SEA LEVEL RISE VULNERABILITY ANALYSIS AND RESILIENCY STRATEGY REPORT

FDEP Agreement Number R1916

JUNE 2020

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1 INTRODUCTION

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 report, Applied Sciences presents the compiled results of the vulnerability analysis and resilience strategy for all tasks under the Florida Department of Environmental Protection (FDEP) Grant Agreement Number R1916.

1.1 Project Location

The City of Tampa has approximately 563 stormwater outfalls of various sizes that discharge to tidally influenced areas susceptible to Sea Level Rise (SLR), shown on **Exhibit 1** at the end of this report. 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 robust mitigation strategies. Six sample locations were selected, and the location basins are shown on Exhibit 1.

1.2 Purpose of the Study

The City received grant funding from FDEP to develop a Vulnerability Analysis for critical stormwater systems located in areas susceptible to sea level rise. The project will focus on high priority stormwater outfalls and impacts to corresponding basins. Alternative mitigation options will be identified to address the sea level rise impacts, from which an overall strategy for addressing all affected outfalls will be developed, including cost estimates. The Vulnerability Analysis will provide an executable plan and road map for addressing the effect of sea level rise in the City of Tampa.

The results of the vulnerability analysis will not only be applied towards mitigation strategies for short-term improvements, but will also be used for adaptation strategies to identify long-term solutions. Adaptation measures applied to stormwater assets also provide benefits to other assets through flood reduction on roads and buildings, improve open space and water quality benefits in Tampa Bay and riverine systems, and provide enhancements to recreation, fishing, and tourism.

Although critical, this report does not focus on storm surge events such as hurricanes, as the focus is on the ability for stormwater systems to meet design conveyance during rainfall events with elevated tailwater conditions due to SLR.

1.3 Project Background

In early 2017, The City of Tampa approved a text amendment to the Tampa Comprehensive Plan to comply with the State of Florida Peril of Flood Act. As outlined in the Hillsborough County City-County Planning Commission Staff Report, the legislation placed new requirements for local

governments to address flooding from sea level rise. These requirements are found in Section 163.3178(2)(f), Florida Statutes.

Sea level rise projections for the Tampa Bay region were originally developed in 2015 by the Tampa Bay Climate Science Advisory Panel (CSAP), and updated in April of 2019. The Planning Commission staff, working closely with the City of Tampa Staff, and with assistance of the Tampa Bay Regional Planning Council (TBRPC), completed a vulnerability assessment for the City based on these projections. The new Peril of Flood Policies are based on these projections.

Some of the notable findings in the Planning Commission Staff's assessment are:

- At least 80% of affected properties are publicly owned;
- Tampa General Hospital and several parks are at risk;
- Critical facilities are not located within at-risk areas; however, the area surrounding McKay Bay Refuse-To-Energy Facility should be monitored;
- Segments of 31 local roads are at-risk; and
- Many Stormwater basins and some stormwater facilities are within the at-risk areas.

If adaptation strategies are not implemented, cities throughout the region will incur substantial economic costs through impacts to infrastructure, properties, environment, and tourism.

1.4 Project Approach

The following approach follows the Task outline within the project agreement with FDEP:

Task 1. Consultant Selection

Task 2. Stormwater Outfall Sample Selection. Review the inventory of City owned and maintained, tidally-influenced outfalls and Identify a sample of affected high-priority stormwater outfalls from which to develop a mitigation strategy.

Task 3. Sea Level Rise (SLR) Vulnerability Assessment. Assess the impacts of future sea level rise on the affected stormwater basins and identify basin specific vulnerabilities.

Task 4. Mitigation Options Summary and Opinion of Probable Costs. Develop alternative mitigation options and cost estimates. Mitigation options can include physical and non-physical mitigation strategies

Task 5. Stormwater Outfall Resiliency Strategy. Develop a long-range strategy for addressing sea level rise needs for stormwater system to be incorporated into Capital Improvement Program.

Task 6. Public Outreach and Communication. Inform stakeholders and citizens and receive input on the Vulnerability Analysis and mitigation and adaptation implementation processes.

2 STORMWATER OUTFALL AND BASIN SELECTION

2.1 Overview

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 robust mitigation strategies.

2.2 Data Collection

Applied Sciences compiled and processed data from several sources including the City of Tampa, Hillsborough County, Southwest Florida Water Management District (SWFWMD), Florida Department of Environmental Protection (FDEP), Florida Department of Transportation (FDOT), Federal Emergency Management Agency (FEMA), and the United States Geological Survey (USGS). Also, the potential range of SLR projections and recommendation strategies varied depending on the source. The following sources were reviewed. The data collected as part of this project generally included:

- 2019 Aerial Photography – Hillsborough County
- 2017 Land Use – SWFWMD
- 2017 Digital Elevation Model (Topography) – SWFMWD
- Existing Studies – City of Tampa
- Flooding Problem Area Documentation – City of Tampa
- Repetitive Loss Areas (RLAs) – FEMA
- Special Flood Hazard Areas (SFHA) – FEMA
- Stormwater Infrastructure Inventory – City of Tampa

2.3 Outfall and Basin Prioritization

Applied Sciences used the data provided to develop a framework for prioritizing and ranking conceptual projects based on a selected set of criteria that aligns with the overall goals of this study. Weighted values and rankings were applied to each stormwater outfall based on generally agreed upon criteria reflecting the characteristics of the outfall, associated drainage area (basin), and other factors summarized in **Table 1**. This planning-level ranking methodology of the stormwater outfalls is qualitative, and each criterion was assigned a weight based on its perceived relative importance. Under each criterion, a project received a score that was then multiplied by the assigned weighting. The weighting and scoring for each stormwater outfall are based on the percentage weight, yielding a numeric score ranging from 0.0 to 10.0, with 10.0 being the highest

priority. Weighting and scoring are assigned with input from City staff. Criteria that were selected to evaluate recommended conceptual projects include:

- Outfall Type
- Priority Facilities within SFHA in Basin
- SFHA within Basin Count
- Repetitive Loss Parcels within SFHA in Basin
- Flood Complaints within SFHA in Basin
- Primary Land Use

There is a one-to-one relationship between stormwater outfalls and basins. The basins are assigned an outfall ID as well as other essential characteristics associated with each of the criteria above. The criteria weighting and scoring have been summarized in **Table 1**. Note the criteria and scoring are subject to change based on further discussion and review by the City and stakeholders.

