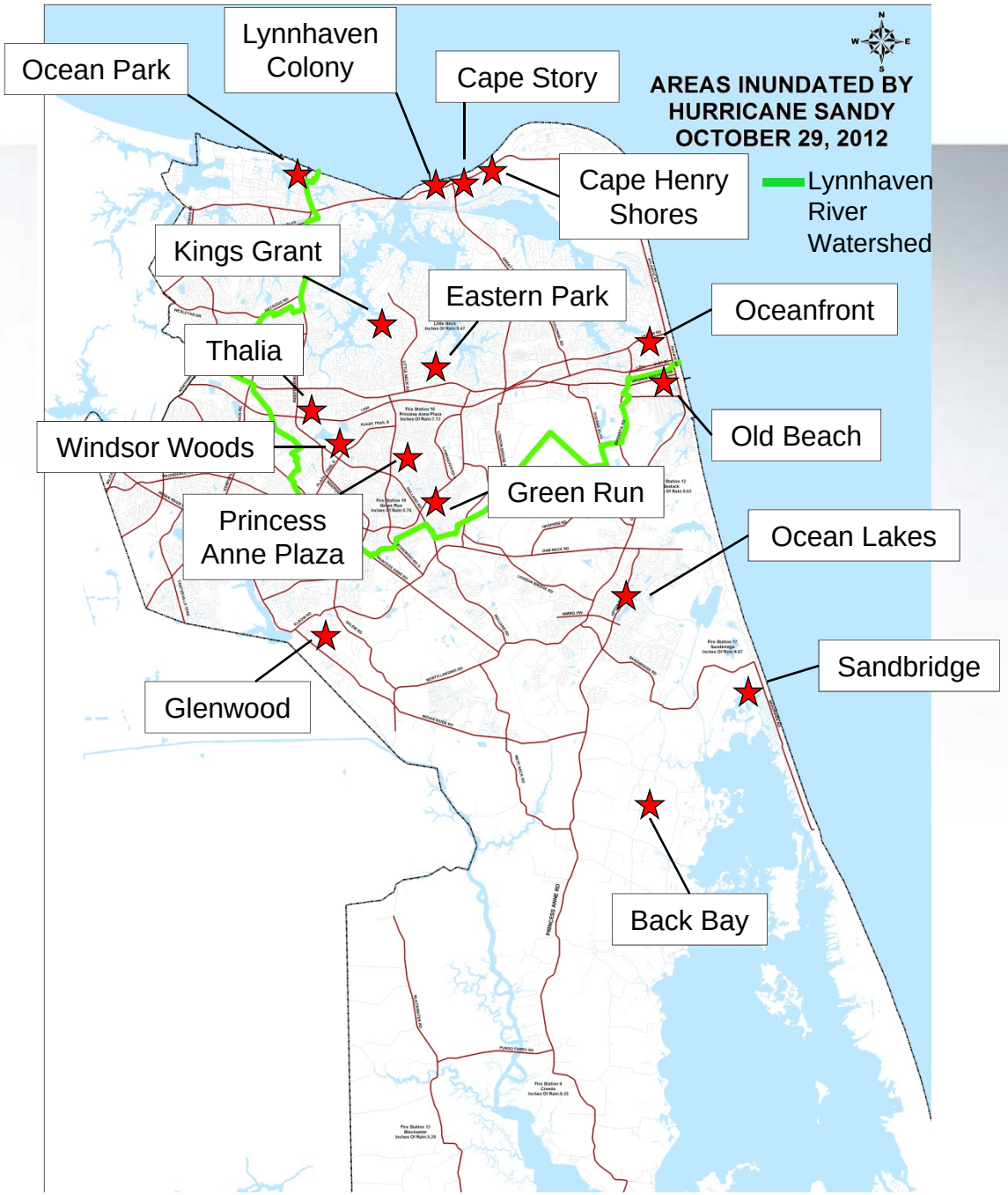
STORM	DATE	WS ELEV ESDDA
Nor'Ida	11/09	6.90
Hurricane Isabel	9/03	6.20*
Thanksgiving N'easter	11/06	6.00*
Twin N'easter #2	1/98	5.85*
Hurricane Sandy	10/12	5.70
Hurricane Irene	8/11	5.50
Columbus Day N'easter	10/06	5.30*
Twin N'easter #1	2/98	5.20*
Hurricane Floyd	9/99	4.25*

- Elevations are referenced to land survey datum NAVD88, * indicates estimated elevation

Sea level is estimated to rise 1.5 ft. to 3.0 ft. in the next 50 Yrs.

Recurrent Flooding, Sea Level Rise, & Coastal Storms

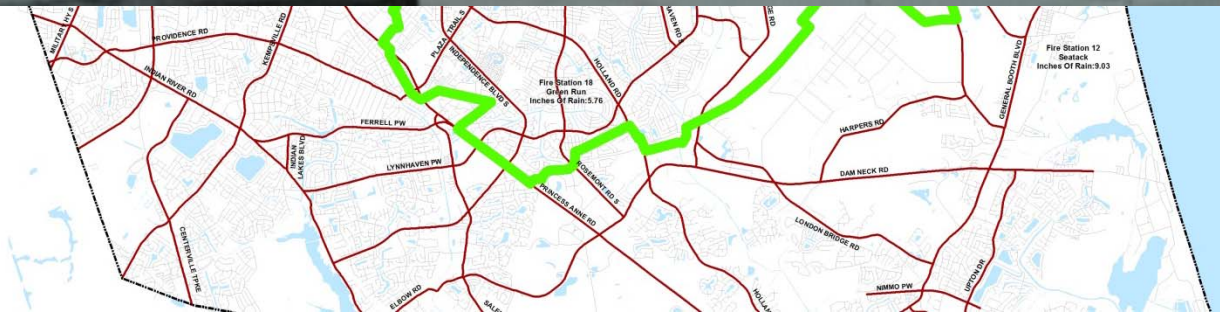
Sea Level Rise + **Coastal Storms** = **Increased and Recurrent Flooding In Many Areas**


AREAS INUNDATED BY HURRICANE SANDY OCTOBER 29, 2012
Lynnhaven River Watershed
Ocean Park
Lynnhaven Colony
Cape Story
Cape Henry Shores
Kings Grant
Eastern Park
Oceanfront
Thalia
Old Beach
Windsor Woods
Green Run
Princess Anne Plaza
Ocean Lakes
Sandbridge
Glenwood
Back Bay

