



DATE: May 26, 2020

TO: Mr. Alexander P. Awad
Chief Planning Engineer
Stormwater Engineering Division
City of Tampa

FROM: Matthew Goolsby, PE, CFM

SUBJECT: Task No. 4 Mitigation Options
City of Tampa Sea Level Rise Vulnerability Analysis
FDEP Agreement Number R1916

Applied Sciences Consulting, Inc. (Applied Sciences) is providing the City of Tampa (City) with consulting engineering services for the City of Tampa Sea Level Rise Vulnerability Analysis. With this memorandum, Applied Sciences presents recommendations for Mitigation Options, per Task Number 4 in the Florida Department of Environmental Protection (FDEP) Grant Agreement Number R1916. The recommended Mitigation Options are planning level concepts for the City to consider. A more detailed preliminary design report would be required to review feasibility and constructability prior to design and implementation.

Introduction

The City of Tampa has approximately 563 stormwater outfalls of various sizes that discharge to tidally influenced areas susceptible to Sea Level Rise (SLR). These outfalls are critical to conveying stormwater discharge and protecting life and property within the full array of land use types across the City. Considering the high number of potentially affected stormwater outfalls, it is not possible to assess impacts to all facilities within the scope and time frame of this grant. As such, Applied Sciences, in cooperation with the City's Stormwater staff, identified and prioritized a statistically significant sample of the affected high priority stormwater outfalls from which to provide a detailed vulnerability assessment and to subsequently develop mitigation options and strategies.

Mitigation Options

The prioritization process (Task 2) identified basins for further vulnerability assessment (Task 3). The outcome of these tasks were six study basins to identify potential mitigation options for future consideration. This section provides details regarding the six study basins and outlines potential mitigation options for the City to consider. A mitigation options exhibit and planning level cost sheet was created for

each study basin and included at the back of this memorandum. Further detail regarding the vulnerability assessment for each study area can be found in the Sea Level Rise Vulnerability Analysis Report submitted in February 2020 as the deliverable for Task 3.

Coastal Study Basin 1 - Davis Islands

Coastal Study Basin 1 is Davis Islands (Outfall ID 313), a neighborhood comprised of two islands south of Downtown Tampa located in Hillsborough Bay. The mitigation options are represented in Exhibit 1 at the end of this memo, and also outlined below:

- A citywide recommendation that would provide a significant benefit to the Davis Islands basin is a detailed stormwater outfall inventory. SLR conditions will reduce the capacity of most outfalls along the bays and Hillsborough River and therefore limit their ability to receive and handle stormwater runoff. The existing City outfall inventory has data gaps that limit the ability to accurately quantify vulnerabilities and perform prioritization of mitigation options. A more robust inventory would include outfall sizes, material, and condition to accurately assess vulnerability on a site-specific basis. Due to the large number of outfalls in the Davis Islands study basin, the aforementioned outfall inventory will be important in performing future resiliency planning, modeling, and capital improvement implementation. The outfall Inventory recommendation is also addressed in the Citywide Guidelines and Recommendations section of this Memo.
- Keeping in mind current limitations regarding outfall information, it is recommended that the City consider installing tide gates/ backflow preventers on all 81 of the identified piped outfalls on Davis Islands. Additionally, the City should consider setting a minimum outfall pipe size, and replace undersized pipes over time as existing outfalls reach their useful life. For example, a minimum elevation of 24 inches would require upgrades to 56 outfalls that range from 12 to 18 inches. The increase in pipe size would provide additional surface area to better drain Davis Islands during increased tidal conditions. Additionally, the increase in pipe size will offset any headloss caused by the installation of backflow preventers.
- Another citywide recommendation that would greatly benefit the Davis Islands basin is a seawall inventory. There is currently no city-wide inventory of existing seawalls. A comprehensive inventory that collected seawall ownership, material, condition, and elevation would allow for more precise vulnerability analysis and also assist with permitting and regulations. Davis Islands is surrounded by seawalls that are primarily privately or owned. The seawall Inventory recommendation is also addressed in the Citywide Guidelines and Recommendations section of this Memo.



- Continued with the seawall recommendations, it is recommended the City consider a seawall ordinance that accounts for future SLR conditions and sets consistent city-wide standards. For example, the City could consider a minimum seawall elevation at 4.5 ft NADV88 (3.5 ft + 1 ft freeboard) that also requires seawall maintenance and replacement standards. The City can also set future minimum seawall requirements. For example, the City of Miami is proposing minimum elevation for all seawalls, natural shorelines, bulkheads and other waterfront protection devices at 6.0-ft NAVD. The seawall ordinance recommendation is also addressed in the Citywide Guidelines and Recommendations section of this Memo.
- A number of roadway segments on Davis Islands are subject to an increased frequency of chronic inundation attributed to Sea Level Rise. To address this The City may consider setting minimum roadway elevation standards for future design and redevelopment. For example, a standard could be set consistent with roadways adjacent to tidal areas to have a minimum elevation consistent with seawall elevations, in this case 4.5 feet NAVD88. This will protect both road surfaces and subbase from damages due to elevated water table conditions and while also meeting level of service by keeping them fully operational and safe for traffic.
- The City should consider developing a dynamic hydrologic and hydraulic model for Davis Islands to assist with vulnerability assessment and capital planning.

Conceptual planning level costs for Coastal Study Basin 1 Mitigation Options are included at the back of this Memo.