Table 1. Project Ranking Criteria and Methodology

	Criteria	Weight	Score	Definition
1	Outfall Type	**10%**	10.0	Large Pipe Diameter (> 42 in.)
			5.0	Small Pipe or unknown
			2.0	Channel
2	Priority Facilities Count[1]	**25%**	10.0	Most facilities within SFHA or >10 within basin
			1.0	Least facilities within SFHA
			0.0	No facility within SFHA
3	Basin Areal Percent within SFHA	**20%**	10.0	100% of basin within SFHA
			0.0	0% of basin within SFHA
4	Repetitive Loss Area (RLA) Parcels Count[1]	**20%**	10.0	Most RLA within SFHA
			1.0	Least RLA within SFHA
			0.0	No RLA within SFHA
5	Flood Complaint Record Count[1]	**20%**	10.0	Most complaints within SFHA
			1.0	Least complaints within SFHA
			0.0	No complaints within SFHA
6	Primary Land Use	**5%**	10	Institutions / Utilities
			8	Commercial / Industrial

[1] Within Special Flood Hazard Area (SFHA)

Criteria	Weight	Score	Definition
		6	High Density Residential Areas
		5	Medium Density Residential Areas
		5	Transportation
		4	Low Density Residential Areas
		5	Reservoirs / Recreational Areas
		1	Undeveloped Land
		0	Waterbodies and Swamps
Project Scoring	**= Multiplier x Weight x Score**		
Maximum Score	10.0		

2.4 Study Basins

A spreadsheet and geodatabase have been created with the scores for each outfall and associated basin, and can be referenced separate from this document. The top five basins have been assigned a High ranking, the next 5 have been assigned a Medium ranking, and the remaining basins have been assigned a Low ranking**. Exhibit 1** is a map showing the basins and their respective rankings based on color. **Exhibit 2** is a map showing the basins and the FEMA Preliminary Coastal Special Flood Hazard Area within the City. It is recommended that the top five high-ranking basins be selected as the sample outfalls for the upcoming vulnerability analysis and mitigation strategy tasks, as well as the Downtown Basin.

The proposed Study Basin areas are listed below:

1. Outfall ID 313 - Davis Islands
2. Outfall ID 73 - Conley Basin
3. Outfall ID 80 - Spring Lake
4. Outfall ID 516 – Buffalo
5. Outfall ID 143 - Cedar Channel
6. Outfall ID 143 - Downtown

3 LOCAL SEA LEVEL RISE TRENDS AND PROJECTIONS

3.1 Sea Level Rise Background

The National Oceanic and Atmospheric Administration (NOAA) Technical Report*, Global and Regional Sea Level Rise Scenarios for the United States* (Sweet et al. 2017b), was produced as a coordinated, interagency task force to identify nationally agreed upon estimates for global and regional SLR to inform the 4th National Climate Assessment (hereinafter the NOAA projections). Notably, the report incorporates regional factors contributing to sea level change for the entire U.S. coastline and assigns conditional probabilities to six SLR projections based on future

greenhouse gas emissions and associated ocean-atmosphere warming in order to help decision makers assess and manage risk (Sweet et al. 2017a).

The Tampa Bay Climate Science Advisory Panel (CSAP), convened in 2014, studied these scenarios, and provided recommendations for local governments in the Tampa Bay Region in a published report that was recently updated, titled *Recommended Projections of Sea Level Rise in the Tampa Bay Region* (CSAP, 2019). Based upon a thorough assessment of scientific data and literature on SLR, the Tampa Bay region can expect to see approximately 1 to 2.5 feet SLR by 2050 and between 2 to 8.5 feet by 2100.

Regional measurements show the Tampa Bay region is already experiencing sea level rise (SLR), and there is broad scientific consensus that this trend will continue into the next century. According to the updated 2019 CSAP Report, the St. Petersburg tide gauge shows that water levels in Tampa Bay have already increased approximately 8.0 inches since 1946 (**Figure 1**).

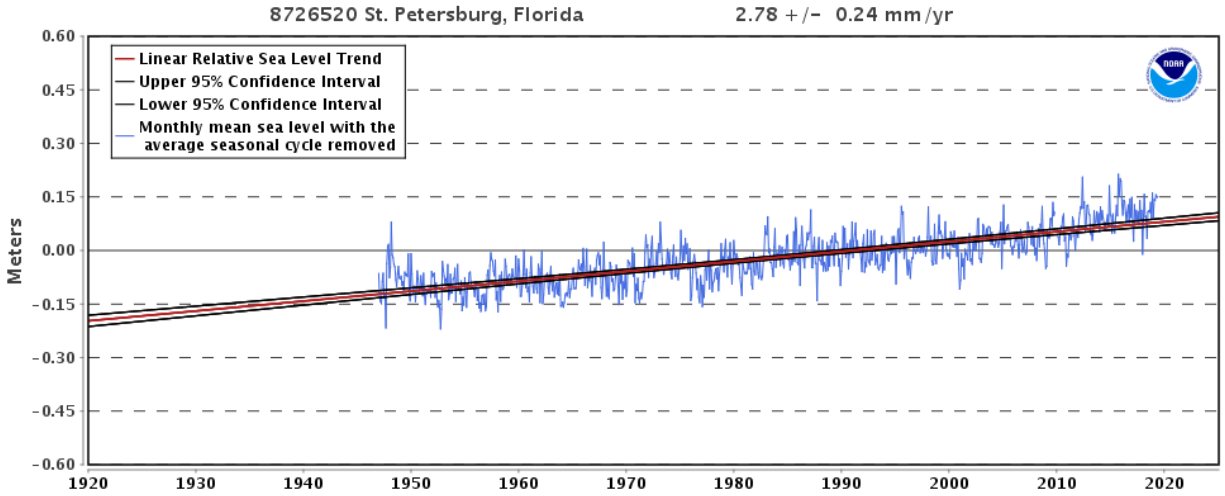


Figure 1. 1946-2018 Monthly Mean Sea Level Trend in St. Petersburg, FL, NOAA Tide Gauge 8726520

As a proactive response, the City has decided to incorporate a level of resiliency within their watershed studies and capital improvement program (CIP) planning and design process by considering future sea-level conditions. In addition, the City continues to evaluate citywide vulnerabilities to identify mitigation opportunities and adaptation strategies to strengthen resiliency within the community.