ATED BY
SANDY
, 2012

haven

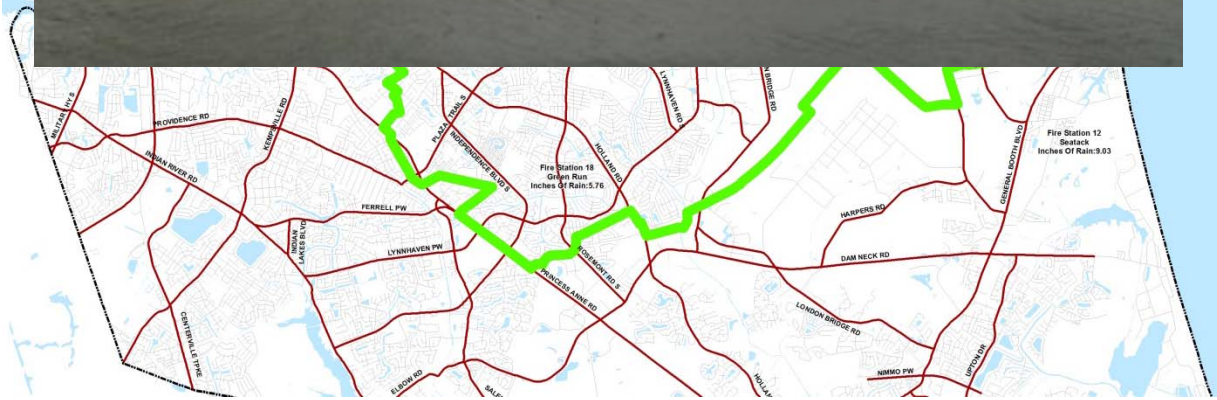
rshed



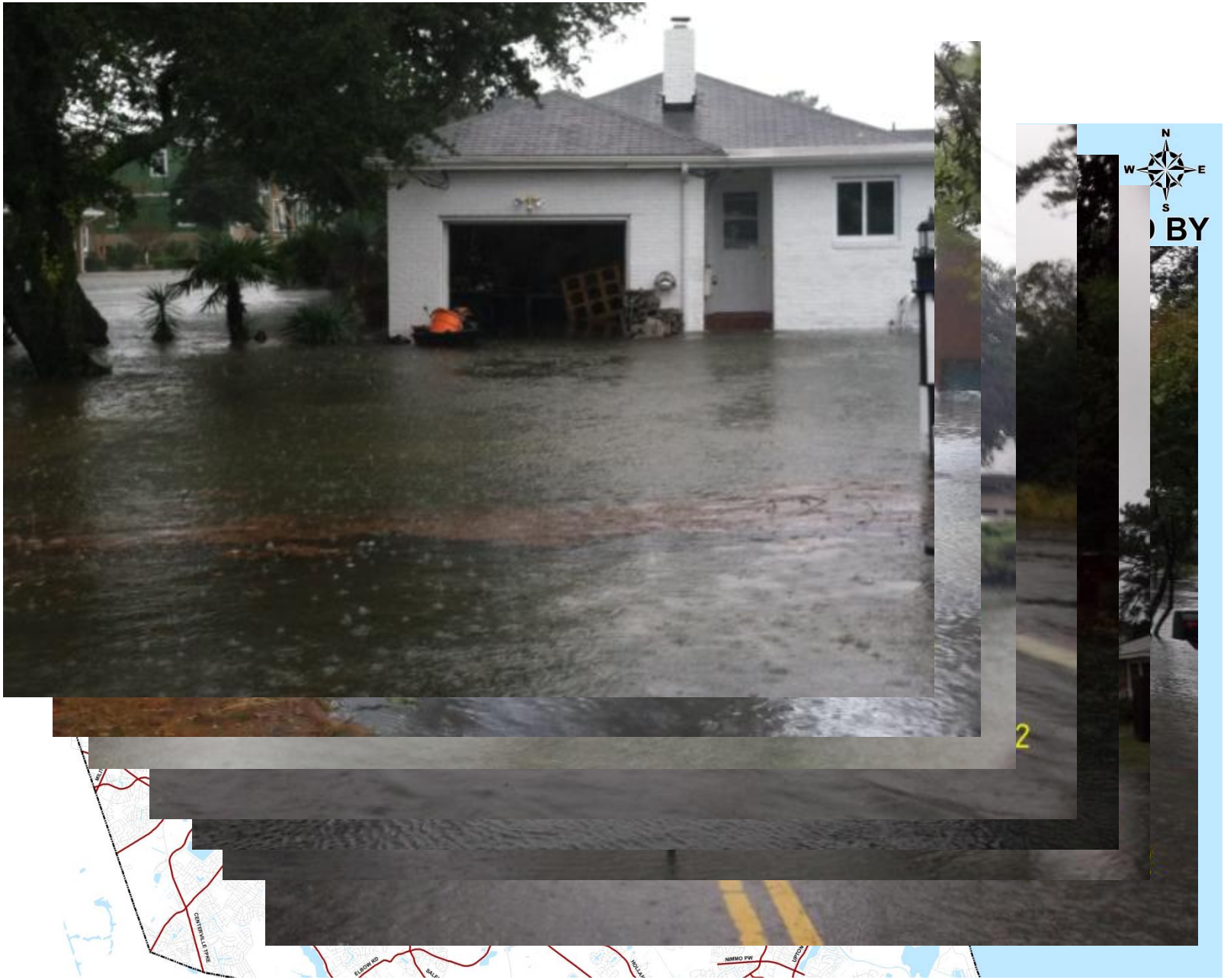
Dockside Vicinity

INUNDATED BY
RICANE SANDY
OBER 29, 2012

Lynnhaven River Watershed



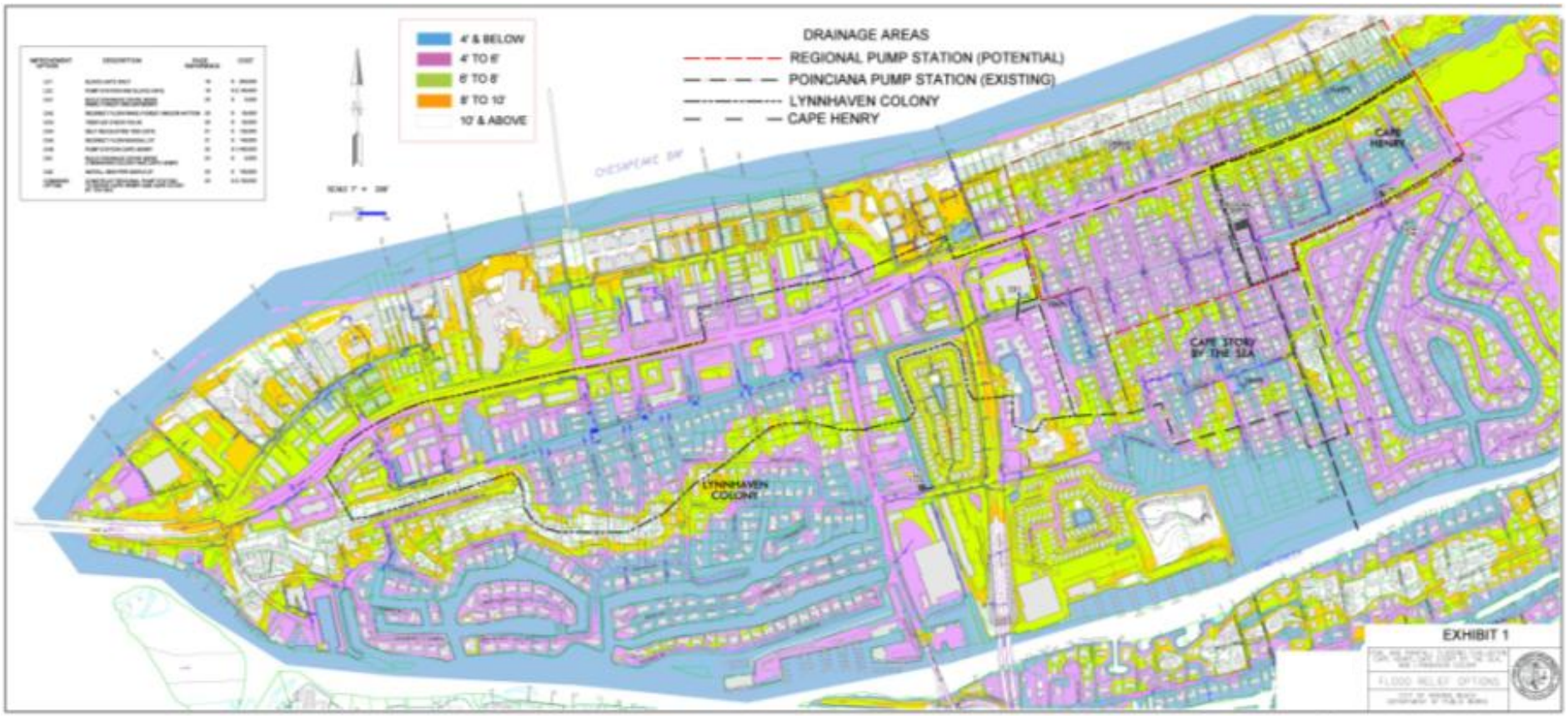
Bubba's



Eastern Shore Drive Neighborhoods

A Particularly Vulnerable Area

Elevation Map of the Eastern Shore Drive Area

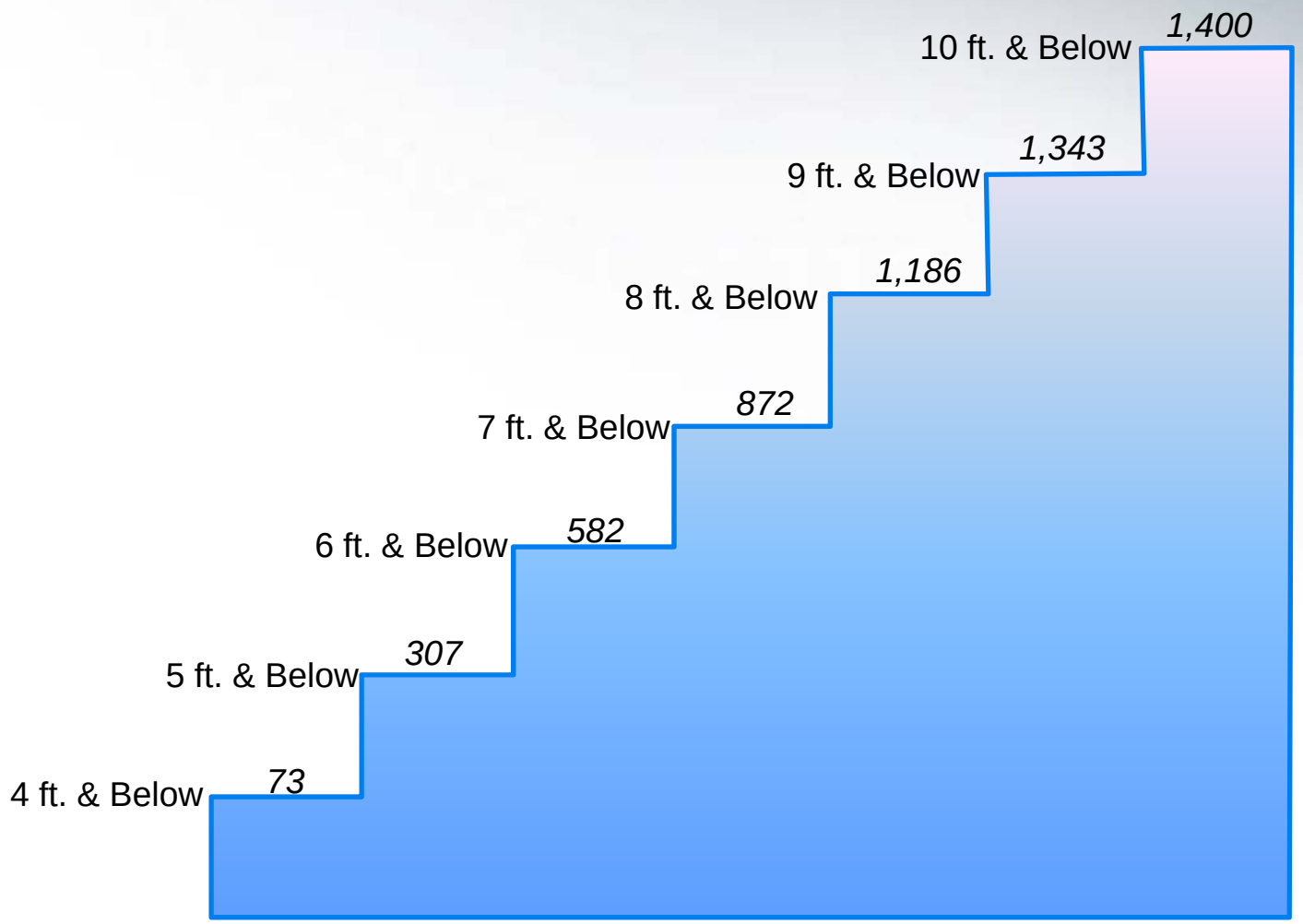


- Sea Level Rise
- High Tides
- Coastal Storms
- Storm Surge
- Low Elevations
- Rainfall

Sandy WSL≃ 5.7

Nor'Ida WSL≃ 6.9

Number of Buildings Potentially Vulnerable



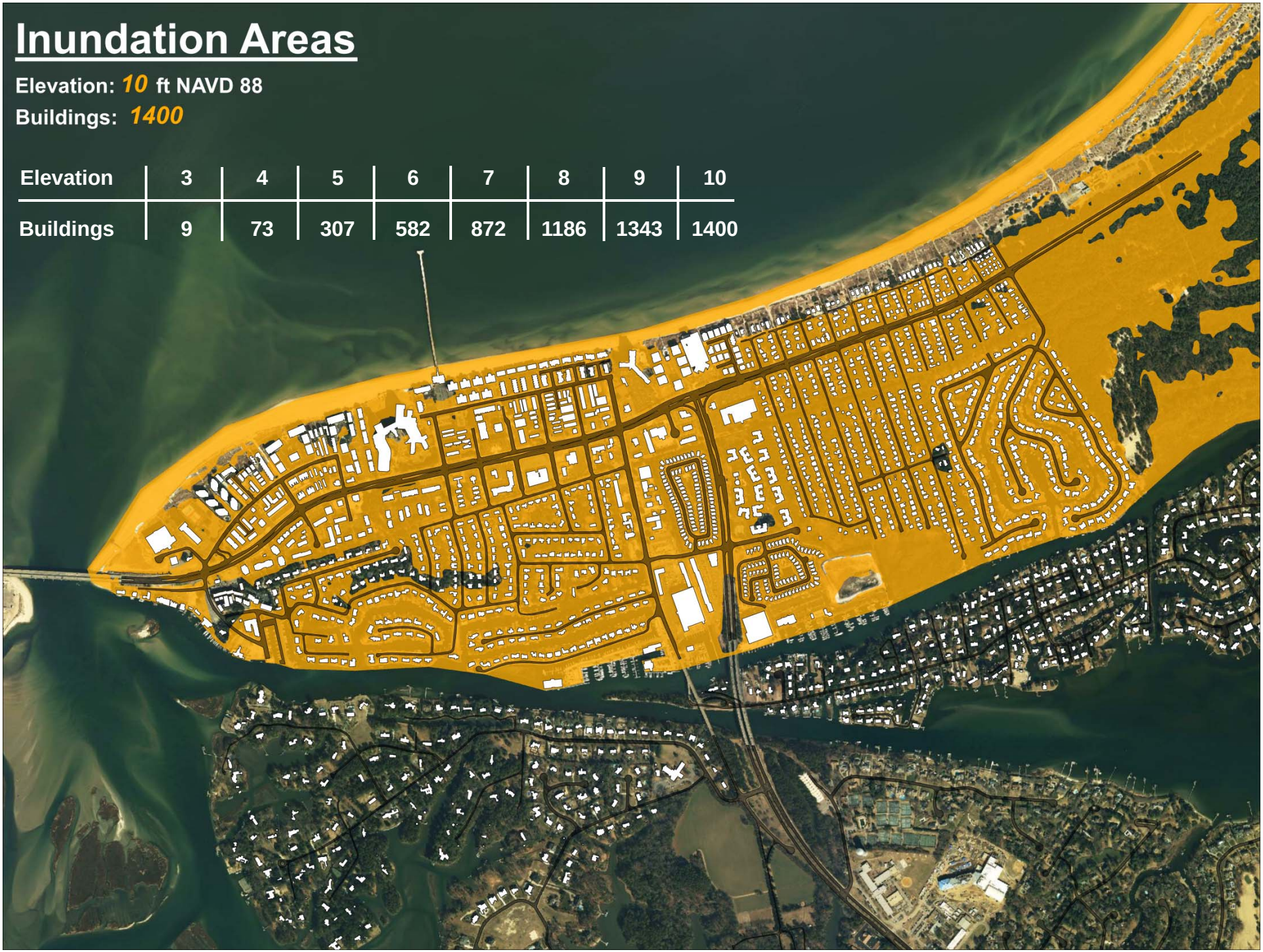
*Based on GIS Mapping and NAVD88 Datum

Inundation Areas

Elevation: *10* **ft NAVD 88**

Buildings: *1400*

Elevation	3	4	5	6	7	8	9	10
Buildings	9	73	307	582	872	1186	1343	1400



What In General Can Be Done About It?

Recurrent Flooding Adaptation Strategies

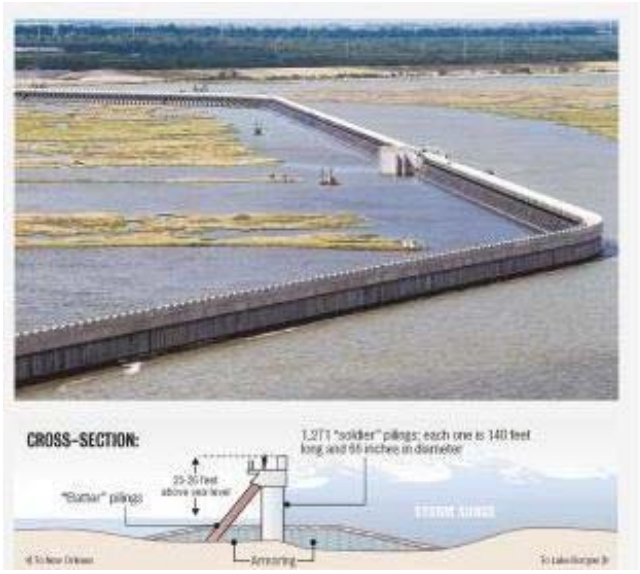
- Management / Retreat
  - Prevent development in high risk areas
  - Discourage rebuilding in high risk areas
- Accommodation
  - Elevating buildings / Flood proofing homes
  - Warning systems / Evacuate
- Engineered Protection Measures
  - Focus of Today's Discussion
    - Interim ✓
    - Comprehensive

Adaptation Strategy: Protection Measures

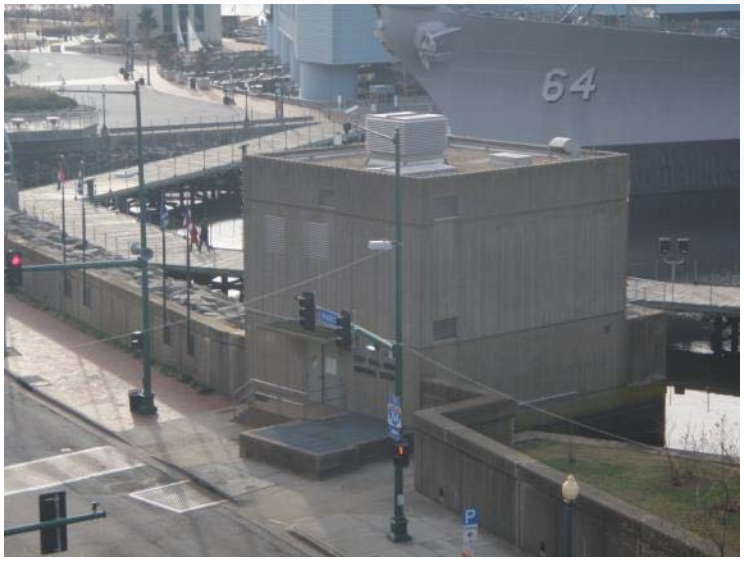
- Engineered Flood Control Measures:
  - Complex
  - Costly
  - O&M Intensive
  - Limit to Effectiveness (LOS)
- LOS Exceedence = Major Flooding

Protection Measures

- Two Primary Components:
  - Flood barriers to prevent high water levels from directly inundating the area
  - Pumps and storm drainage systems to convey rainwater and minor overtopping out



New Orleans



Downtown Norfolk

NEW ORLEANS AREA HURRICANE PROTECTION

After Katrina, Congress gave the Army Corps of Engineers $14.6 billion to repair and improve hurricane and flood protection in New Orleans. About $10 billion later, the 130-mile system of levees, walls and gates designed to keep out a 100-year storm surge is essentially complete. The corps says the city now is safe from flooding in a storm that has a 1 percent chance of hitting in any year, and the levee system also is designed to significantly reduce flooding from even larger storms. Interior drainage improvements designed to deal with heavy rainfall, however, are still under construction.