Coastal Study Basin 2 - Conley Basin

Coastal Study Basin 2 is Conley Basin (Outfall ID 73), located in the neighborhoods Ballast Point and Interbay, on the southeastern shoreline of lower peninsula of Tampa. The mitigation options are represented in **Exhibit 2** placed at the end of this memo, and also outlined below:

- The Lower Peninsula Watershed Management Plan study, completed in 2019, identified flood improvements in this basin under BMP Project Number 7. This study also evaluated proposed improvement projects while accounting for future SLR conditions. The study included modeling analysis, and recommendations for the Conley Basin included a pump station and conveyance improvements, and a new outfall to the bay to relieve the existing system. These elements are included in the Mitigation Options for Conley Basin and reflected in the Exhibit.



- Conley Avenue is subject to increased inundation during future SLR conditions and would benefit from regrading to recommended minimum roadway elevation design criteria or standards.
- An earthen berm at approximately 4 ft NAVD close to the outfall should be considered to prevent tidal inflows from increasing flooding along Conley Avenue and adjacent properties during future SLR conditions. This berm would need to tie into adjacent grades to protect the area.
- In conjunction with the earthen berm, a tide gate would be required to fully protect properties from chronic flooding associated with future SLR conditions.
- Some of the properties along the shore, particularly in the RLAs in the south, don't have seawalls. The City may consider collaborative efforts with private entities in this area as well as other areas around the peninsula to implement natural or 'living' shoreline solutions to provide flood protection and habitat creation.

Conceptual planning level costs for Coastal Study Basin 2 Mitigation Options are included at the back of this Memo.

Coastal Study Basin 3 - Spring Lake

Coastal Study Basin 3 is Spring Lake (Outfall ID 80), a basin that discharges to the Spring Lake Canal on the west side of the Tampa peninsula, with a primary stormwater collection system along El Prado Boulevard. The mitigation options are represented in **Exhibit 3** placed at the end of this memo, and also outlined below:

- Recent conveyance improvement projects have been implemented in this project area along El Prado Boulevard and Vasconia Street, which are been represented in the Exhibit. Additionally, the City identified that they recently acquired two repetitive flood loss properties in this basin.
- There are additional ongoing conveyance improvements along Manhattan that will provide further flood reduction benefit in the Spring Lake basin.
- The City may consider backflow prevention on the recently improved outfalls to take into account future SLR conditions, but the benefits should be evaluated closely, as the cost is expected to be high and there are a number of other outfalls to the Spring Lake Canal that may also require backflow prevention.
- It has been identified and noted that properties along the Spring Lake Canal may benefit from raised Seawalls if the City elects to adopt a Seawall Ordinance in the future.
- Although significant flood reduction benefits are expected from the ongoing improvement projects, is It is recommended that the City continue observe flood complaints and flood loss records in this basin, and consider strategic acquisitions of any recurring flood loss properties in the future.



Conceptual planning level costs for Coastal Study Basin 3 Mitigation Options are included at the back of this Memo.

Coastal Study Basin 4 - Buffalo

The Buffalo Basin (Outfall ID 516) is located along the west side of the Hillsborough River north of Columbus Drive and South of Hillsborough Avenue, with the primary basin outfall discharging at the Dr Martin Luther King Boulevard bridge. The basin also encompasses the Wellswood neighborhood. The mitigation options are represented in **Exhibit 4** placed at the end of this memo, and also outlined below:

- There are approximately seven existing outfalls in this basin, and it is recommended that the City consider installing backflow preventers on each of these outfalls.
- It has been identified and noted that properties along the Hillsborough may benefit from raised Seawalls if the City elects to adopt a Seawall Ordinance in the future. Specifically, there are properties along the river that are located in a repetitive loss area (RLA) and do not have engineered seawalls.
- The Rome Avenue Wastewater Pump Station may be impacted by chronic flooding during future SLR conditions. The City should evaluate this pump station to better understand the flood damage risks, and consider the most effective flood protection measures. Options include, elevation, floodproofing, and relocation of the pump station.
- The swales and conveyance in the Wellswood neighborhood (Wishart Blvd. between Armenia and Erma Avenue) appear to be under capacity based on flood complaint records and limited review of the area. The conveyance capacity and functionality of the systems are expected to be hindered under future SLR conditions. An improved secondary stormwater collection system is recommended to provide flood reduction benefits to the Wellswood neighborhood.
- A regional dynamic hydrologic and hydraulic model of the Lower Hillsborough Watershed, or at least the Buffalo Basin, would provide increased ability to assess current and future flooding conditions in the areas along the Hillsborough River, and will assist in future stormwater capital improvement planning that also incorporate SLR resilient elements.

Conceptual planning level costs for Coastal Study Basin 4 Mitigation Options are included at the back of this Memo.

Coastal Study Basin 5 - Cedar Channel

Cedar Channel Basin (Outfall ID 143), lies north of the Spring Lake Basin (Study Basin 3) on the peninsula. The west part of the basin is aligned with Westshore Boulevard, and the primary stormwater system runs south along Trask Street until it discharges into Cedar Channel, which runs underneath Westshore Boulevard Bridge to the tidal canal out to Old Tampa Bay. The mitigation options are represented in **Exhibit 5** placed at the end of this memo, and also outlined below:



- The Upper Peninsula Watershed Management Plan study identified flood improvements in this basin that are actively being implemented through a Design-Build effort. The study included modeling analysis and feasibility for conveyance improvements starting at Dale Mabry Highway, down Watrous Avenue, Manhattan Avenue, and outfalls to Estrella Street.
- It has been identified and noted that properties along Cedar Channel would likely benefit from raised Seawalls should the City elects to adopt a Seawall Ordinance in the future
- Although significant flood reduction benefits are expected from the improvement project, it is recommended that the City continue to monitor flood complaints and flood loss records in this basin, and consider strategic acquisitions of any recurring flood loss properties in the future.