3.2 Sea Level Rise Projections Overview

The CSAP advises that local governments and regional agencies continue to use the SLR scenarios included in the Fourth US National Climate Assessment (NCA4) and subsequent assessments, adjusted to local conditions, to inform adaptation and infrastructure planning efforts in the Tampa Bay region. Although the CSAP generally recommends following the NCA, only three of the six SLR scenarios included in the NCA4 are part of the CSAP recommendation: NOAA Intermediate-Low, Intermediate, and High. The reason for excluding the other three scenarios are explained below.

Observed (not modeled) changes over 25 years, published in 2018, demonstrate that the rate of SLR is increasing at an accelerated rate. Therefore, the CSAP recommends that the NOAA Low scenario (which depicts a linear rate of rise with no projected acceleration) should be excluded from entities planning for SLR, and the NOAA Intermediate-Low scenario should be considered the lowest plausible bound for future sea level change.

Similarly, the NOAA Extreme scenario represents the maximum ice sheet melt that is physically possible. However, the probability of this occurrence is exceptionally low and not yet supported by established science. Therefore, the CSAP recommends that entities planning for SLR use the NOAA High as the upper bound for future sea level change, until additional information related to ice sheet processes is settled.

Finally, the NOAA Intermediate scenario is recommended as a projection to fully capture the plausible range of likely SLR given the probabilistic framework laid out in the NCA4, which means the intermediate-High scenario is excluded. These projections are represented in **Figure 2** below.

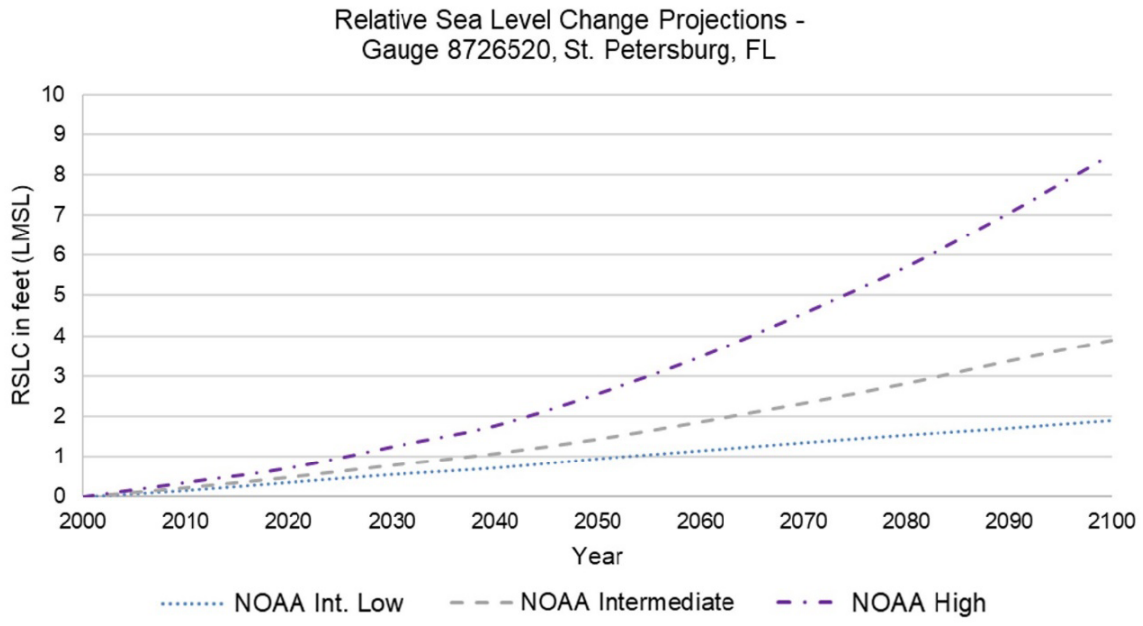


Figure 2. Relative Sea Level Change (RSLC) Scenarios for St. Petersburg, Florida, as calculated using the regionally corrected NOAA 2017 curves. (USACE 2019)

Table 2. Sea Level Change Relative to the Year 2000 for St. Petersburg, as calculated using the regionally corrected NOAA 2017 curves. (USACE 2019)

Year	NOAA 2017 Int-Low	NOAA 2017 Intermediate	NOAA 2017 High
2030	0.56	0.79	1.25
2040	0.72	1.08	1.77
2050	0.95	**1.44**	2.56
2060	1.15	1.87	3.48
2070	1.35	2.33	4.56
2080	1.54	2.82	5.71
2090	1.71	3.38	7.05
2100	1.90	3.90	8.50

3.3 Data Collection

The potential range of SLR projections and recommendation strategies varied depending on the source. The following sources were reviewed:

- City of Tampa, Hillsborough County City-County Planning Commission; Sea Level Rise Vulnerability Assessment for the City of Tampa (February 2017)
- Tampa Bay Climate Science Advisory Panel, Recommended Projection of Sea Level Rise in the Tampa Bay Region (August 2015)
- USACE, NOAA, Sea-Level Change Curve Calculator (Version 2017.55)
- Coastal Vulnerability Assessment: City of Clearwater, Florida, Florida Department of Economic Opportunity (June 2016)
- Florida Highway Administration, Resilience & Durability to Extreme Weather Pilot Program, Resilient Tampa Bay Transportation Group (April 2019)
- Tampa Bay Climate Science Advisory Panel, Recommended Projections of Sea Level Rise in The Tampa Bay Region, (Updated April 2019)

3.4 Recommended Scenario

Given this range of uncertainty in future SLR, the CSAP recommends that local governments and other agencies consider a variety of factors, including the expected lifespan of the project, project cost, and criticality of function when developing adaptation strategies. Scenario planning offers opportunities to initiate actions now by balancing the costs of inaction against reasonable returns on investments made to reduce future impacts on the built environment.

With the assumption that a typical stormwater improvement project has a project useful life of approximately 30-40 years, this also aligns with the 2050 NOAA intermediate-high value of 1.44 ft. Since the existing conditions evaluation used average historical data and probabilistic data not adjusted for sea level rise, the relative change of 1.44 feet is directly added to the current model

boundary condition. Therefore, the modeled 1-year stillwater elevation with 1.44 ft SLR as the tailwater design condition (2.0 feet +1.44 feet = 3.44 feet NAVD88) is recommended to be applied when evaluating resiliency for future capital improvement projects. The recommended new tailwater incorporates an element of resiliency against the predicted 2050 sea level rise conditions.