St. Charles Parish levee

Project: The levee that was unfinished during Katrina was raised and strengthened, giving the east bank of the parish its first real protection.

Notable feature: The new levee blocks off a potential back door for surge to flow from the lake through the LaBranche Wetlands to the river and then east into Jefferson Parish.

Left to be done: Armoring.

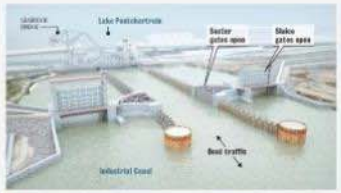
New Orleans drainage canals

Project: Temporary gates and pumps block Lake Pontchartrain storm surge from invading the city.

Notable feature: The Katrina-weakened walls of the 17th Street Canal have been strengthened by injecting concrete into their foundations. That will allow the canal to take more rainwater than has been allowed.

Left to be done: Permanent gates and pumping stations will be built at the head of each canal, to replace temporary gates built in 2006.

Seabrook Floodgate

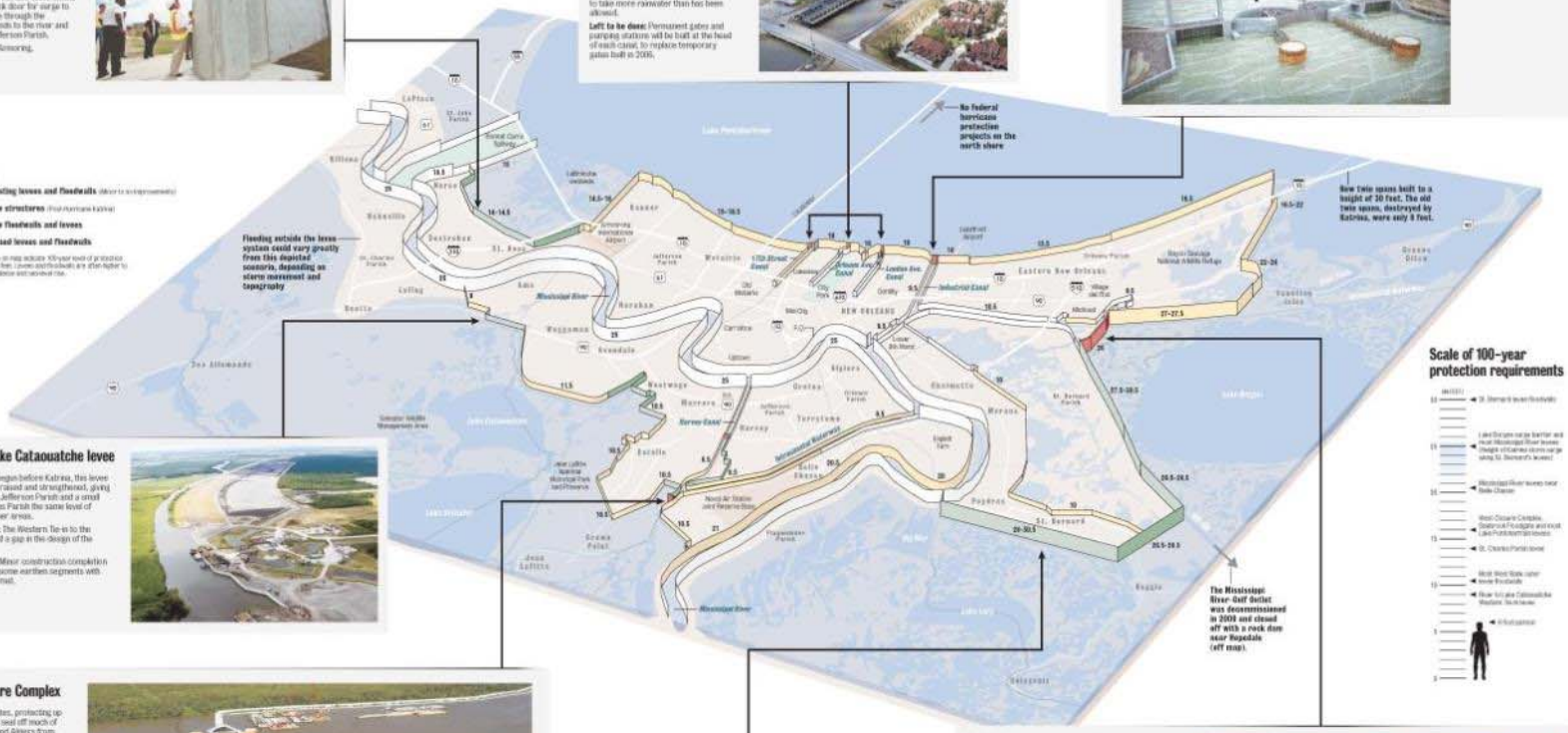


Project: Block Lake Pontchartrain water, up to 16 feet, from flowing into the Industrial Canal, as happened during Hurricane Katrina.

Notable feature: When the gates close, the Industrial Canal can store water that overtops the Lake Borgne surge barrier during hurricanes.

Left to be done: Minor work remains, but the gate already provides 100-year protection.

◀ HOW IT WORKS



River to Lake Cataouatche levee

Project: Barely begun before Katrina, this levee was redesigned, raised and strengthened, giving the west bank of Jefferson Parish and a small part of St. Charles Parish the same level of protection as other areas.

Notable feature: The Western Tie-in to the Mississippi closed a gap in the design of the original levee.

Left to be done: Minor construction completion and armoring of some earthen segments with grass and fabric mat.

Scale of 100-year protection requirements

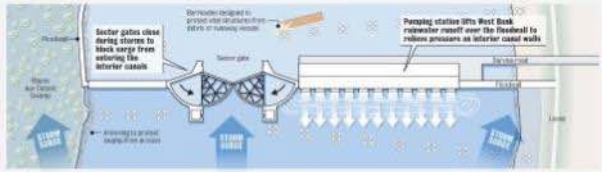
West Closure Complex

Project: Giant gates, protecting up to 16 feet, would seal off much of West Jefferson and Algiers from surge from the marsh to the south. And huge pumps will dump West Bank rainwater runoff from the reinforced Harvey and Algiers canals over the gates. The project cost $1 billion.

Notable feature: 11 pumps can fill an Olympic swimming pool in four seconds, making it the largest drainage pump station in the world.

Left to be done: Minor construction not affecting the project's protection capability.

HOW IT WORKS:



St. Bernard levee floodwalls

Project: The dirt levees that failed in Katrina, sweeping St. Bernard Parish, were scraped away and rebuilt. Several gates allow fishing access.

Notable feature: Heavy clay was brought in for the base, which was topped by concrete T-walls, more than doubling the height of the old levee. The tops of the walls are seven feet higher than the Katrina surge.

Left to be done: Armoring the land side of the earthen levee with a combination of grass and fabric mat.

Lake Borgne surge barrier

Project: A nearly two-mile-long, 26-foot-high wall was constructed to block the deadly surge from Lake Borgne that ravaged the Lower 9th Ward. Two gates used for barges and fishing boats are open unless a storm threatens. The project cost $1.1 billion.

Notable feature: The barrier is designed to be a few feet lower than the new levees on both sides, allowing some surge water to be stored in the Gulf Intracoastal Waterway and Industrial Canal for a few hours until a storm passes.

Left to be done: A new bridge will be built to provide access to the wall segment between Bayou Dupre and Bayou Bienvenue.

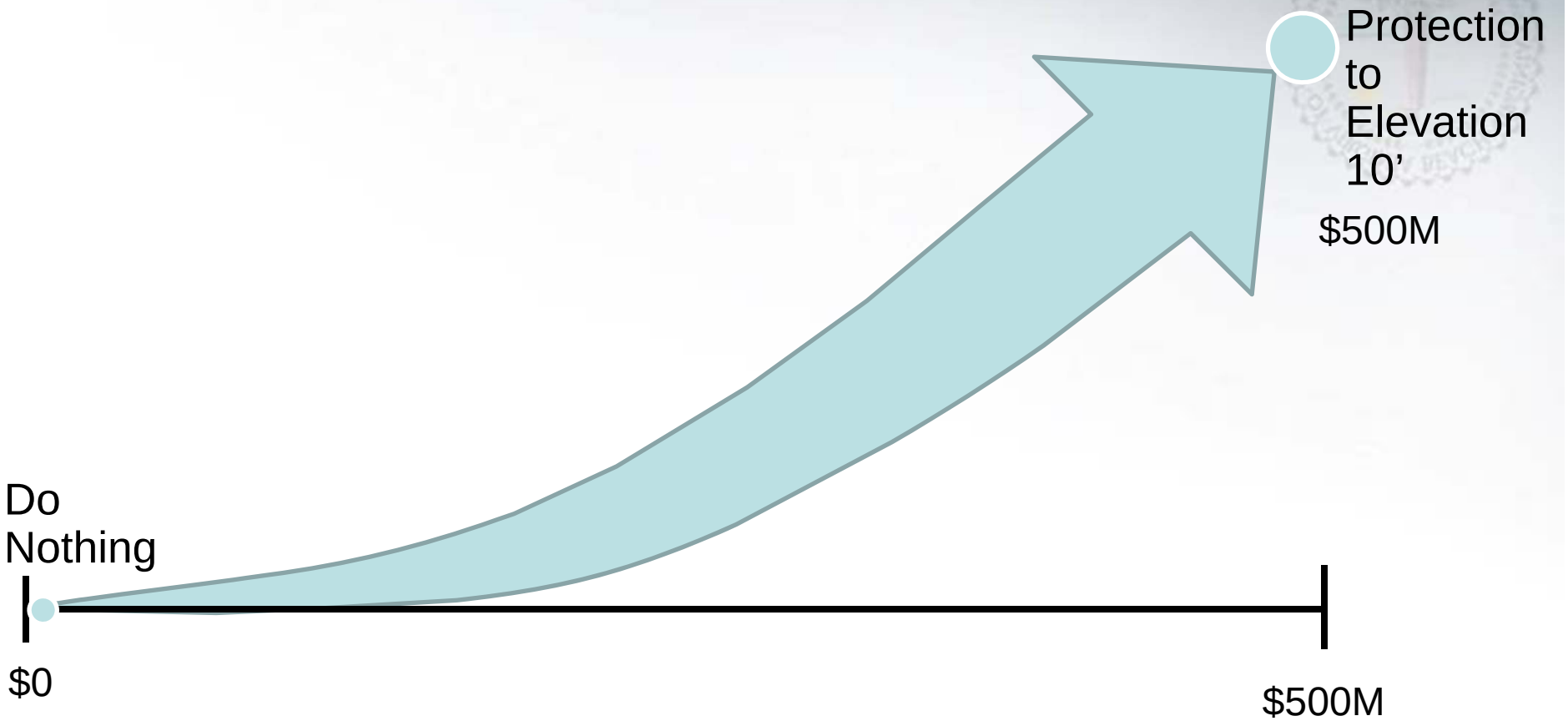
HOW IT WORKS:

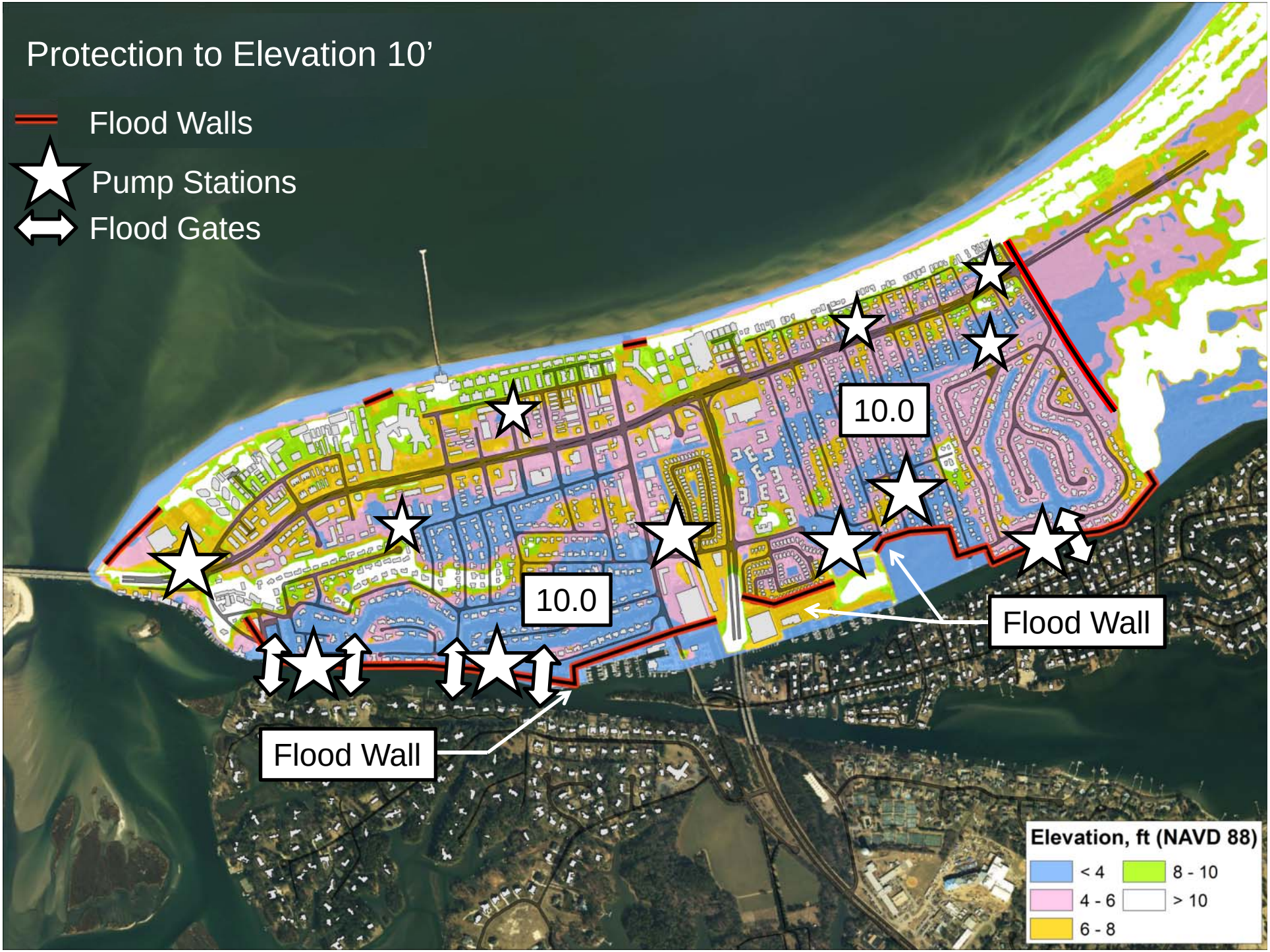
CROSS-SECTION:

Source: Army Corps of Engineers 3-D illustrations provided by the Army Corps of Engineers

PHOTOS BY DAVID GRUNFELD, TED JACKSON, JOHN McCUSKER AND BRETT DUKE; GRAPHIC BY DAN SWINSON/THE TIMES-PICAYUNE

Engineered Flood Protection Measures for the ESDDA Area




Protection to Elevation 10’
Flood Walls
Pump Stations
Flood Gates
10.0
10.0
Flood Wall
Flood Wall
Elevation, ft (NAVD 88)
< 4
8 - 10
4 - 6
> 10
6 - 8

Summary Thus Far

- Sea Level Rise in the last 50 years approx: 1’
- Sea Level Rise: 1.5 – 3.0 feet in the next 50 Years
- Data suggests high water levels produced by coastal storms are increasing
- The Eastern Shore Drive Area is particularly vulnerable
- Nor’Ida produced a high water level of nearly 7.0’
- Without flood protection measures most of the ESDDA will experience increasing flooding from coastal storms and sea level rise
- But flood protection measures to elevation 10’ have a major impact and are very costly

Engineering Flood Protection Measures

The flood protection question becomes:

Is it “all or nothing” or is there an initial level of flood protection - a core set of improvements - that:

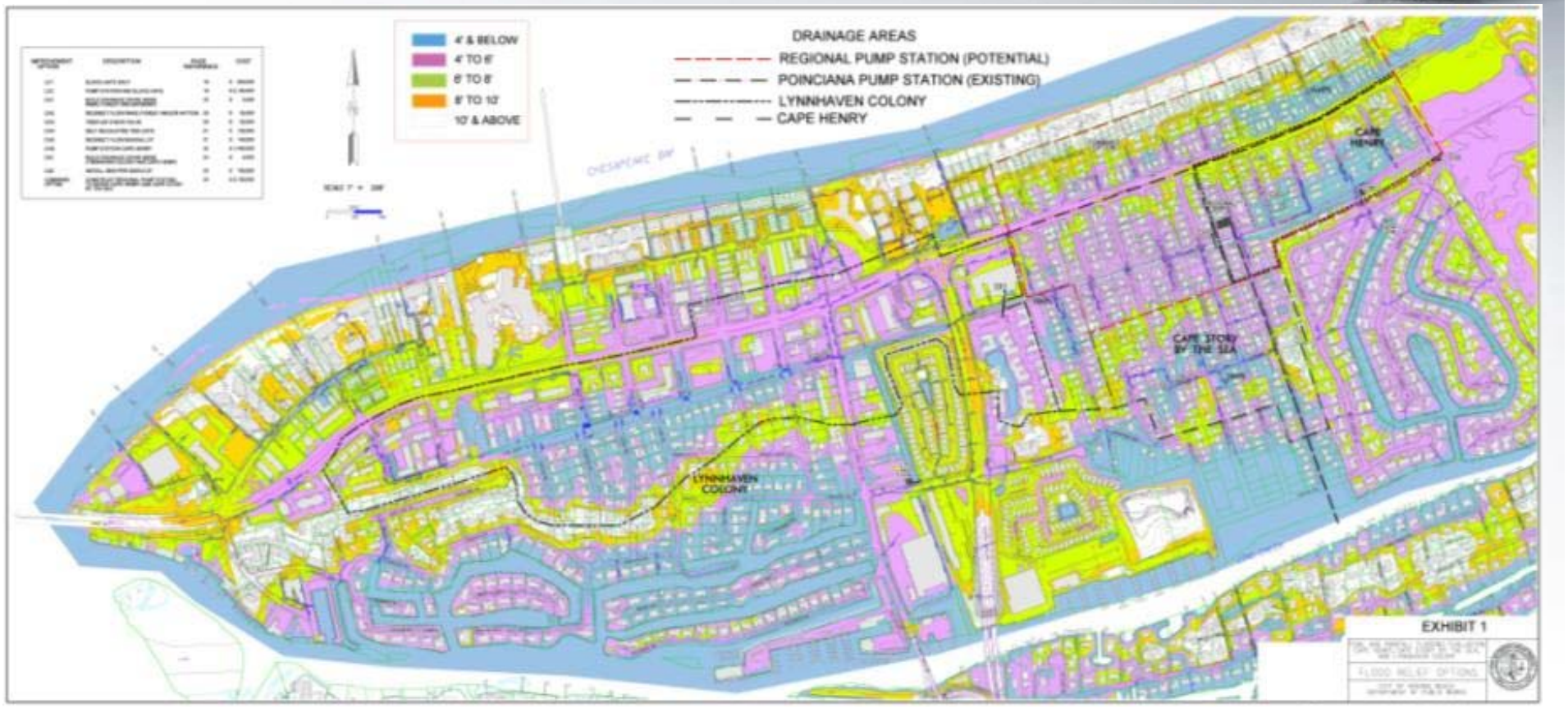
- Provides a level of flood protection in the near term
- Is expandable in the future
- Is minimally disruptive to the community

What Core Set of Flood Protection Measures Might Be Considered?

Factors Guiding the Development of Core Improvement Alternatives

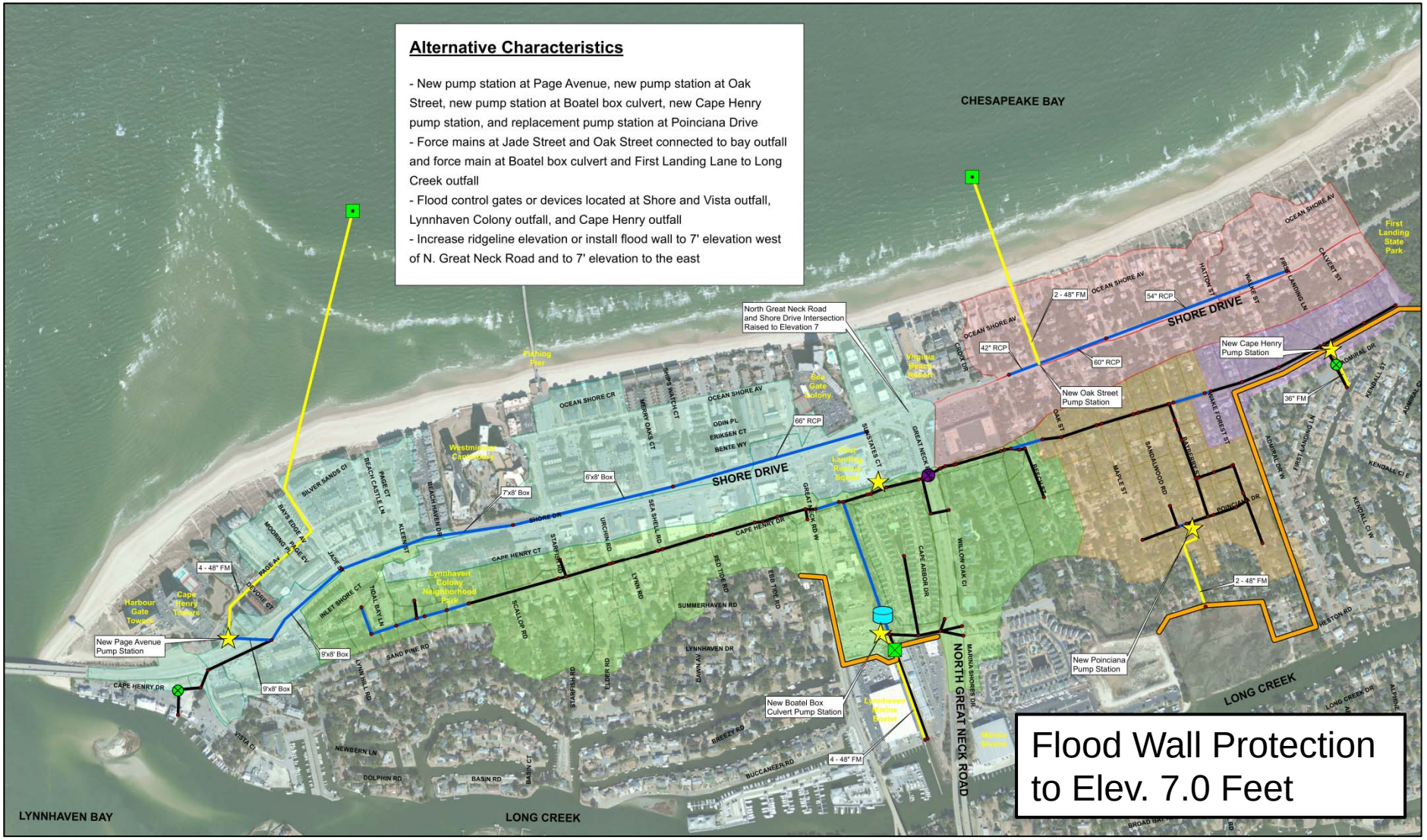
- **Reduce Overall Cost**
- **Allow improvements to be Phased**
  - First Phases ⇨ Greatest Protection
  - Flexibility in Subsequent Phasing
- **Leverage Existing Infrastructure / Use Natural Topography**
- **Minimize Infrastructure Impacts in/around the Neighborhoods**
- **Provide a Level of Water Quality Treatment**
- **Can Be Fully Utilized in the Future with Expanded Flood Protection Measures**