Conceptual planning level costs for Coastal Study Basin 5 Mitigation Options are included at the back of this Memo.

Coastal Study Basin 6 - Downtown Basin

The Downtown Basin (primary Outfall ID 351), includes the Tampa downtown area. The southern half of the basin is encompassed by the Hillsborough River, Garrison channel and Ybor channel. The northern end of the basin includes the I-275 and I-4 interchange, and the eastern side of the basin intersects with the Selmon Expressway. The mitigation options are represented in **Exhibit 6** placed at the end of this memo, and also outlined below:

- There are approximately 41 stormwater outfalls in the Downtown Basin. The City should consider backflow preventers on these outfalls, with particular focus on the outfalls in the southwestern portion of the basin near the convention center.
- In line with the other basins, a seawall inventory and stormwater outfall inventory would allow for a better assessment and prioritization of future mitigation strategies for this basin.
- The City recently implemented improvements to the Krause wastewater pump station, which included flood protection measures such as elevation of critical components and floodproofing measures. Similar consideration should be made to other critical infrastructure identified in the basin that are located in low lying areas susceptible to chronic or acute flood risk that is further impacted by future SLR conditions.
- A stormwater model, ideally as part of a regional watershed model, is strongly recommended for the downtown area. Stormwater outfall inventory would benefit modeling efforts in this area.

Conceptual planning level costs for Coastal Study Basin 6 Mitigation Options are included at the back of this Memo.



Citywide Guidelines and Recommendations

The protection of coastal areas from the collective risks of SLR, high tides, and storms cannot be accomplished through one strategy. The implementation of multiple control measures following best practices can allow stormwater collections systems to function effectively and meet design level of service even during elevated tide conditions.

Seawall inventory

There is currently no city-wide inventory of existing seawalls. A comprehensive inventory that collected seawall ownership, material, condition, and elevation would allow for more precise vulnerability analysis and also assist with permitting and regulations.

Seawall ordinance

It is recommended that the City consider a seawall ordinance that accounts for future SLR conditions and sets consistent city-wide standards. For example, the City could consider a minimum seawall elevation at 4.5 ft NADV88 (3.5 ft + 1 ft freeboard) that also requires seawall maintenance and replacement standards.

Stormwater outfall inventory and improvements

SLR conditions will reduce the capacity of most outfalls along the bays and Hillsborough River and therefore limit their ability to receive and handle stormwater runoff. The existing outfall inventory has data gaps that limit the ability to accurately quantify vulnerabilities and perform prioritization of mitigation options. A more robust inventory would include outfall sizes, material, and condition to determine vulnerability of specific sites. In many locations, backflow preventors will be important to maintain roadway level of service while also allowing stormwater conveyance during rainfall events.

Raising of roadways

The City may consider setting minimum roadway elevation standards for future transportation capital projects. For example, a standard could be set consistent with roadways adjacent to tidal areas to have a minimum elevation consistent with seawall elevations, in this case 4.5 feet NAVD88. This will protect both road surfaces and subbase from damages due to elevated water table conditions and while also meeting level of service by keeping them fully operational and safe for traffic.

Outreach

To assist with adherence to the Florida Building Code, City Building Code, the City may consider hosting coastal construction workshops for local design and construction professionals. These workshops could go over technical elements such as Flood Resistant Design and Construction Standards (e.g. ASCE 24) and (Coastal Construction Manual FEMA P-55) for coastal properties.



Modeling

The City of Tampa does not currently have a dynamic hydrologic and hydraulic model in all tidal areas subject to SLR. It is recommended that the City work to develop of a comprehensive hydrologic and hydraulic model of the city, with a priority on areas with tidal outfalls. This effort would provide benefit by improving stormwater management and infrastructure planning both for existing conditions and future scenarios with SLR conditions. Some priority areas identified would be the Lower Hillsborough Watershed, Downtown area, and Davis Islands.