4 SEA LEVEL RISE VULNERABILITY ANALYSIS FOR STUDY BASINS

Based on the constraints of the scope of work, the Vulnerability Analysis is limited to the selected Study Basins. The Vulnerability Analysis builds off of the selected basin criteria and provides a more detailed assessment to identify specific exposure and sensitivities from the projected sea level rise scenario. For the exposure in these basins, a sea level rise inundation polygon was created to map the static 3.44-foot elevation. This layer provided a visual representation of risk to identify which areas, infrastructure, and land uses may be affected. Following the exposure and sensitivity assessments is the review of adaptative capacity for each basin to determine the degree to which the basin is equipped to adapt to sea-level rise through the existence of policies, structures, or other resources.

From a stormwater focus, the conveyance capacity impacts to the outfalls from sea level rise were analyzed utilizing existing watershed models, where available. If watershed models were not available, approximations and general assumptions are required regarding anticipated capacity reductions and flood impacts to the areas.

The outcome of this Vulnerability Analysis is intended to serve as a framework for future assessments and a road map for capital planning strategy.

4.1 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 basin is primarily high density residential (70 percent), followed by commercial and services (21 percent). The Peter O. Knight airport is located in the southeast of the island. Most parcels are privately owned; however, the City of Tampa owns several larger parcels on the northeast of the basin. Ground elevations in the basin range from sea level to 10 feet NAVD88. Davis Islands Basin with vulnerability features are shown in **Exhibit 3**.

4.1.1 Stormwater Outfalls

Davis Islands has a total basin area of 781 acres, which encompasses the entire island. The basin contains approximately 81 outfalls discharging directly into to Hillsborough Bay or indirectly through the Hillsborough River or canals on the island. The outfall types include two 6 ft x 5 ft culverts and 79 stormwater pipes ranging between 12 and 48 inches in diameter.

4.1.2 Critical and Priority Facilities

There are four critical facilities, all within SFHA. The City of Tampa owns a fire station and a wastewater pump station on the east side of the basin, near the Seddon channel. Also, Tampa

General Hospital is located at the north tip of Davis Islands. There is also an assisted living facility on the island.

There is one major road on Davis Islands, Davis Boulevard, connecting through a bridge system to Bayshore Boulevard and the mainland. While not formally classified as an evacuation route, Davis Boulevard is the only entrance or exit from the island. Also, while not located in the basin itself, the bridges are critical facilities that need to be considered, including the bridge approaches.

4.1.3 Special Flood Hazard Area

The entire basin is classified to be within the preliminary SFHA. Most of the basin, approximately 80 percent, is designated as FEMA flood zone AE. The base flood elevation (BFE) within Zone AE ranges from 11 ft for most of the island, to 12 ft along the shore. These BFEs would result in depth of flooding ranging from about 1.5 to 7 ft. The airport and seaplane basin park area are in designated flood zone VE with a BFE of 13 ft. The depth of flooding ranges from 5.5 to 8.5 ft. The Limit of Moderate Wave Action (LiMWA) boundary passes roughly 100 to 300 ft off the shoreline along the west basin side and cuts across the southern portion of the island, north of the Airport and S Davis Boulevard. The areas located between the LiMWA and the shoreline are identified to be affected by wave action in excess of 1.5 ft during the 1 percent coastal event, thus are identified to be at a higher risk of damage.

4.1.4 Repetitive Loss Areas

Six RLAs are located within the SFHA, two are directly at the shore and four are further inland, close to the major canal. A repetitive loss property is defined as any insurable building for which two or more flood claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period since 1978. This is the highest number of RLAs of all six selected basins, covering 81 parcels. All parcels within the RLA's were single family residential. These areas are more vulnerable to coastal flood events, which will be heightened by sea level rise, and they can also be susceptible to rainfall with an elevated tailwater condition, such as the August 2015 storm.

4.1.5 Flood Complaint Records

The City has a record of 66 flood complaints on Davis Islands over the past 23 years. 51 of the complaints were filed more recently, between 2014 and 2017. These complaints included flooding or standing water in streets, yards, and garages.

4.1.6 Sea Level Rise Impacts

4.1.6.1 SLR + 1-Year Stillwater

As previously determined, the SLR+ 1-Year Stillwater scenario is estimated at an elevation of 3.44 feet NAVD88. This elevation is at a high enough level to potentially overtop low sea walls, create backflow through stormwater outfalls, elevate groundwater tables, and inundate low lying areas. At a water level of 3.44 ft, approximately 2 percent of the basin would be inundated, affecting mainly streets and some residential properties. From the LiDAR Data, inundation is

mapped across several smaller residential streets and access roads, such as Arbor Place, Baltic Circle, and Columbia Drive. Also, segments of Davis Boulevard experience flooding out from the edge of pavement but do not inundate the crown of the road. None of the critical facilities are directly impacted from the adjusted Stillwater condition.

4.1.6.2 Impacts from Rainfall Combined with SLR

Although none of the outfall inverts have been surveyed or modeled, it would be expected that all of the outfalls would be submerged at the future projected stillwater elevation based on the low-lying nature of the island and pipe cover requirements. The average outfall size on the island is 18 inches, which doesn't include the 6 ft x 5 ft box culverts. The typical ground elevation of 5 feet along the edge of the island and 2 feet of cover, in the best case, would put the top of pipe at approximately 3 feet, meaning 0.44 feet of head would be built up on the outfall. The pipe invert could even be significantly lower given the flat nature of the island and minimum pipe slope requirements for conveyance. Regardless, the tailwater change is nearly 1.5 feet, which is significant.

In addition to conveyance restrictions from SLR, the soil storage capacity in low lying areas will be impacted based on elevated groundwater conditions. This would result in increased runoff across the island, creating additional capacity issues for the stormwater collection system.

4.1.7 Summary of Vulnerabilities

Being an island located in Hillsborough Bay, Davis Islands is directly exposed on all sides to sea level rise. The entire basin is in the SFHA, with a significant number of roads and structures well below the base flood elevations. Most of the land on the island is privately owned, but roads and other infrastructure belong to the City. The critical infrastructures include a WW pump station and a fire station, both closely located to the shore and low areas within the basin. The bridges are the only connection between the island and the City. This results in Davis Islands being a highly vulnerable basin that will require future mitigation alternatives.