Look at Natural Topography



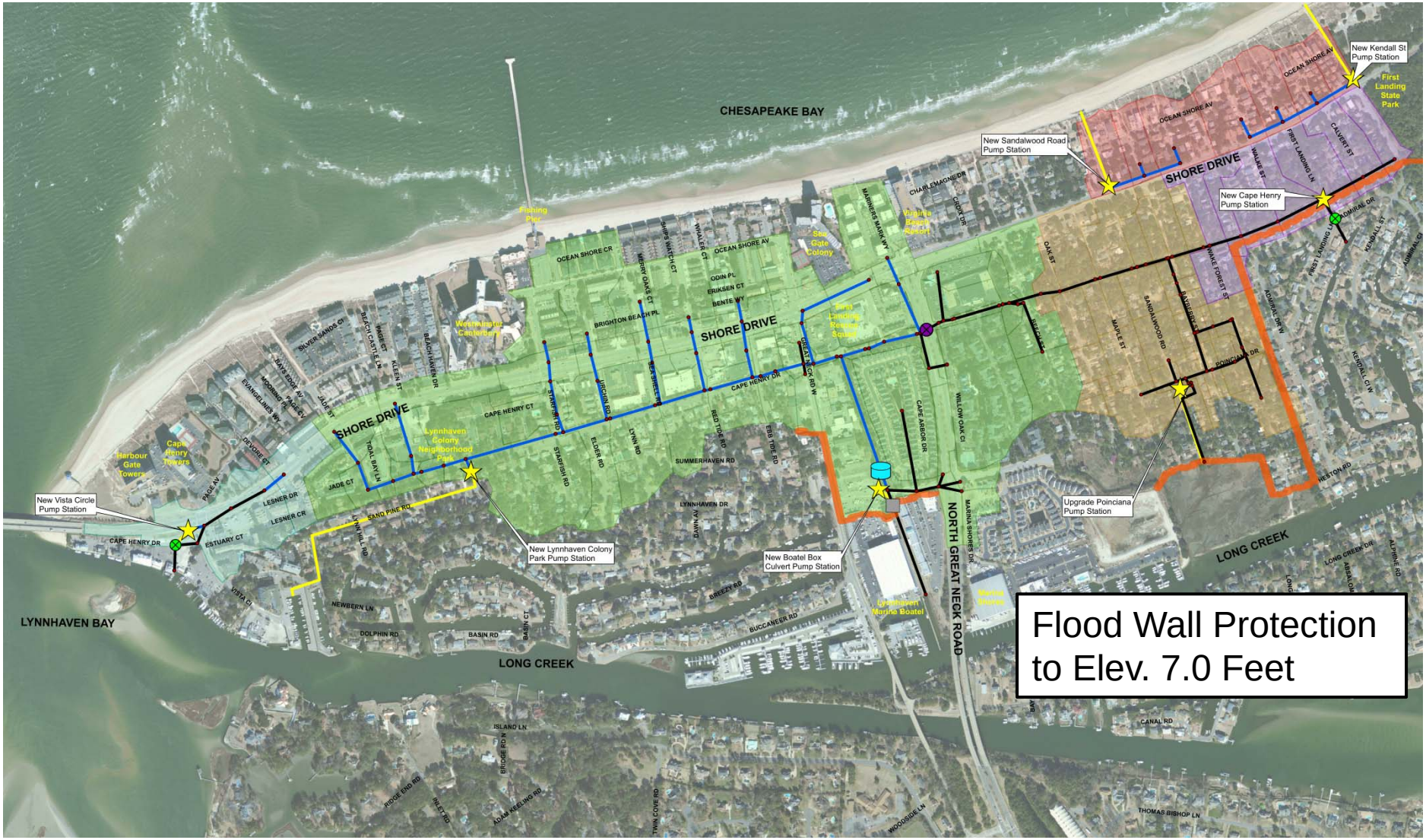
Bay Discharge – Alternative

Budgetary Estimate = $230 M +



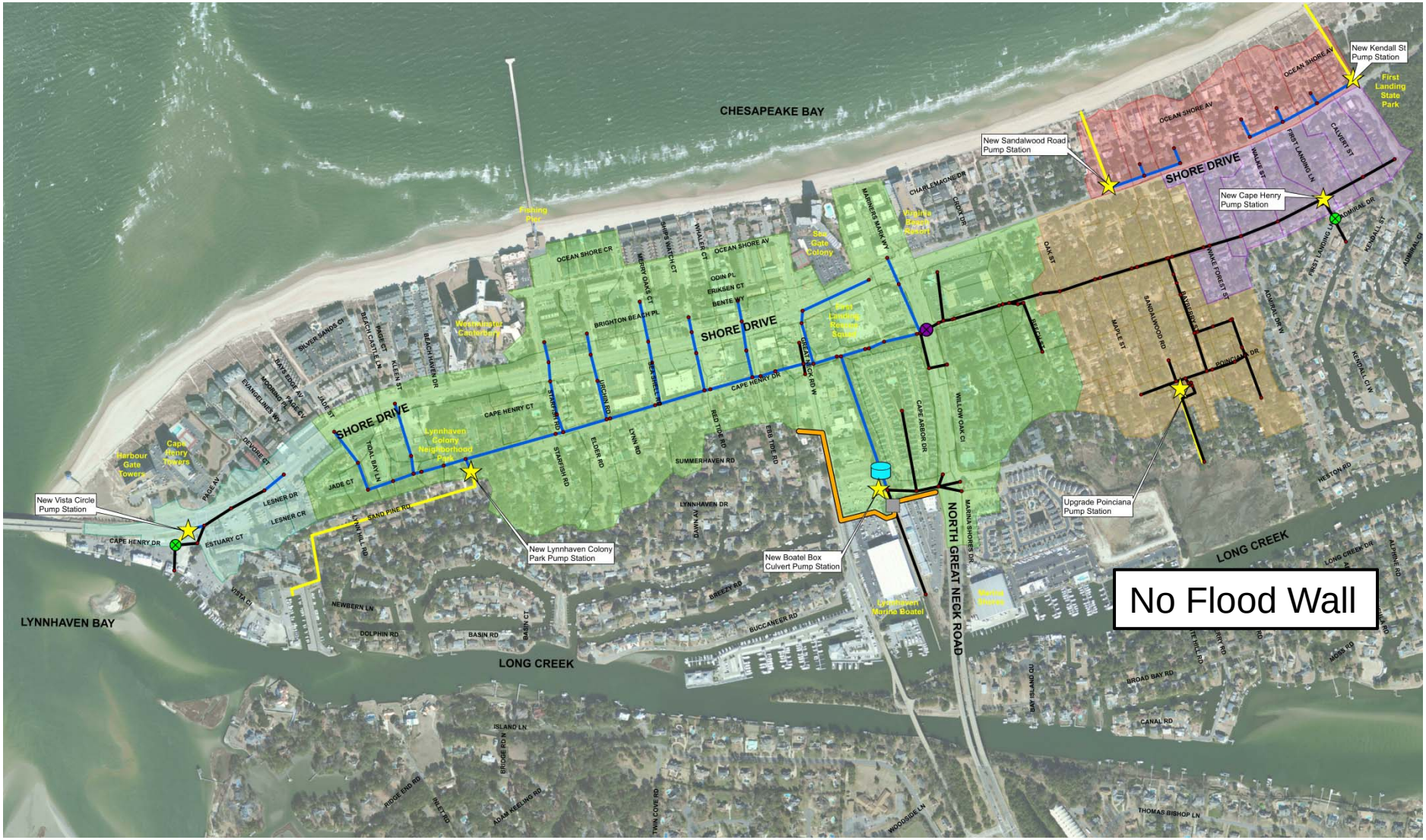
Southern Discharge with Flood Protection to 7 ft.

Budgetary Estimate = $130 M

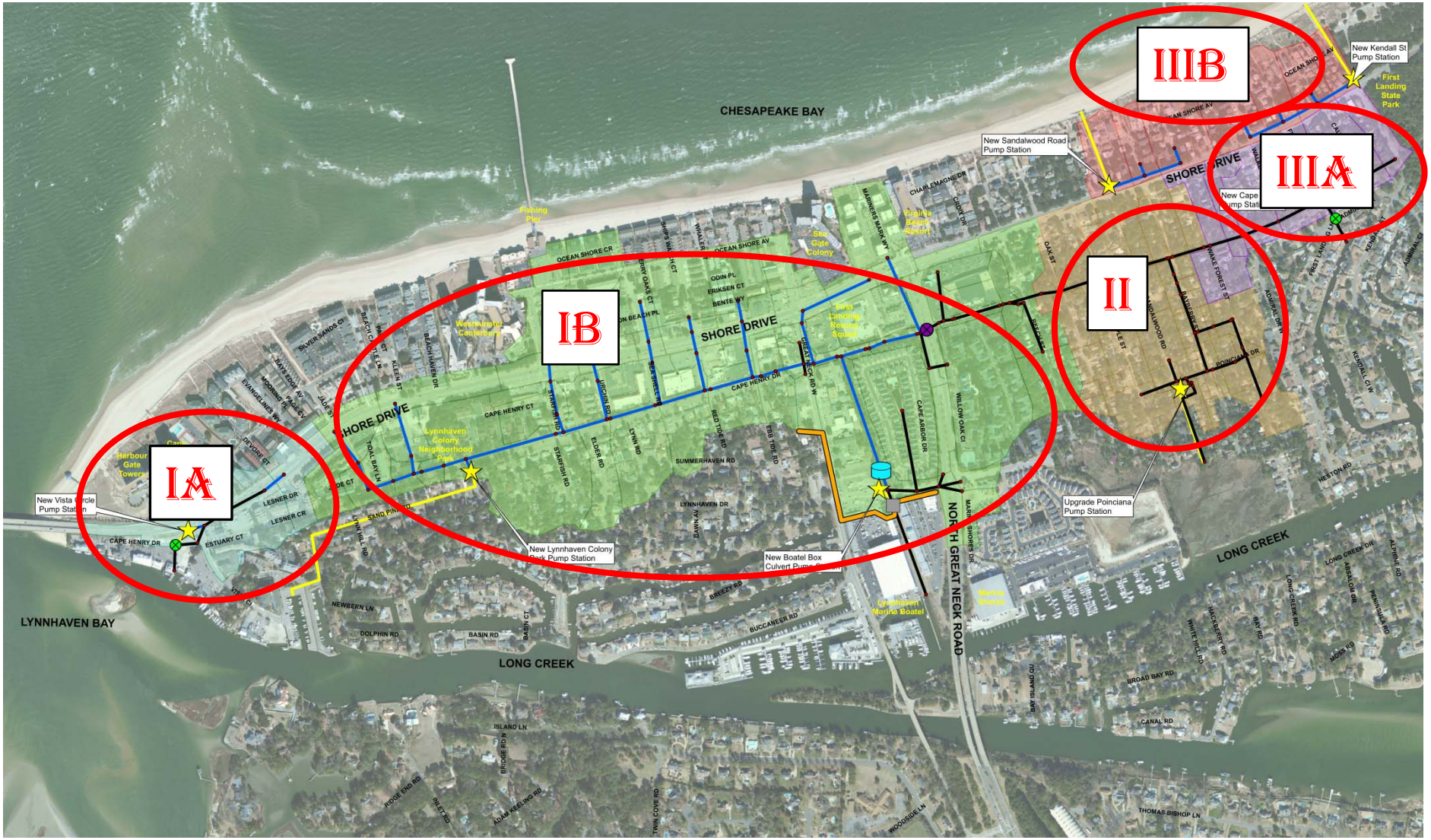


Southern Discharge – Alternative

Budgetary Estimate = $71 M



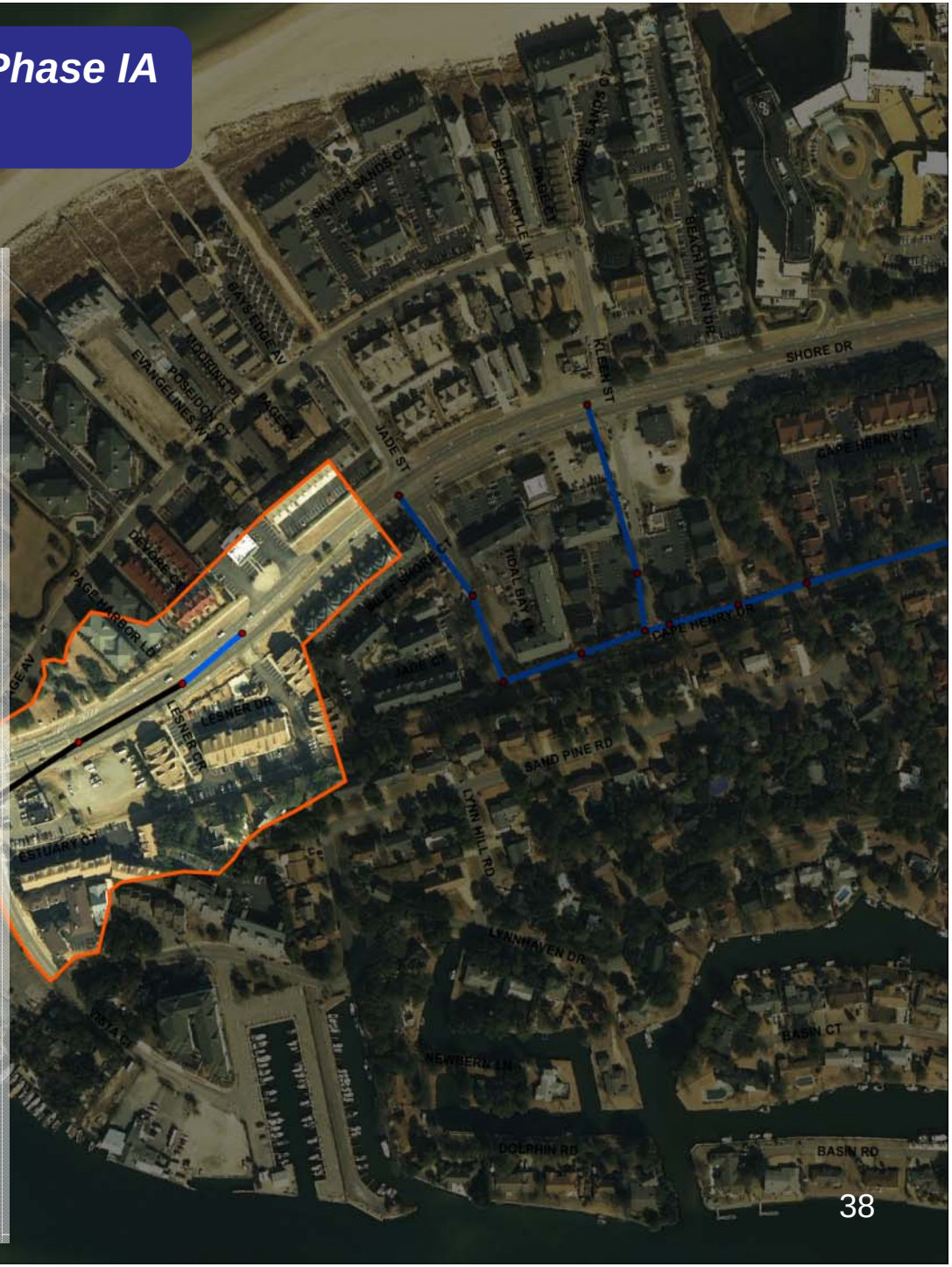
Phase Map - Southern Discharge Alternative