EXHIBITS



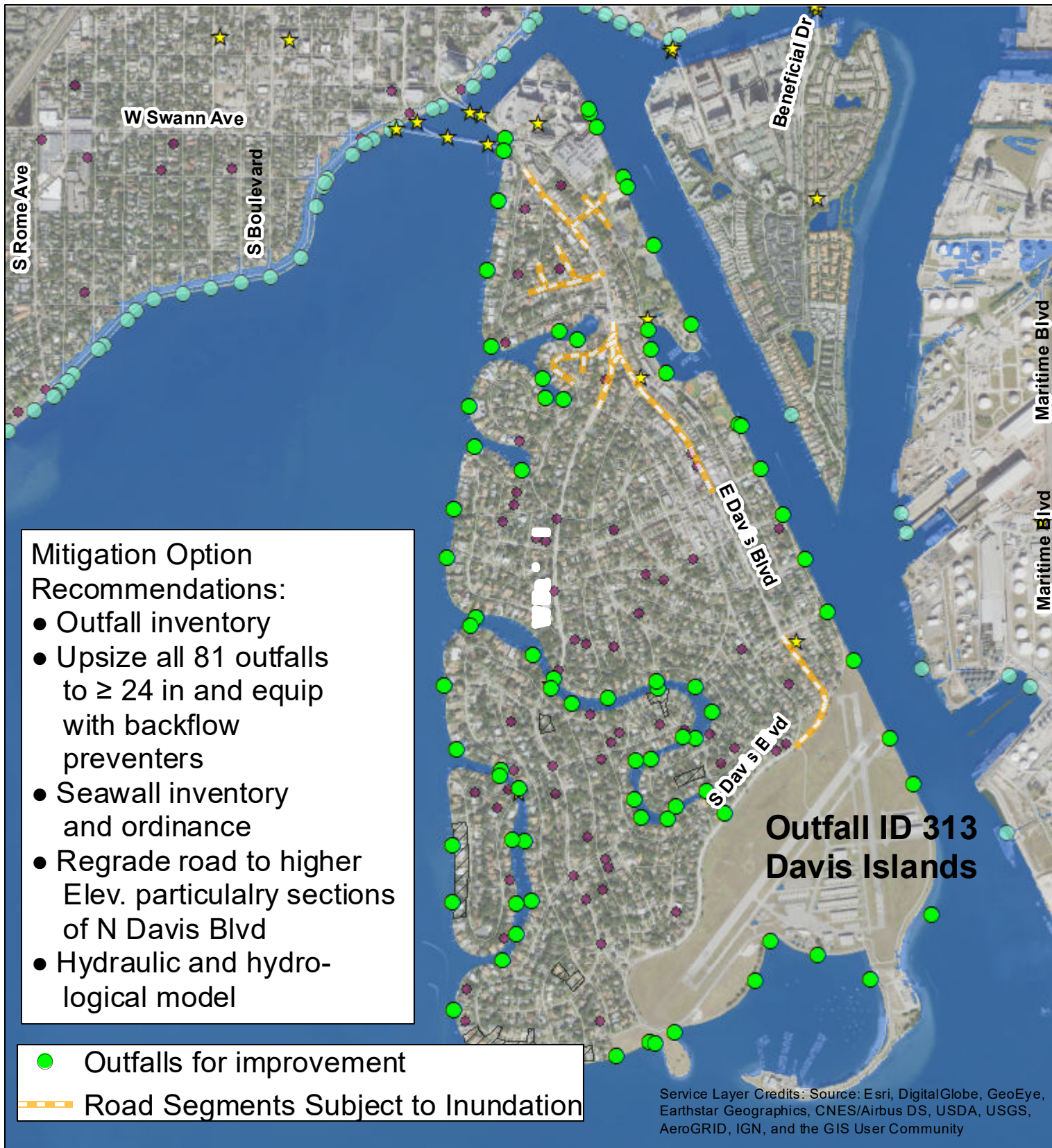
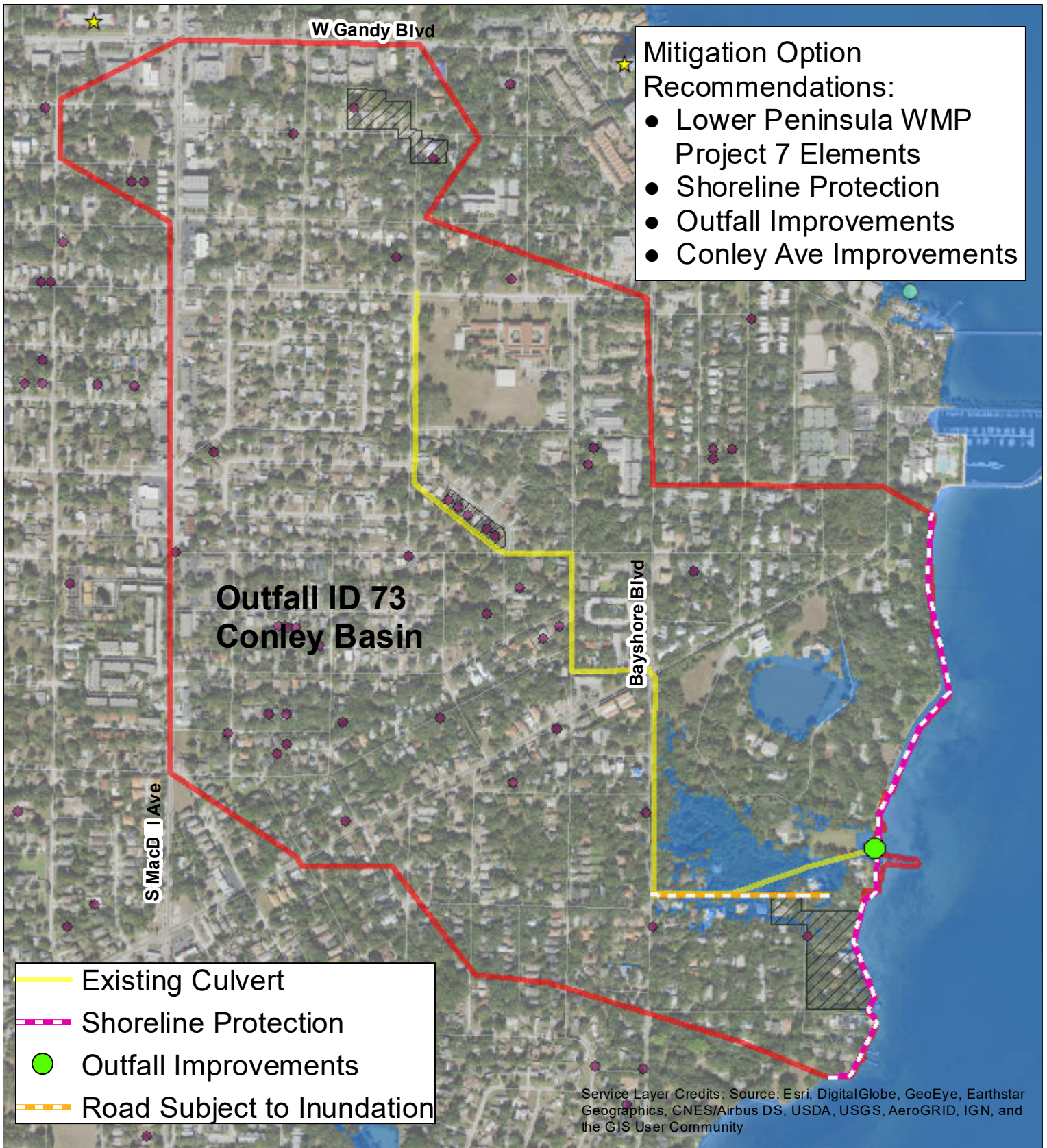