4.2 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 south stretch of Tampa. Elevations in Conley Basin range from sea level to 18.5 ft NAVD88. The east side of Conley Basin borders 3,500 ft with Hillsborough Bay, while runoff from the basin is discharged through a 6x4 foot culvert. Approximately 75 percent of the area are high density residential and 12 percent are commercial and services. The basin also contains three parcels owned by the City of Tampa. Conley Basin with vulnerability features are shown in **Exhibit 4**.

4.2.1 Priority Facilities

There is no City identified critical infrastructure within Conley Basin, but there are two assisted living facilities near the basin boundary, and Ballast Point Elementary School is also identified within the basin. The major roads in the basin are Bayshore Boulevard, Interbay Boulevard, and S MacDill Avenue. The segment of Bayshore Blvd has an estimated Average Annual Daily Traffic (AADT) of 11,000, MacDill Ave has 2,900, and Commerce St has 5,300.

4.2.2 Special Flood Hazard Area

Approximately 279 out of 366 acres, or 76 percent, of the basin is in the SFHA Zone AE. The BFE ranges between 12 feet close to the shore to 10 feet further inland the basin. The LiMWA indicates that the areas of up to 600 feet inland from the coastline may be affected by 1.5 ft wave action. This affects 20 low and high-density residential areas, of which many are also partially within the high velocity zone (Zone VE).

4.2.3 Repetitive Loss Areas

There are three RLAs in Conley Basin, in both high and low-residential areas. The repetitive loss areas encompass 16 parcels. One of the repetitive loss areas is adjacent to the basin outfall on the coastline, one is along the conveyance system in the middle of the basin, and the third RLA is at the upstream end of the basin. It is expected that all three areas would be impacted from SLR, but the area near the outfall is the most susceptible. Recent flood loss records indicate Hurricane Frances and the August 2015 event as dates of losses.

4.2.4 Flood Complaint Records

This catchment has received a high number of flood complaints, 59 within the flood zone and 72 in total. The complaints are mostly in high-density residential areas in the center of the basin, concentrated along the primary Conley Box Culvert System. Flooding complaints range from yard and street flooding (nuisance) to garage and house flooding (major). Already under existing conditions, the basin is vulnerable to flooding and standing waters.

4.2.5 Sea Level Rise Impacts

4.2.5.1 SLR + 1-Year Stillwater

The SLR + 1-Year Stillwater static Inundation shows standing water in large areas on the east, affecting almost 5 percent of the basin, or up to 16.5 acres. This area includes approximately 67 privately owned parcels. Some of the parcels are undeveloped, but largely low and high-density residential areas are impacted. The sea level rise will impact the normal water level of the lake at Ballast Point through groundwater seepage and saltwater intrusion. The Lykes neighborhood along Conley Avenue, where the basin outfall is located, is expected to be severely impacted by the elevated Stillwater condition. The floodplain shows impacts to the majority of Conley Avenue and extends out to Bayshore Boulevard.

4.2.5.2 Impacts from Rainfall Combined with SLR

This basin and collection system were modeled as part of the Lower Peninsula Watershed Management Plan (LP WMP) Analysis, completed for the City in 2019 using XPSWMM. Also, the SLR conditions were modeled as part of an addendum to the LP WMP. The existing conditions model confirms the flood complaint records, as the inundation products show large floodplains across the basin, but mostly concentrated along the collection system. The largest increase in peak stage along the Conley Box system for all storm events is approximately 0.35 feet. This is likely because the available storage at the outfall basin is already reaching capacity during the existing condition simulations, and any additional inflows are not being retained and are

immediately discharging to the tidal boundary via shoreline overland flow. Keep in mind that any amount of increase may make the difference between a road or structure being damaged or not A summary of the peak stages near the Conley System Outfall are included in **Table 3** below.

Table 3. Comparison of Peak Stages (feet NAVD88) with and without SLR for Conley Basin

NODE	Description	CRITICAL EL. (CROWN OF ROAD)	5YR-8HR			25YR-24HR			100YR-24HR		
			EX	EX SLR	DELTA	EX	EX SLR	DELTA	EX	EX SLR	DELTA
NLF0010	Conley Ave. (Lykes Subdivision)	2.9	4.15	4.49	**0.34**	4.53	4.74	**0.21**	4.91	5.03	**0.12**
NLF0080	Bayshore Blvd. and Conley Ave.	5.2	4.15	4.49	**0.34**	4.53	4.74	**0.21**	4.91	5.03	**0.12**
NLF0710	Pearl Court	5.1	7.78	7.79	**0.01**	8.01	8.02	**0.01**	8.29	8.3	**0.01**

4.2.6 Summary of Vulnerabilities

The primary conveyance system (Conley box culvert) has a disproportionately large contributing area, which creates capacity issues. The localized depressions along the stormwater system are susceptible to recurring flooding, but the depressions further inland are less susceptible to SLR. As previously identified, the coastal based SFHA also covers a substantial portion of the basin, due to the combination of being located adjacent to Hillsborough Bay and having relatively low topography. These same conditions make the basin highly vulnerable to SLR and changes in tidal water levels, as reflected in the SLR + 1-Year Stillwater Static Inundation summary. Existing topography, land use characteristics, and shoreline land ownership suggest challenges and limitations to short term mitigation options and long-term resiliency strategies, but opportunities are still available.

4.3 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, with a primary stormwater collection system along El Prado Boulevard. The lowest elevations are at sea level and the highest elevations are approximately 18 ft NAVD88. The basin is entirely built out (minimal open space), with the primary land use being high-density residential (90 percent). There are three City-owned parcels in the basin. Spring Lake Basin with vulnerability features are shown in **Exhibit 5**.

4.3.1 Stormwater Outfalls

The Spring Lake Box Culvert system travels along an easement parallel to El Prado Boulevard, and eventually discharges at S Shamrock Rd into the Spring Lake Canal and out to Old Tampa Bay. The outfall is a 6 ft x 4 ft box culvert. Secondary collection systems include stormwater pipes along Dale Mabry Highway (36-inch diameter), Grady Street (48 inch), and Manhattan Avenue (24 inch).

4.3.2 Priority Facilities

There is one critical infrastructure identified in the basin, a TECO Substation, but no City of Tampa owned critical infrastructure. Immediately downstream of the outfall is the South West Shore Blvd bridge over Spring Lake canal. Located near the high point and northern boundary of the watershed is an assisted living facility. Priority roadways include Dale Mabry Highway, El Prado Boulevard, Manhattan Avenue, and Church Avenue.