Southern Discharge Alternative - Phase IA - Shore Drive at Vista Circle

- Pump Capacity = 60 cfs

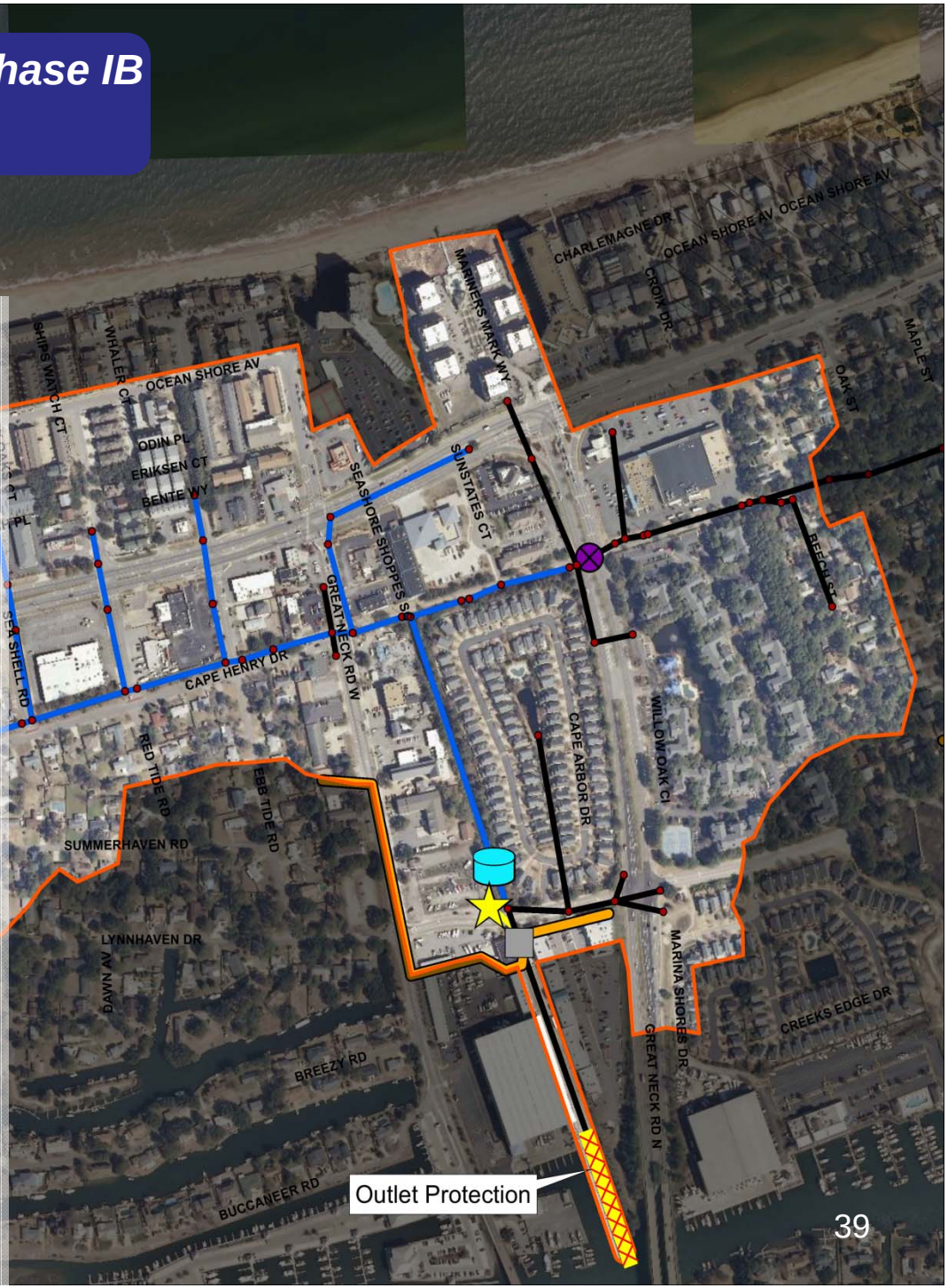
- Drain low area on Shore Drive (900 L.F.)
- Improvements:
  - Storm drain system
  - 60 cfs Pump Station
  - 36” Force main
  - Tide valve
- Protects to Elevation 7 Feet NAVD88
- 1,500 L.F. of roads made passable
- Mitigates building flooding at 2 townhouse buildings ($1.1 M building value)
- Phase Cost: $9 M
- Design / Acquisition / Permitting: 2 years
- Construct: 2 years



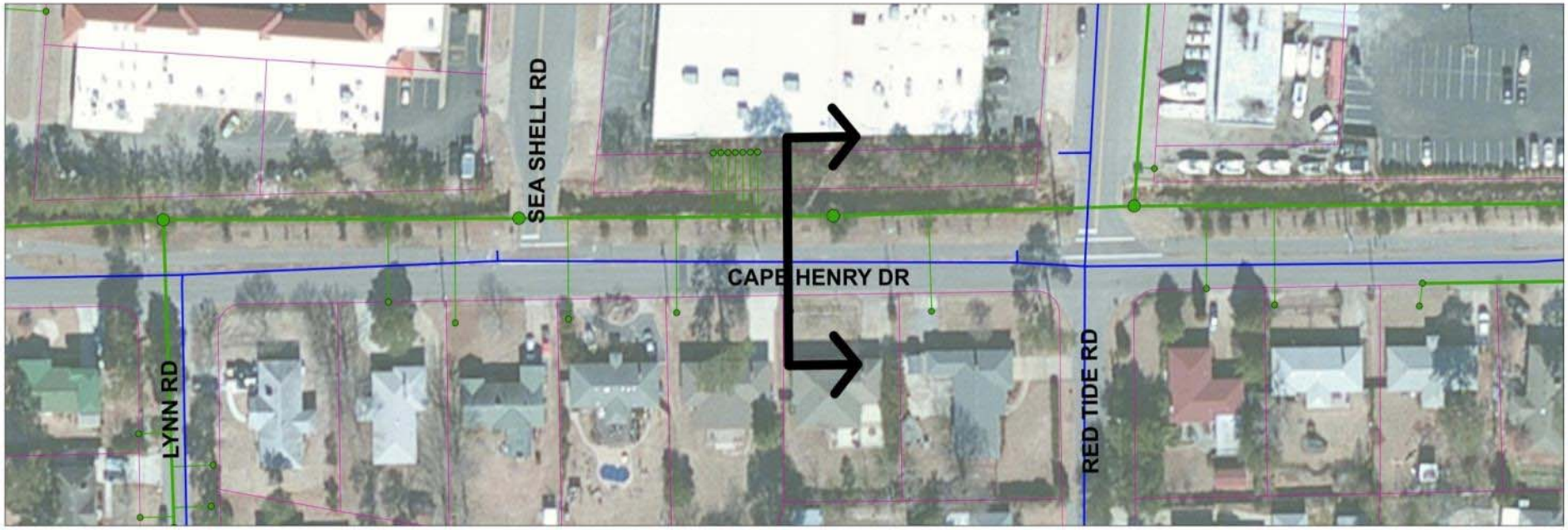
Southern Discharge Alternative – Phase IB
- Lynnhaven Colony

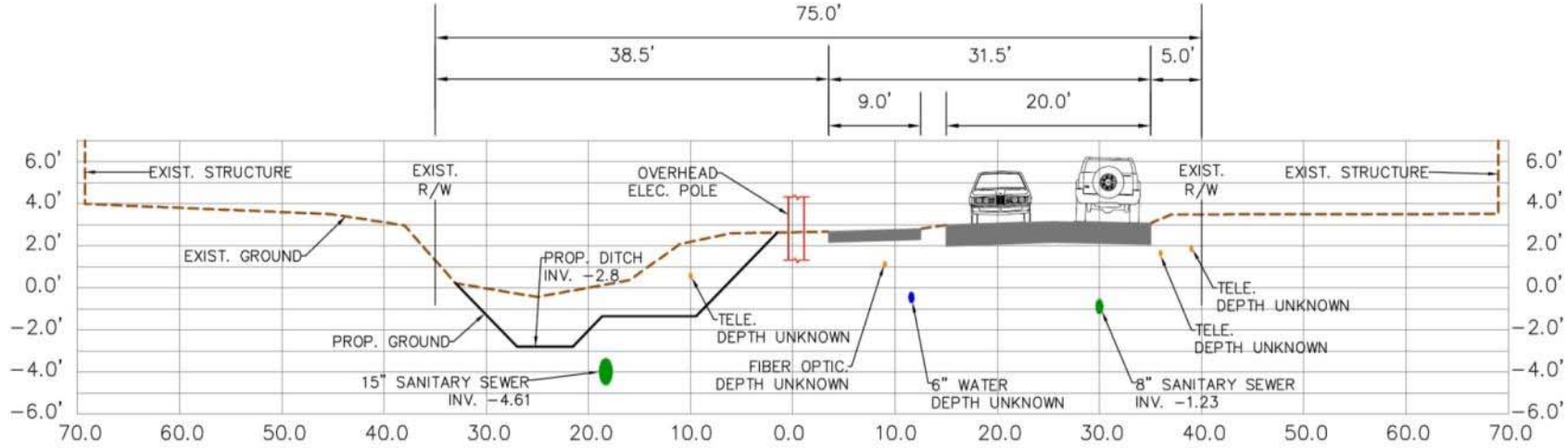
- Pump Capacity = 200 cfs

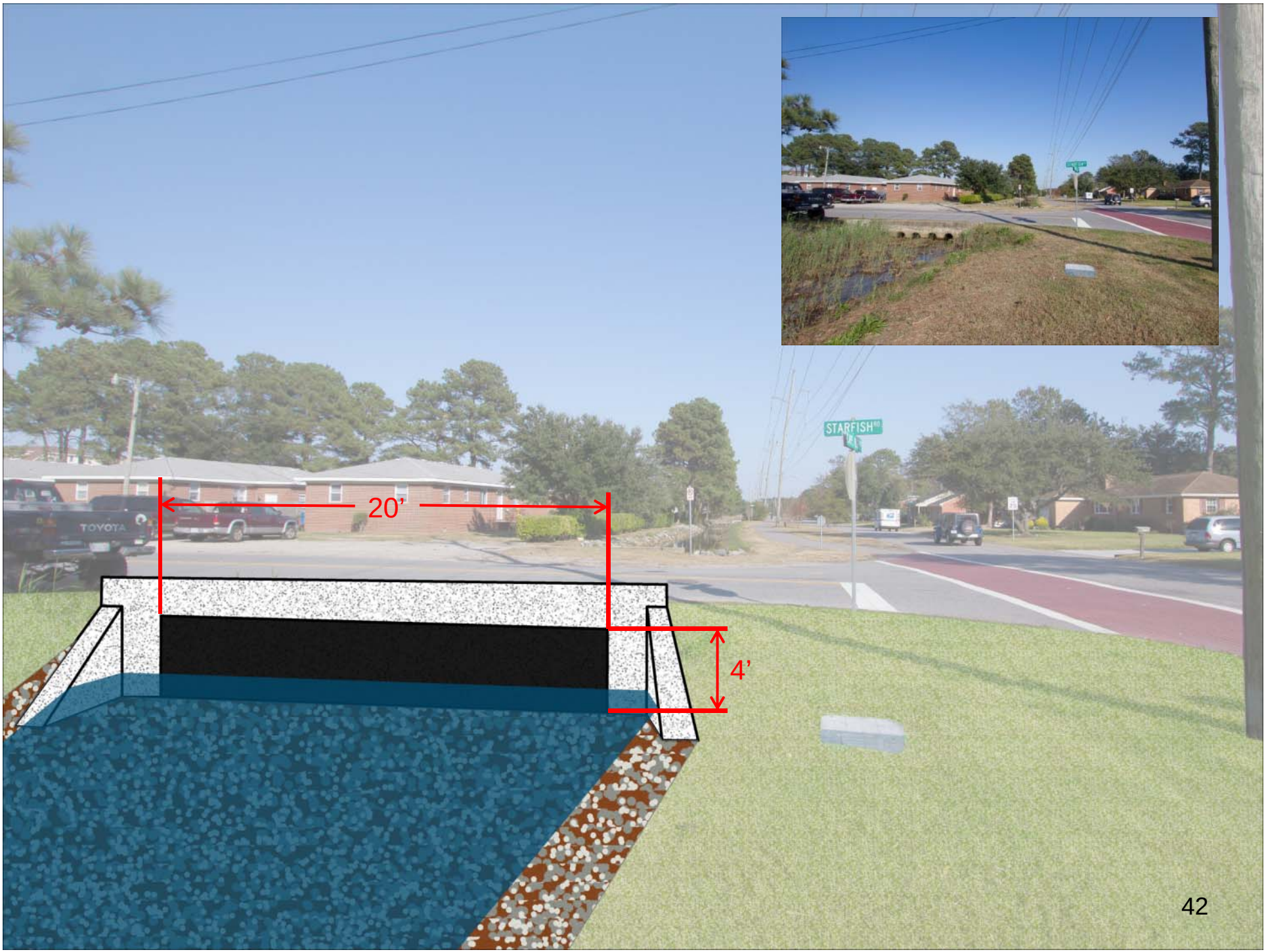
- Drain Lynnhaven Colony along the Cape Henry Ditch and Shore Drive from Starfish Road to North Great Neck Road
- Improvements:
  - Storm drain systems
  - Widen and lower Cape Henry Ditch
  - Two Pumps (50 cfs and 150 cfs)
  - 10’ by 6’ Flood Gate
  - Build up Lynnhaven Drive / W. Great Neck Road to Elev. 7’
- Flood protection up to Elevation 7 Feet NAVD88
- 15,500 L.F. of roads made passable
- Mitigates flooding at 152 buildings ($55 M building value)
- Phase Cost: $41 M
- Design / Acquisition / Permitting: 3 years
- Construction: 2 years