Exhibit 1 Davis Islands City of Tampa Florida Resilient Coastlines Program

Legend

- ★ Critical Infrastructure
- Coastal Outfalls
- Flood Complaints
- ▨ Repetive Loss Areas
- SLR Inundation (3.44 ft)



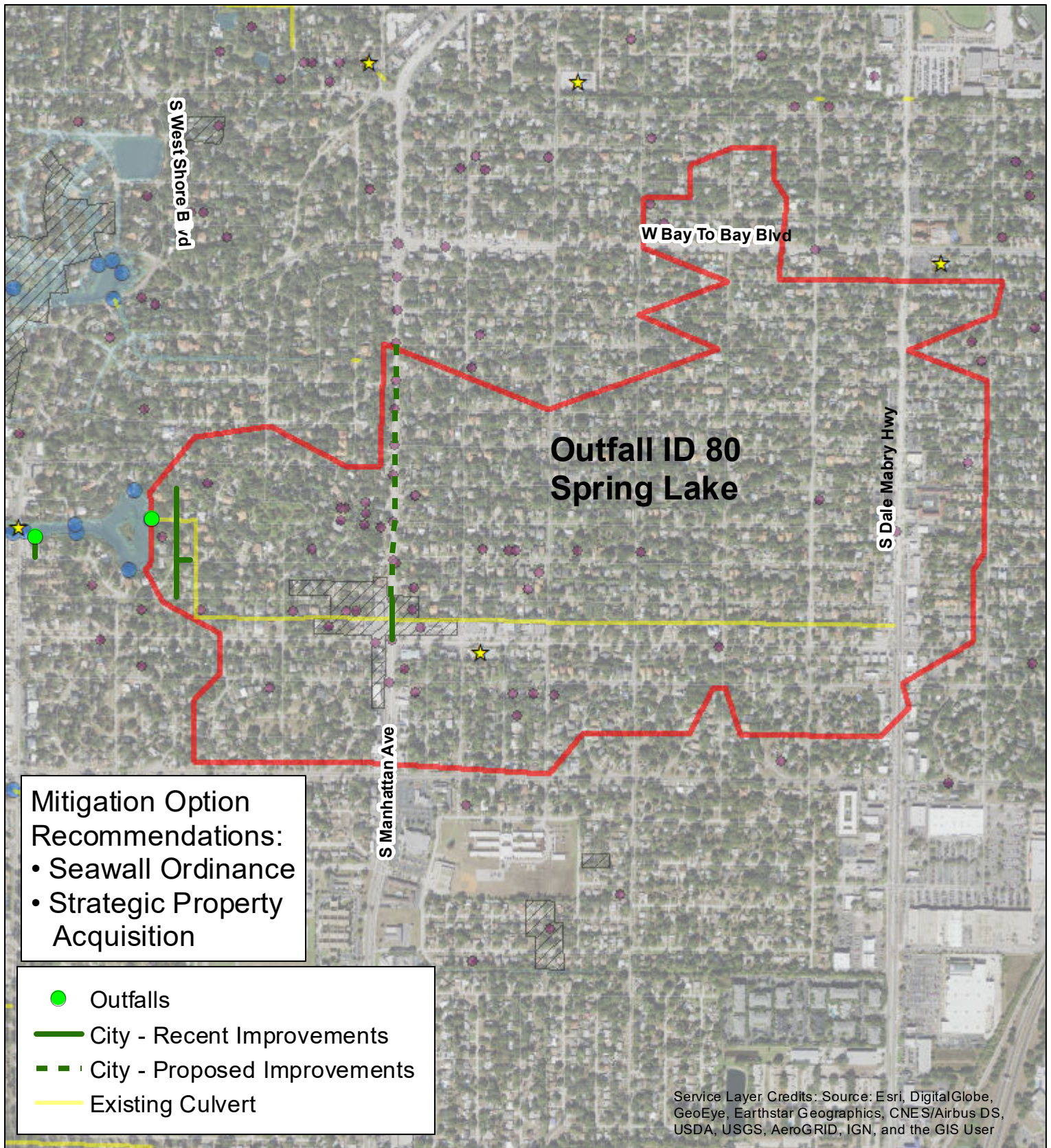
0 0.05 0.1 0.2 Miles



Exhibit 2 Conley Basin City of Tampa Florida Resilient Coastlines Program

Legend

- ★ Critical Infrastructure
- Coastal Outfalls
- Flood Complaints
- ▨ Repetitive Loss Areas
- SLR Inundation (3.44 ft)



0 0.075 0.15 0.3 Miles



Exhibit 3 Spring Lake City of Tampa Florida Resilient Coastlines Program

Legend

- ★ Critical Infrastructure
- Coastal Outfalls
- Flood Complaints
- ▨ Repetitive Loss Areas
- SLR Inundation (3.44 ft)