4.3.3 Special Flood Hazard Area

Approximately 198 acres of the total basin area of 419 acres (47 percent) are in the SFHA and is all Zone AE. This coastal based SFHA covers the entire western half of the basin. The SFHA is almost equally split between BFE 10 and 11 ft, with 10 feet being closer to outfall.

4.3.4 Repetitive Loss Areas

Spring Lake has one Repetitive Loss Area that encompasses 21 high-density residential and commercial and service parcels. This is located at the low spot in the basin near the intersection of Vasconia Street and Manhattan Avenue. There are also 11 historical loss structures (at least one claim) outside the RLA, one of them has repetitive flood loss claims.

4.3.5 Flood Complaint Records

A total of 80 out of 89 complaints have been recorded within the SFHA, the highest number of all basins. The flood complaints are mostly from residents, but also from commercial parcels, referring mostly to street, yard, and garage flooding. Approximately half of the complaints are concentrated around Manhattan Avenue and El Prado Boulevard.

4.3.6 Sea Level Rise Impacts

4.3.6.1 SLR + 1-Year Stillwater Static Inundation

The SLR + 1-Year Stillwater Static Inundation layer does not show visible impacts to the basin. However, the intersection of Manhattan Avenue and Vasconia Street is at approximately 4 feet NAVD88, which is only about 0.5 feet above the future Stillwater elevation. This will greatly impact the water table along the western half of the basin, which will increase runoff. The outfall and channel will be filled with water, potentially affecting stormwater drainage in the basin.

4.3.6.2 Rainfall Combined with SLR

This basin and collection system were modeled as part of the Spring Lake Flood Analysis, which was later incorporated into the Upper Peninsula Watershed Management Plan (UP WMP) model, performed in XPSWMM. The model parameters suggest the future stillwater condition will backfill the primary box culvert system up to and beyond Manhattan Avenue. The existing conditions model confirms the flood complaint records. Running select design storm event simulations with future stillwater boundary conditions results in peak stage increases up to approximately 1.10 feet near the outfall boundary. The impacts decrease as distance up the stormwater collection system increases, `becoming negligible around Grady Avenue. It is worth noting that any amount of

increase may make the difference between a road or structure being damaged or not. A summary of the peak stages near the Spring Lake Outfall are included in **Table 4** below.

Table 4. Comparison of Peak Stages (feet NAVD88) with and without SLR for Spring Lake Basin

NODE	Description	CRITICAL EL. (CROWN OF ROAD)	5YR-8HR			25YR-24HR			100YR-24HR		
			EX	EX SLR	DELTA	EX	EX SLR	DELTA	EX	EX SLR	DELTA
Shmrck 1.1	Vasconia St & Shamrock Rd	5.0	3.92	5.02	**1.10**	4.43	5.27	**0.84**	5.08	5.66	**0.58**
Sevilla1	Hesperides St & Vasconia St	4.9	7.61	7.93	**0.32**	8.37	8.61	**0.24**	9.54	9.73	**0.19**
M4	Vasconia St & Manhattan Ave	4.7	7.64	7.93	**0.29**	8.38	8.61	**0.23**	9.55	9.71	**0.16**
Lois	Lois Ave & El Prado Blvd	5.9	7.81	8.05	**0.24**	8.46	8.68	**0.22**	9.57	9.76	**0.19**

4.3.7 Summary of Vulnerabilities

The vulnerability analysis for Spring Lake Basin provides a better understanding of specific hazards within the basin. Nearly half of the basin is located at elevations susceptible to coastal flood events, based on the SFHA boundaries, which would also indicate higher flood risks when factoring in sea level rise. The basin has received many flood complaints in the past, especially in these low-lying areas, indicating that existing capacities to handle storm events are limited. The outfall for the basin is a culvert that discharges to the Spring Lake Canal and out to Old Tampa Bay. Under SLR and 1-year Stillwater conditions, the culvert capacity will be further inhibited, putting currently vulnerable areas at even higher risk.

4.4 Coastal Study Basin 4 - Buffalo

The Buffalo Basin (Outfall ID 516) is the largest selected basin, 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 elevations range from sea level to 47.5 ft NAVD88. High density residential areas cover almost 50 percent of the basin, followed by commercial and services (28 percent) and institutional (11 percent). The areas near the river are mostly residential. Buffalo Basin with vulnerability features are shown in **Exhibit 6**.

4.4.1 Stormwater Outfalls

The primary collection system for the runoff from the basin is conveyed and discharged through a box culvert that is approximately 14 x 6.5 feet, with six secondary outfall pipes that range in diameter from 24 to 42 inches.

4.4.2 Priority Facilities

There are 19 critical facilities located in the basin, the highest number of all basins considered. These are 7 ambulatory surgical centers, 5 assisted living facilities, 3 hospitals, 2 nursing homes,

a TECO substation, and a wastewater pump station. The pump station is City-owned and lies within the SFHA, the others are spread across the basin. Priority roadways include Dr Martin Luther King Boulevard, Wishart Boulevard, Armenia Avenue, Rome Avenue, and Habana Avenue

4.4.3 Special Flood Hazard Area

Approximately 40 acres of the 960-acre basin, about 5 percent, are located in the SFHA Zone AE. This is the area along the river reaching up to 1,000 ft inland. The BFE is 11 ft. As the basin is located at the river, it will not be directly affected by LiMWA.

4.4.4 Repetitive Loss Areas

There are two Repetitive Loss Areas in the basin, with a total of approximately 17 parcels with historical flood flosses. The parcels are primarily high-density residential. The river is the primary flood source for 8 parcels and 9 parcels are likely impacted by local conveyance.

4.4.5 Flood Complaint Records

Four flood complaints concerning garages and yards have been filed within the SFHA and a total of 39 for this basin. The remaining complaints are primarily in residential areas, along the secondary stormwater collection systems for the basin. Flooding and standing waters affected streets, yards, and garages.

4.4.6 Sea Level Rise Impacts

The basin will not be directly affected by the modeled 1-year Stillwater elevation. However, as predicted, intermediate 2050 sea level rise conditions would significantly elevate water levels in the river, affecting stormwater drainage in the basin and potentially causing severe backup in the pipe systems.