Typical Ditch Improvement



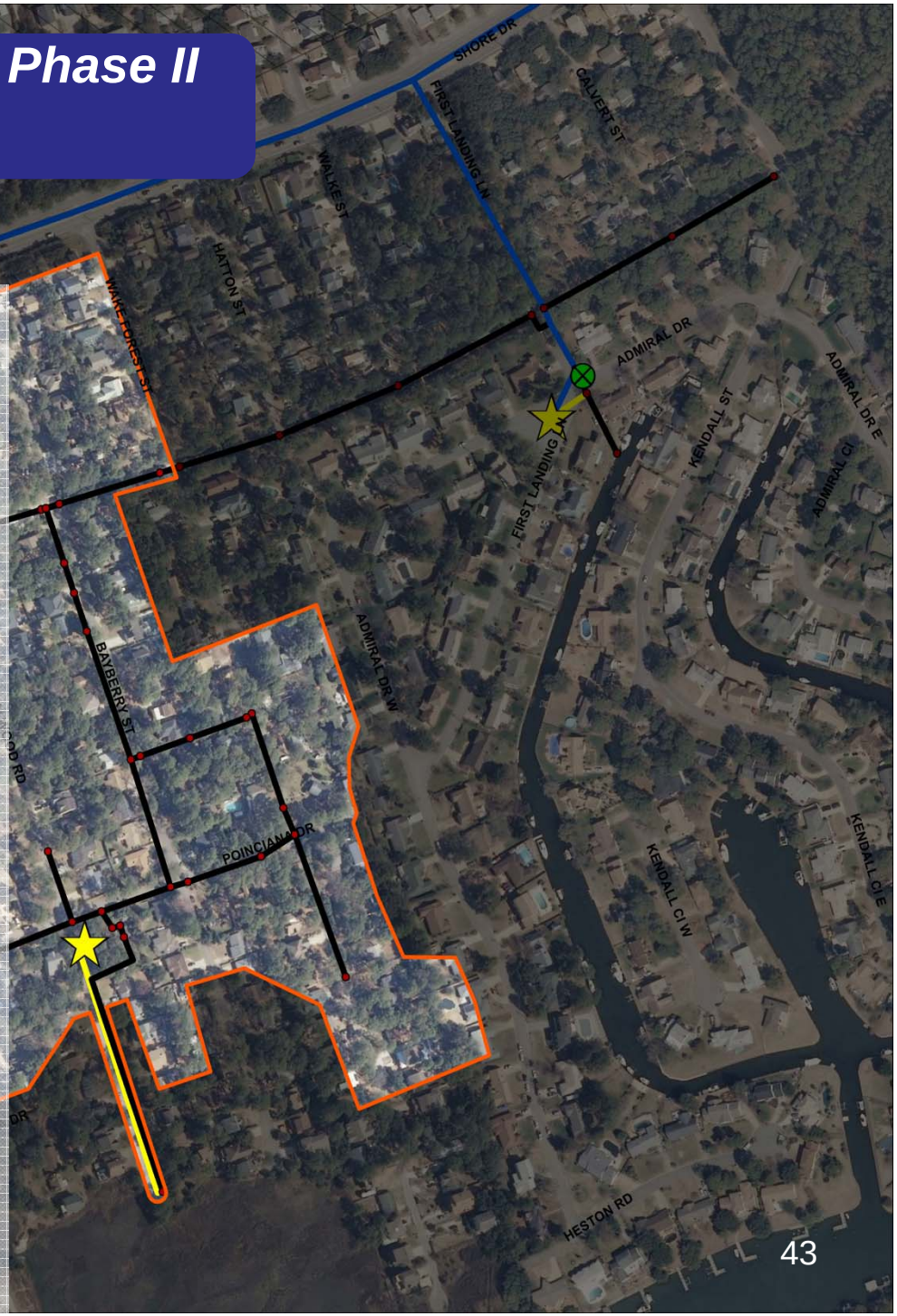



20’
4’
STARFISH

Southern Discharge Alternative – Phase II - Cape Story by the Sea

- Pump Capacity = 80 cfs

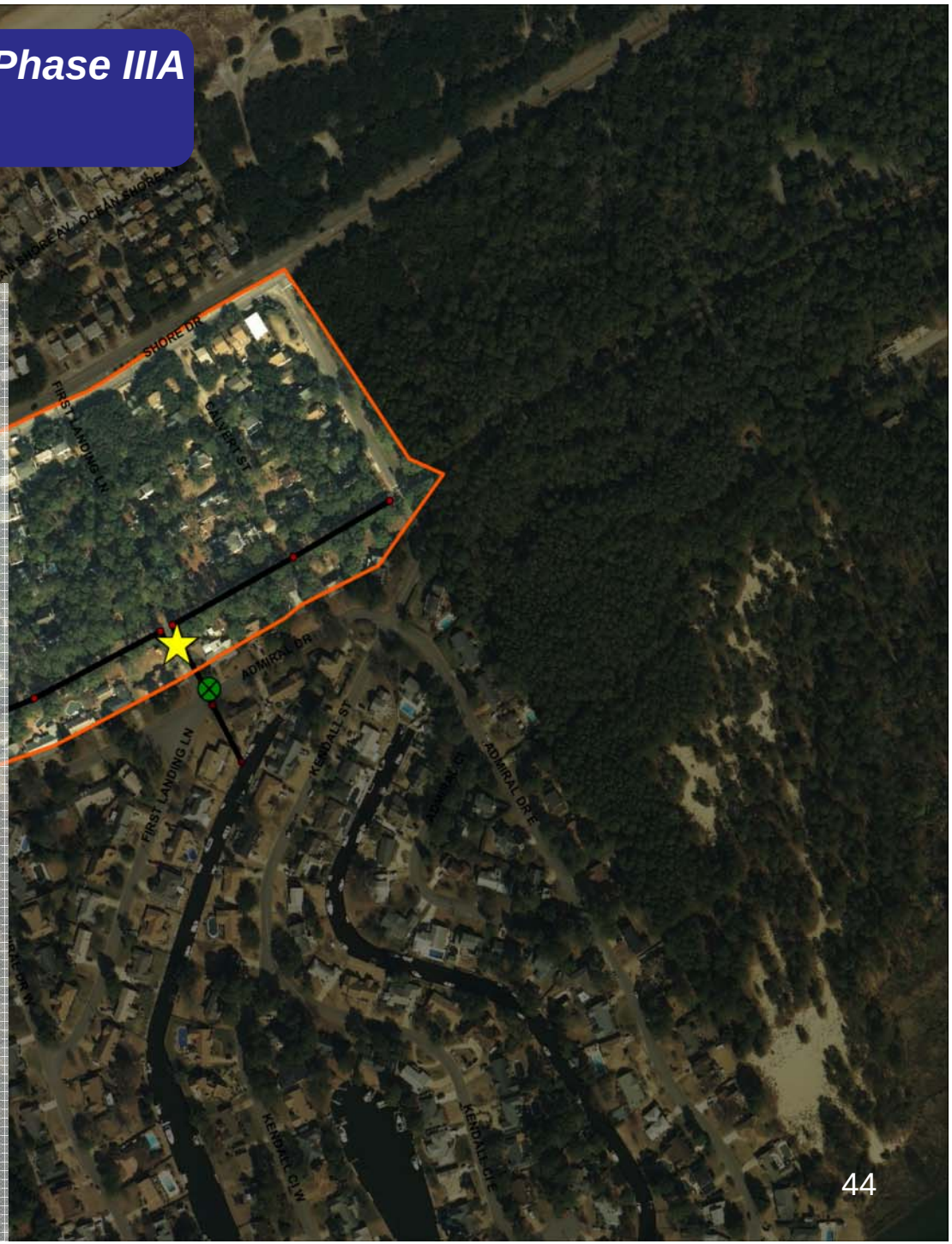
- Improve pump-out of Cape Story By The Sea neighborhood
- Improvements:
  - Replace & Upgrade Existing Stormwater Pump Station from 50 cfs to 80 cfs
  - Larger pump station intake
  - Larger Force Main
- Protects to Elevation 5 Feet NAVD88
- 1,800 L.F. of road made passable
- Mitigates Flooding at 8 houses ($0.8 M building value)
- Phase Cost: $7.5 M
- Design / Acquisition / Permitting: 2 years
- Construction: 2 years



Southern Discharge Alternative – Phase IIIA - Cape Henry

- Pump Capacity = 20 cfs

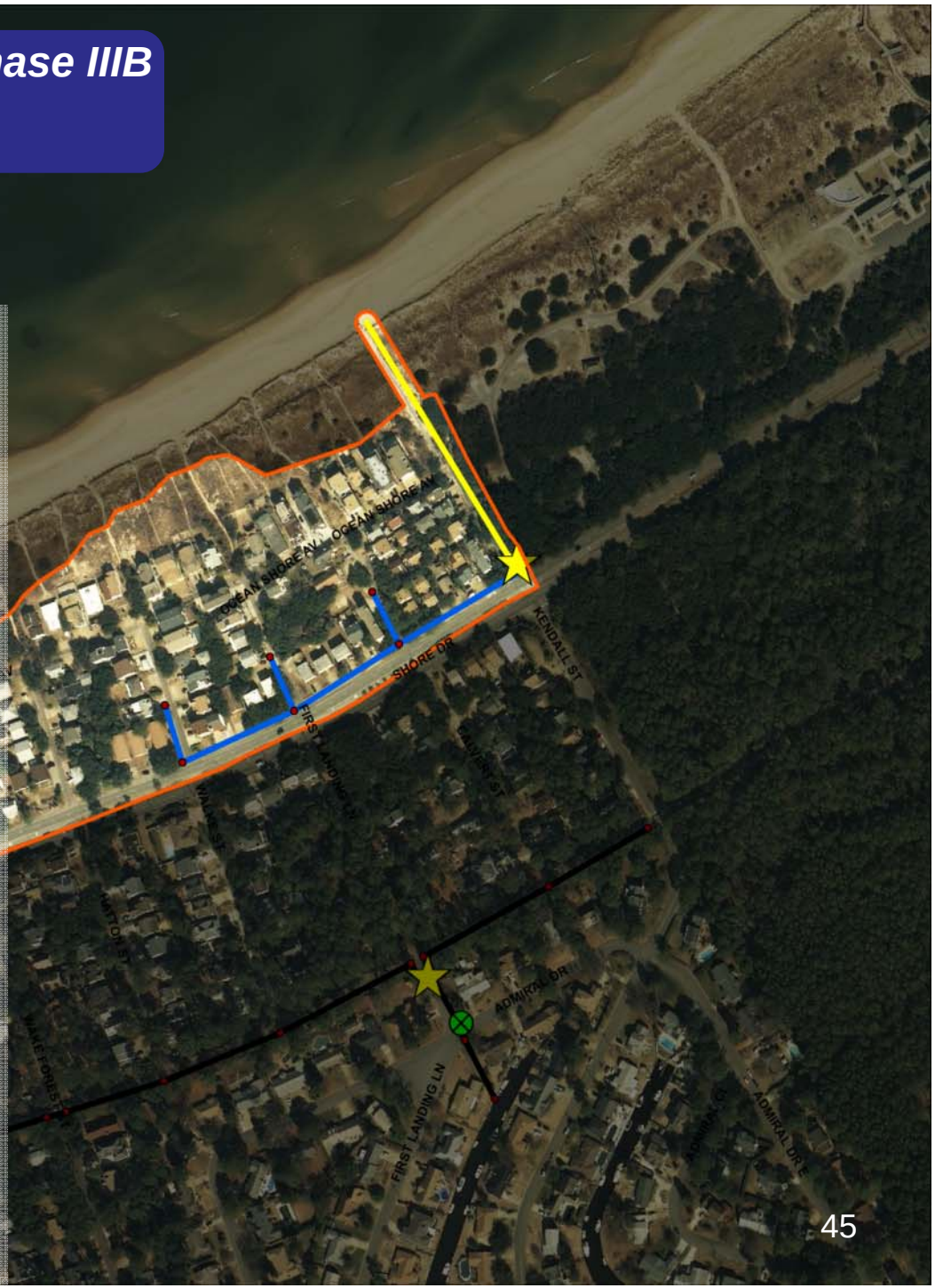
- Remove stored water behind flood gate (to be installed in late 2014)
- Improvements:
  - Excavate Cape Henry Ditch
  - 20 cfs Pump Station at First Landing Lane and Admiral Drive
  - Slipline outfall pipe
- Protects to Elevation 5 Feet NAVD88
- 2,950 L.F. of road made passable
- Mitigates Flooding at 7 Houses ($0.7 M building value)
- Phase Cost: $4.5 M
- Design / Acquisition / Permitting: 2 years
- Construction: 2 years



Southern Discharge Alternative – Phase IIIB
- Kendall and Sandalwood Streets

- Pump Capacity = 10 cfs each

- Relieves nuisance rainfall flooding near 7 intersections with Shore Drive
- Improvements:
  - Replace buried or nonexistent infiltration systems with new infiltration trenches
  - sump pumps
  - small (< 15") force mains
  - perforated cisterns under beach
- 2,500 L.F. of road made passable
- Affects access to 43 residential buildings
- Phase Cost: $9 M
- Design / Acquisition / Permitting: 2 years
- Construction: 2 years



Phase Summary

Southern Discharge Alternative

Phase	Cost	Buildings Protected* (No./$)	Total Buildings (No./$)	Roads Made Passable (L.F.)
IA	$9M	2 / $1.1 M	15 / $13 M	1,500
IB	$41M	152 / $55 M	207 / $86 M	15,500
II	$7.5M	8 / $0.8 M	141 / $22M	1,800
IIIA	$4.5M	7 / $0.7 M	97 / $16 M	2,950
IIIB	$9.0M	0 / $0	181 / $58 M	2,500
Total	$71M	169 / $57.6	641 / $ 195 M	24,250

*IA & IB protected to elev 7; II, IIIA & IIIB protected to elev 5

Each Phase Can Be Independently Built

Southern Discharge Alternative Positive Considerations

- Provides improved flood protection for a significant portion of the ESDDA
- Can be fully integrated with additional flood protection measures in the future.
- Acquisition and infrastructure impacts to the community are minimized
- Reduces drainage costs for the Shore Drive Phase III project and allows the project to proceed
- Leverages existing infrastructure and topography
- A constructible phasing sequence
- Addresses drainage issues of Cape Henry Drainage Ditch while providing water quality and aesthetics improvements