Mitigation Option Recommendations:

- Equip outfalls with backflow preventers
- Seawall ordinance and inventory
- Hydrologic and hydraulic model

Floodproof Rome Ave pump station

Outfall ID 516
Buffalo Basin

N Rome Ave

N Habana Ave

W Tampa Bay Blvd

Wellswood
Neighborhood
Drainage
Improvements

- ★ Pump Station
- Outfalls
- ▨ Neighborhood Drainage Imp.
- Existing Culvert

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

0 0.1 0.2 0.4 Miles



Exhibit 4
Buffalo Basin
City of Tampa
Florida
Resilient
Coastlines
Program

Legend

- ★ Crit. Infrastr.
- Coastal Outfalls
- Flood Complaints
- ▨ Repetitive Loss Areas
- SLR Inundation (3.44 ft)



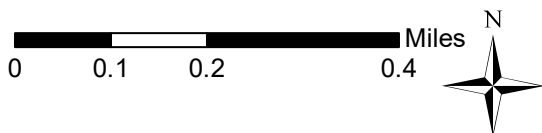
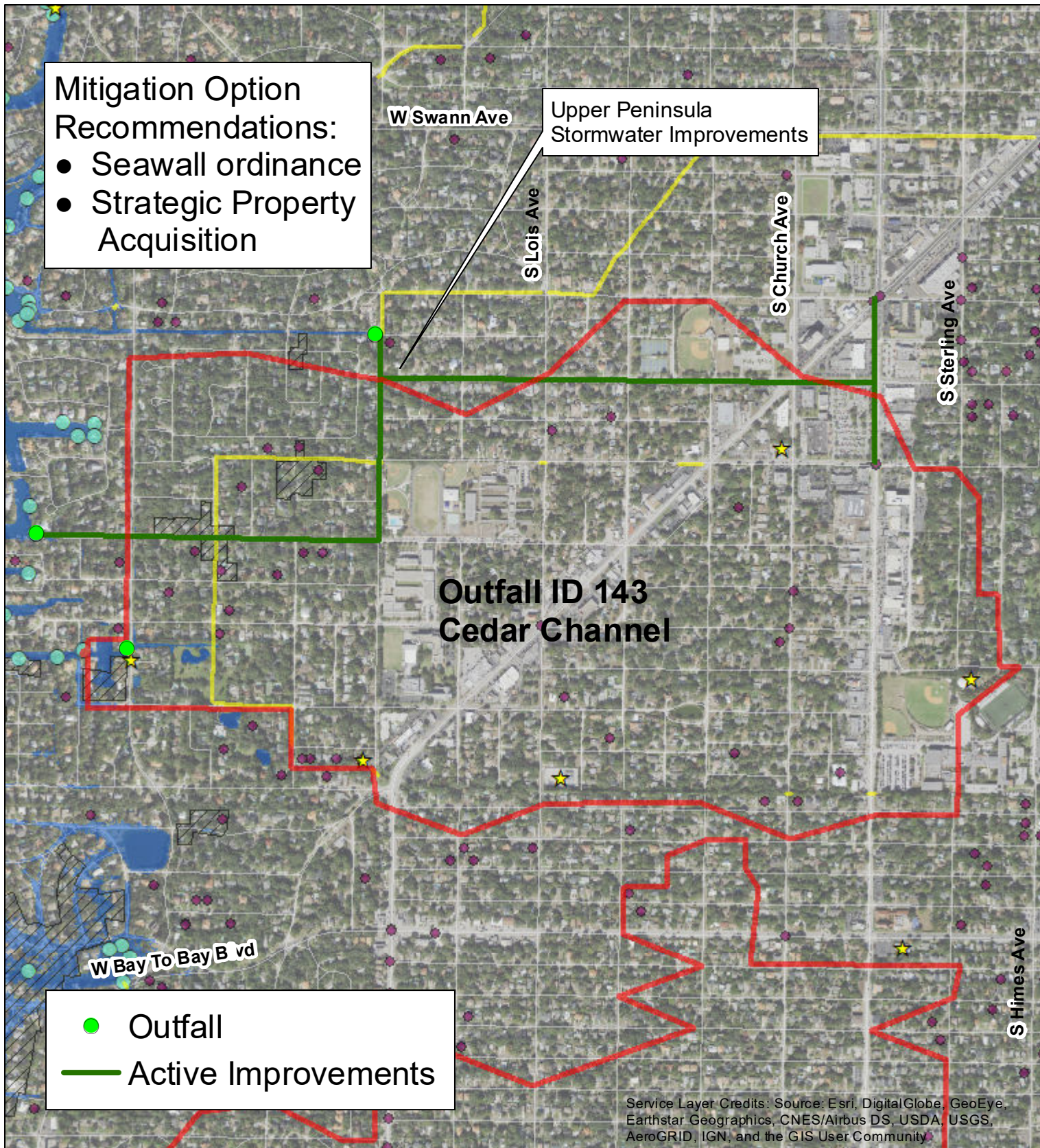


Exhibit 5
Cedar Channel
 City of Tampa
 Florida
 Resilient Coastlines

Legend

- Existing Culvert
- ★ Crit. Infrastr.
- Coastal Outfalls
- Flood Complaints
- Repetitive Loss Areas
- SLR Indundation (3.44 ft)

Mitigation Option Recommendations:

- Equip outfalls with backflow preventors
- Seawall Inventory
- Hydraulic and Hydrologic Model