4.4.6.1 SLR + 1-Year Stillwater

As previously determined, the SLR+ 1-Year Stillwater scenario is estimated at an elevation of 3.44 feet NAVD88. This elevation is at a sufficiently high level to overtop sea walls, create backflow through stormwater outfalls, elevate groundwater tables, and inundate low lying areas. At a water level of 3.44 ft, several parcels are shown to be impacted. None of the critical facilities are directly impacted from the adjusted stillwater condition. However, the Rome wastewater Pump Station parcel conveyed impacts, and the structure is extremely close to being impacted.

4.4.6.2 Impacts from Rainfall Combined with SLR

Although the stormwater infrastructure has not been surveyed and the basin has not been modeled, it is expected that the culvert and pipes would be submerged during the elevated stillwater conditions in the river based on ground elevations at the outfalls and factoring in pipe cover requirements.

In addition to conveyance restrictions from SLR, the soil storage capacity in low-lying areas will be impacted from elevated groundwater conditions. This would result in increased runoff across the basin, creating additional capacity issues for the stormwater collection system. It is

recommended that the City model the Lower Hillsborough River Watershed to better estimate risk and identify problem areas in the future.

4.4.7 Summary of Vulnerabilities

This basin is intended to reflect typical vulnerabilities experienced along the Lower Hillsborough River. Even 3.5 miles upstream from the Hillsborough Bay, the river is still tidally influenced and will experience impacts from future sea level rise. The basin has many critical facilities, though most are located in higher elevation areas. The runoff from the basin is primarily managed through the large box culvert, with support from six piped outfalls. The elevations along the shoreline are low enough to see impacts from SLR during the 1-year stillwater conditions, which will severely reduce the outfall conveyance capacity and ability to maintain current roadway flood level of service. The limited capacity of the outfalls could result in basin-wide impacts.

4.5 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 lowest elevations in this basin range from sea level to 23.4 ft NAVD88. Approximately 68 percent of the land use is high-density residential, followed by 18 percent commercial and services, and then 12 percent institutional. Cedar Channel Basin with vulnerability features are shown in **Exhibit 7**.

4.5.1 Stormwater Outfalls

The current primary collection system discharges a 6 x 3.5 ft box culvert into Cedar Channel that conveys underneath Westshore boulevard through a 9.5 x 4.5 ft box culvert, which then discharges into the tidal canal section.

4.5.2 Priority Facilities

Cedar Channel has 5 critical facilities: a water tank, a fire station, a TECO substation, a wastewater pump station and a 12-inch aerial main crossing -all except the substation are owned by the City. The San Carlos pump station and the water main aerial crossing are within the SFHA. The water main crossing is at the Westshore Boulevard bridge. Priority roadways include Westshore Boulevard, Lois Avenue, Church Avenue, Henderson Boulevard, and Dale Mabry Highway.

4.5.3 Special Flood Hazard Area

Approximately 140 acres of the 534-acre basin area (26 percent) are located in SFHA Zone AE. The SFHA takes up the western quarter of the basin, generally west of Manhattan Avenue. All of Zone AE in this basin has a BFE of 11 feet.

4.5.4 Repetitive Loss Areas

Cedar Channel Basin contains four RLAs representing approximately 22 high-density residential parcels, which are all within the SFHA. The RLAs are in the west-section of the basin, which is susceptible to tidal flooding, but two of the RLAs are along the primary stormwater collection system, suggesting vulnerability from the local conveyance systems.

4.5.5 Flood Complaint Records

A total of 19 flood complaints have been recorded within the SFHA out of the 47 within the basin. Many of these refer to standing water in streets and yard and garage flooding, but several were flooding of residential and commercial buildings. One complaint of standing water was filed for the wastewater pump station.

4.5.6 Sea Level Rise Impacts

The predicted intermediate 2050 SLR conditions would flood some areas at the southwest of the basin (up to 0.5%), including two of the RLAs, W San Miguel St. and potentially S West Shore Blvd. Most channels connecting the upper peninsula to the Bay will be filled under these conditions and may highly limit the drainage of stormwater from this and neighboring basins.

4.5.6.1 SLR + 1-Year Stillwater Static Inundation

The SLR + 1-Year Stillwater static Inundation layer shows visible impacts to the basin near the outfall, impacting two of the basin RLA's. The parcels at the canal west of the Westshore Bridge show flooding impacts. Also, the edge of pavement on segments of Westshore Boulevard and Trask Street show inundation. Additionally, the elevated stillwater condition will greatly impact the water table along the western half of the basin, which will increase runoff. The outfall and channel will be filled with water, affecting stormwater drainage in the basin.

4.5.6.2 Rainfall Combined with SLR

This basin and collection system were modeled as part of the Upper Peninsula Watershed Management Plan (UP WMP) model, performed in XPSWMM. The model parameters suggest the future stillwater condition will backfill the primary box culvert system and secondary systems all the way up to Manhattan Avenue. The existing conditions model confirms the flood complaint records. Running the design stormwater with the future Stillwater conditions increases the peak stages in the basin up to as much as 0.5 feet. Any amount of increase can be the tipping point that results in a road or structure being damaged. The projected impacts decrease as the distance up the stormwater collection system increases, and become negligible around Grady Avenue. A summary of the peak stages near the Spring Lake Outfall are included in **Table 4** below.

Table 5. Comparison of Peak Stages (feet NAVD88) with and without SLR for Spring Lake Basin

NODE	Description	CRITICAL EL. (CROWN OF ROAD)	5YR-8HR			25YR-24HR			100YR-24HR		
			EX	EX SLR	DELTA	EX	EX SLR	DELTA	EX	EX SLR	DELTA
NSR0050	DS Westshore Blvd Bridge (Occident St)	3.50	3.87	4.36	**0.49**	4.26	4.61	**0.35**	4.79	5.04	**0.25**
NSR0150	US Westshore Blvd Bridge	5.00	4.14	4.61	**0.47**	4.58	4.91	**0.33**	5.21	5.41	**0.20**
NSR0490	San Rafael St	4.40	4.78	4.97	**0.19**	5.03	5.21	**0.18**	5.55	5.69	**0.14**
NSR0510	Melrose Ave & Trask St	4.20	5.19	5.28	**0.09**	5.42	5.49	**0.07**	5.74	5.82	**0.08**
NSR0550	Estrella St & Trask St	4.30	5.55	5.57	**0.02**	5.73	5.75	**0.02**	5.97	6.00	**0.03**

4.5.7 Summary of Vulnerabilities

The vulnerability analysis for Cedar Channel Basin provides a better understanding of specific hazards within the basin. Over one third of the basin is located at elevations susceptible to coastal flood events, based on the SFHA boundaries, which would also indicate higher flood risks when factoring in sea level rise. The basin has received many flood complaints in the past, especially in low-lying areas, indicating that existing capacities to handle storm events are limited, and SLR would potentially exacerbate the current flood conditions. The outfall for the basin is a culvert that discharges to the Cedar Channel and out to Old Tampa Bay. Under SLR and 1-year Stillwater conditions, the culvert capacity will be further inhibited, placing currently vulnerable areas at higher risk.