Southern Discharge Alternative Limitations

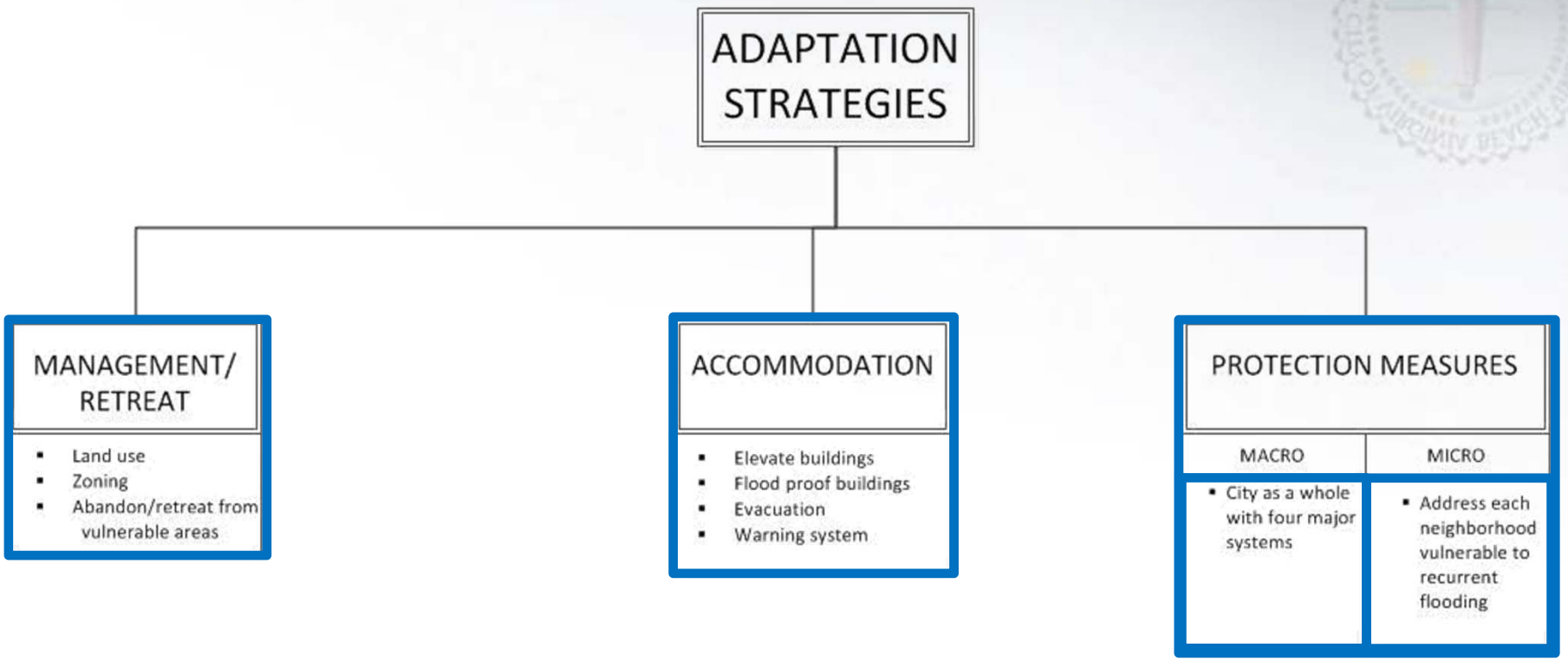
- Provides Enhanced Flood Control for 260 Acres of the 676 Acre ESDDA
- Level of Service for Phases 1A & 1B
  - Tidal Elevation 7.0
  - 10-Year Rainfall
- Level of Service for Phases II, IIIA, & IIIB
  - Tidal Elevation 5.0
  - 2-Year Rainfall

The Bigger Picture

Recurrent Flooding Adaptation Strategies

- Management / Retreat
  - Prevent development in high risk areas
  - Discourage rebuilding in high risk areas
- Accommodation
  - Elevating buildings / Flood proofing homes
  - Warning systems / Evacuate
- Engineered Protection Measures
  - Two primary components
    - Flood Barriers
    - Pumps and Enhanced Drainage Systems

Planning the City Response to Recurrent Flooding/Sea Level Rise

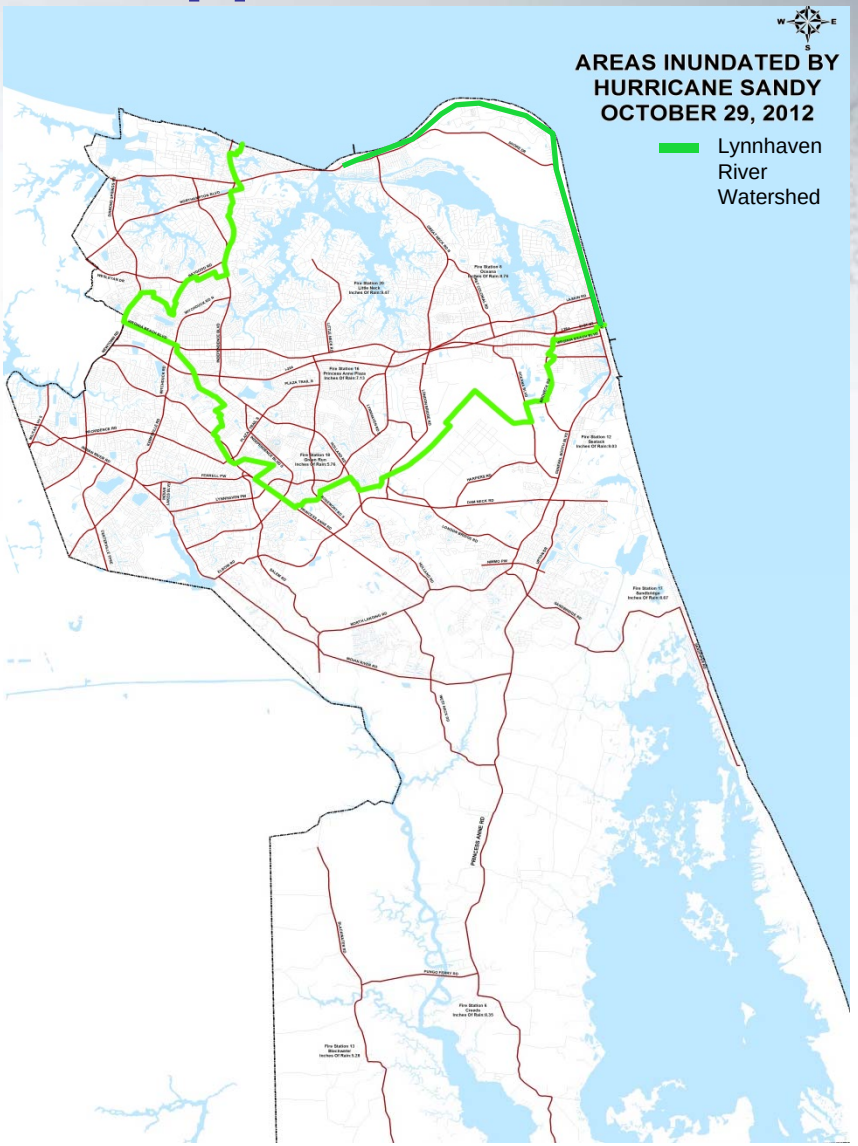


Adaptation Strategies:
Engineered Protection Measures
Micro Approach

- Neighborhood Specific Improvements & Impacts
- One Area at a Time Approach
- Phased Approach – More Readily Funded

Adaptation Strategies:
Engineered Protection Measures
Macro Approach

- Comprehensive Approach
- System-wide Improvements
- Costs
  - Initial Comprehensive Analysis
  - Improvement Costs



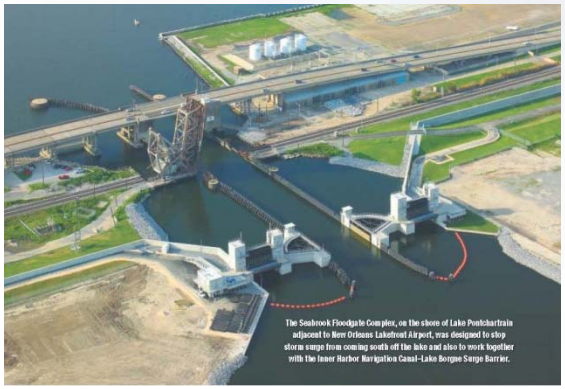
Adaptation Strategies:
Engineered Protection Measures
Macro Approach

Beach Erosion Control and Hurricane Protection Plan

Adaptation Strategies:

Engineered Protection Measures

Macro Approach, New Orleans



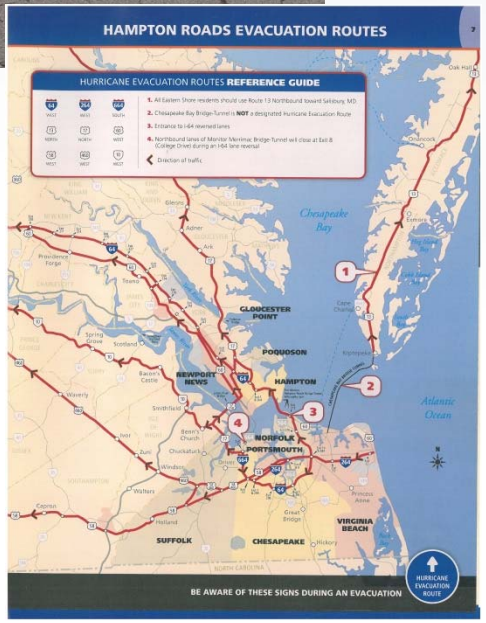
Macro Approach, New York City

Sources: “Defending New Orleans,” by Robert L. Reid, November 2013, Civil Engineering magazine
“plaNYC- A STRONGER, MORE RESILIENT NEW YORK” June 11, 2013

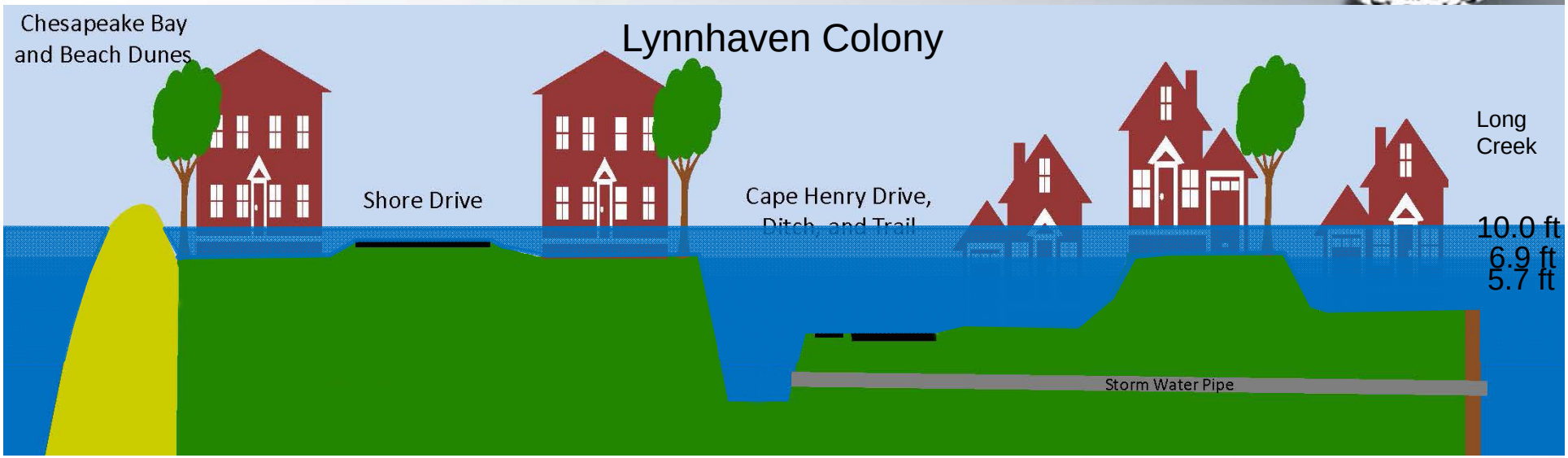
Adaptation Strategies:

Accommodation

- Elevate Buildings
- Flood Proof Buildings
- Evacuation
- Warning systems (Reverse 911)



Normal Tide and Flood Tide Elevations



Adaptation Strategies:
Management / Retreat

- Major Policy Issues
- Land Use (Zoning, Floodplain, Site Plan, Subdivision Ordinances, Etc.)
- Abandon / retreat from vulnerable areas
- Balance Major City Goals
  - Community for a Lifetime
  - Neighborhood Revitalization
  - Plan for the Future
  - Financial Sustainability

Adaptation Strategies: SUMMARY

- Ultimately the City Response to SLR / Recurrent Flooding will likely include all Three Adaptation Strategies
- A Comprehensive SLR / Recurrent Flooding Analysis would serve as the basis for the City Response and would:
  - Identify the probable extent of SLR / Recurrent Flooding impacts
  - Evaluate the appropriate role of each Adaptation Strategy in the vulnerable areas
  - Identify budgetary costs for Engineered Protection Measures (both micro and macro) and other recommended adaptation programs

Staff Recommendations

- Two Concurrent Actions
  - Proceed with project delivery for the Eastern Shore Drive Drainage Area Southern Alternative Improvements Phases IA,IB and II ($57.5M) and program Phases IIIA and IIIB ($13.5M)
  - Proceed with a Comprehensive Citywide SLR / Recurrent Flooding Analysis with initial focus on the Lynnhaven Watershed
- Utilize Funding in the Proposed FY15- FY20 CIP for analysis, design and acquisition ($16.1M)
- Construction and other funding to be programmed with future CIPs

Closing Thoughts

- Measured flood protection in the ESDDA
  - Flood protection for a significant portion of the ESDDA
  - Flood protection can be expanded in the future
  - Flood protection will be minimally disruptive to the community
  - Flood protection is limited to Elevation 7’ in Phases IA & IB
  - Flood protection is limited to Elevation 5’ in Phases II, IIIA, & IIIB
- Comprehensive SLR/Recurrent Flooding Analysis of Lynnhaven Watershed will:
  - Serve as the basis to address SLR/Recurrent Flooding in the entire watershed
  - Identify vulnerable areas
  - Evaluate the role of each of the three Adaptation Strategies in each vulnerable area
  - Identify budgetary costs and funding options to address SLR/Recurrent Flooding in the watershed

Council Discussion