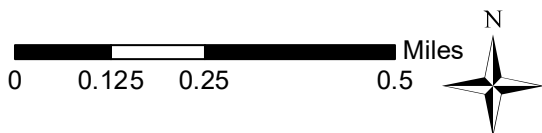
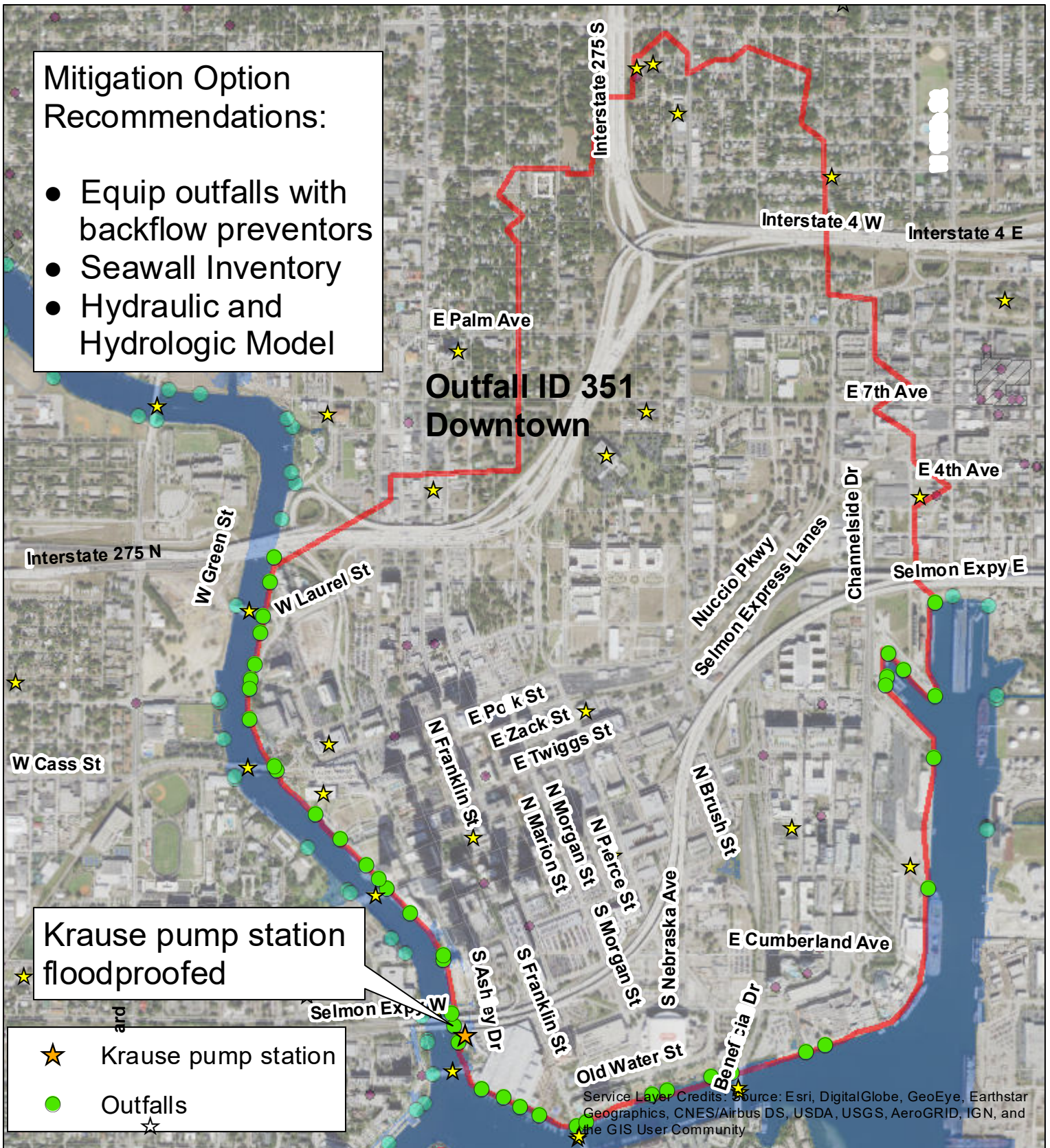


Exhibit 6 Downtown City of Tampa Florida Resilient Coastlines Program

Legend

- ★ Critical Infrastructure
- Coastal Outfalls
- Flood Complaints
- ▨ RLA
- SLR Inundation (3.44 ft)

PLANNING COSTS



PLANNING LEVEL COST					
COASTAL STUDY BASIN 1 - DAVIS ISLANDS			CONSULTANT: APPLIED SCIENCES		
PROJECT: R1916 SEA LEVEL RISE VULNERABILITY ANALYSIS			CLIENT: CITY OF TAMPA		
ID NO	ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	TIDE GATES (AVERAGE SIZE 24 INCH DIA.) COST INSTALLED	EA	81	\$ 12,000.00	\$ 972,000.00
2*	REGRAIDING LOW SEGMENTS OF DAVIS ISLAND BLVD AND LOCAL STREETS	MI	1.0	\$ 1,000,000.00	\$ 1,000,000.00
3	H&H MODEL DEVELOPMENT	LS	1	\$ 75,000.00	\$ 75,000.00
4					
5					
6	GEOTECH, SURVEY, AND PERMITTING COST (ITEM 2)	%	5	\$ 50,000.00	\$ 50,000.00
7	ENGINEERING DESIGN COST (ITEMS 2-5)	%	15	\$ 150,000.00	\$ 150,000.00
8					
9					
10					
	TOTAL ESTIMATED COSTS				\$ 2,247,000.00

*Note: FDOT Cost per Mile Models for Long Range Estimating: Mill and Resurface 4 Lane Undivided Urban Roadway with 4' Bike Lanes

PLANNING LEVEL COST					
COASTAL STUDY BASIN 2 - CONLEY BASIN			CONSULTANT: APPLIED SCIENCES		
PROJECT: R1916 SEA LEVEL RISE VULNERABILITY ANALYSIS			CLIENT: CITY OF TAMPA		
ID NO	ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	LOWER PENINSULA PROJECT 7 (DESIGN, CONSTRUCTION, & CONTINGENCIES)	LS	1	\$ 9,464,000.00	\$ 9,464,000.00
2	REGRADING CONLEY AVENUE	LS	1	\$ 100,000.00	\$ 100,000.00
3	EARTHEN BERM	LS	1	\$ 80,000.00	\$ 80,000.00
4	TIDE GATE AT CONLEY OUTFALL	LS	1	\$ 100,000.00	\$ 100,000.00
5	NATURAL 'LIVING' SHORELINE PROJECT (STRUCTURAL&NONSTR. ELEMENTS)	LS	1	\$ 1,000,000.00	\$ 1,000,000.00
6	GEOTECH, SURVEY, AND PERMITTING COST (ITEMS 2-5)	%	5	\$ 64,000.00	\$ 64,000.00
7	ENGINEERING DESIGN COST (ITEMS 2-5)	%	15	\$ 192,000.00	\$ 192,000.00
8					
9					
10					
TOTAL ESTIMATED COSTS					\$ 11,000,000.00

*Note: FDOT Cost per Mile Models for Long Range Estimating: Mill and Resurface 2 Lane Undivided Urban Roadway
Sea Grant Shoreline Protection Cost Estimates Document

PLANNING LEVEL COST					
COASTAL STUDY BASIN 3 - SPRING LAKE			CONSULTANT: APPLIED SCIENCES		
PROJECT: R1916 SEA LEVEL RISE VULNERABILITY ANALYSIS			CLIENT: CITY OF TAMPA		
ID NO	ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	MANHATTAN AVENUE STORMWATER IMPROVEMENTS (W/ UTILITY UPGRADES)	LS	1	\$ 6,000,000.00	\$ 6,000,000.00
2	PROPERTY ACQUISITION (ESTIMATED)	EA	4	\$ 400,000.00	\$ 1,600,000.00
3	TIDE GATES (LARGE OUTFALL) COST INSTALLED	EA	2	\$ 100,000.00	\$ 200,000.00
4					
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7					
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10					
	TOTAL ESTIMATED COSTS				\$ 7,800,000.00

PLANNING LEVEL COST					
COASTAL STUDY BASIN 4 - BUFFALO BASIN (WELLSWOOD)				CONSULTANT: APPLIED SCIENCES	
PROJECT: R1916 SEA LEVEL RISE VULNERABILITY ANALYSIS				CLIENT: CITY OF TAMPA	
ID NO	ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	WELLSWOOD NEIGHBORHOOD IMPROVEMENTS (DESIGN & CONSTRUCTION)	LS	1	\$ 3,000,000.00	\$ 3,000,000.00
2	TIDE GATES TO BASIN OUTFALLS (AVERAGE 36 INCH DIA), COST INSTALLED	EA	7	\$ 25,000.00	\$ 175,000.00
3	BUFFALO BASIN REGIONAL WATERSHED MODEL	LS	1	\$ 100,000.00	\$ 100,000.00
4	ROME AVENUE FLOOD PROTECTION	LS	1	\$ 250,000.00	\$ 250,000.00
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	TOTAL ESTIMATED COSTS				\$ 3,525,000.00

PLANNING LEVEL COST					
COASTAL STUDY BASIN 5 - CEDAR CHANNEL BASIN			CONSULTANT: APPLIED SCIENCES		
PROJECT: R1916 SEA LEVEL RISE VULNERABILITY ANALYSIS			CLIENT: CITY OF TAMPA		
ID NO	ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	UPPER PENINSULA IMPROVEMENTS (DALE MABRY TO ESTRELLA)	LS	1	\$37,000,000.00	\$ 37,000,000.00
2	PROPERTY ACQUISITION (ESTIMATED)	EA	4	\$ 400,000.00	\$ 1,600,000.00
3	TIDE GATES (LARGE OUTFALL)	EA	2	\$ 100,000.00	\$ 200,000.00
4					
5					
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7					
8					
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10					
	TOTAL ESTIMATED COSTS				\$ 38,800,000.00

PLANNING LEVEL COST					
COASTAL STUDY BASIN 6 - DOWNTOWN BASIN			CONSULTANT: APPLIED SCIENCES		
PROJECT: R1916 SEA LEVEL RISE VULNERABILITY ANALYSIS			CLIENT: CITY OF TAMPA		
ID NO	ITEM	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	TIDE GATES (AVERAGE SIZE 30 INCH DIA.) COST INSTALLED	LS	36	\$ 20,000.00	\$ 720,000.00
2	TIDE GATES (LARGE OUTFALL) COST INSTALLED	LS	5	\$ 90,000.00	\$ 450,000.00
3	H&H MODEL DEVELOPMENT	LS	1	\$ 100,000.00	\$ 100,000.00
4	STUDY OF DOWNTOWN CRITICAL INFRASTRUCTURE AND MITIGATION OPTIONS	LS	1	\$ 75,000.00	\$ 75,000.00
5					
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7					
8					
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10					
	TOTAL ESTIMATED COSTS				\$ 1,345,000.00