4.6 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. Elevations range from sea level along the shore up to 80 ft in the northern part of the basin. The primary land use type in the basin high-density residential (41 percent) followed by commercial and services (20 percent). The land use types located within the SFHA are commercial, transportation, institutional, as well as some residential areas. Downtown Basin with vulnerability features is shown in **Exhibit 8**.

4.6.1 Stormwater Outfalls

The basin has 41 outfalls that discharge into the Hillsborough River or the Garrison and Ybor Channels. This includes 5 box culverts ranging from 4 x 3 ft to 13 x 6 ft and 36 pipes ranging from 12 to 72 inches diameter.

4.6.2 Priority Facilities

There are 15 critical facilities located in the basin including: a fire station, a police department headquarters, a stormwater and a wastewater pump station, the Tampa Museum of Art, a T&I Data Center as well as a Fire Signal shop and division from the City. Furthermore, there is a nursing home, an assisted living facility, and four TECO substations. Five of these facilities are located in the SFHA, these are the Tampa Museum of Art and the T&I Data Center close to the river, the Krause wastewater pump station next to the convention center as well as the York St stormwater pump station and a TECO Substation on the east side. There are many priority roadways in the Downtown Basin, of which the following are considered at particularly at risk: Kennedy Boulevard, Ashley Drive, Cass Street, Laurel Street, Channelside Drive, and Jackson Street.

4.6.3 Special Flood Hazard Area

Approximately 246 acres, or 22 percent, of the 1,121-acre basin is located in the SFHA Zone AE. The floodplain along the Hillsborough River south of Cass Street Bridge and along the channels has a BFE of 12 ft and decreases to 11 feet in some areas as the floodplain extends further inland. The Hillsborough River portion north of Cass Street has a BFE of 11 feet. On the east side of the Basin, near the Channel District, the SFHA extends as far as 2,000 feet inland.

4.6.4 Repetitive Loss Areas

There are no RLAs in the basin, but there is a historical flood loss property along the river near Brorein Street and Ashley Drive. Based on the topographic information, this area is uniquely low and vulnerable to coastal flood events.

4.6.5 Flood Complaint Records

There are 23 recorded flood complaints in the Downtown Basin. Six flood complaints are located within the coastal SFHA, all along the eastern side of the basin. Flooding affected streets, garages and yards and at least two houses in 2002 were reported as frequently flooded. Most remaining flood complaints are along primary stormwater collection systems, suggesting that these areas will likely be vulnerable to drainage impairments from sea level rise.

4.6.6 Sea Level Rise Impacts

4.6.6.1 SLR + 1-Year Stillwater

The SLR+ 1-Year Stillwater scenario, estimated at an elevation of 3.44 feet NAVD88, would elevate the water levels in the river and channels surrounding downtown and may highly limit stormwater drainage. The future stillwater scenario is at an elevation that is high enough to overtop low sea walls, create backflow through stormwater outfalls, elevate groundwater tables, and inundate low lying areas in this basin. Specifically, inundation estimates indicate potential flooding on S Ashley Dr. near the convention center and around the Krause pump station.

4.6.6.2 Impacts from Rainfall Combined with SLR

Although none of the outfall inverts have been surveyed, or modeled, it would be expected that all outfalls would be submerged at the future projected stillwater elevation, given the low ground elevations adjacent to the river and channels as well as pipe cover requirements. The average and median outfall size is approximately 24 inches, which doesn't include the four box-culvert systems. With a typical ground elevation of 5 feet along the edge of Downtown Basin and 2 feet of cover, a best case scenario would yield the top of pipe at approximately 3 feet, meaning 0.44 feet of head would be built up at the outfall. The pipe invert could be significantly lower given the flat nature of the southern part of the basin and minimum pipe slope requirements for conveyance. Regardless, the tailwater change is nearly 1.5 feet, which is significant.

In addition to conveyance restrictions from SLR, the soil storage capacity in low-lying areas will be impacted based on elevated groundwater conditions. This would result in increased runoff across the island, creating additional capacity issues for the stormwater collection system.

4.6.7 Summary of Vulnerabilities

Being located at the urban core, the downtown basin is a crucial area of the city. It is densely populated and contains a significant amount of critical infrastructure (15 facilities). Many critical infrastructures are owned by the City of Tampa and are located close to the river and channel where elevations are low. Due to its direct boundaries to the Hillsborough River and several channels, this basin is highly exposed to changes in SLR. The elevations along the shoreline are low enough to see impacts from SLR during the 1-year Stillwater conditions, which will severely reduce the outfall conveyance capacity and ability to maintain current roadway flood level of service. The limited capacity of the outfalls could result in basin-wide impacts.

5 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.

5.1 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 3** 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.

5.2 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 4** 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.

5.3 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 5** 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.

5.4 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 6** 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.

5.5 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 7** 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.

5.6 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 8** 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.

6 CITYWIDE RESILIENCY STRATEGY RECOMMENDATIONS

The City intends to apply the resiliency strategy towards long-range planning that incorporates sea level rise challenges into stormwater improvement projects and potentially incorporating the framework into the overall Capital Improvement Program. The City recognizes that 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. Over time the City plans to set aside budget in various departments to incorporate resiliency into Capital Projects and development regulations.

6.1 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.

It is recommended that the City look to strategically dedicate a portion of the annual budget towards surveying segments of the City Shoreline over the next 5-10 years, and subsequently schedule routine conditions assessments on seawall assets. This inventory can benefit multiple City departments, and thus coordination should occur regarding how to best perform and budget this collaborative effort. Additionally, the City can identify cost sharing opportunities through regional, state, or federal cooperative funding or grant programs to help complete this effort.

6.2 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.

The City should look to current adopted seawall ordinance as well as draft ordinances of coastal communities around the state. For example, the City of Miami is proposing a seawall amendment to require seawalls at 6 feet NAVD88, with 8 feet NAVD88 by 2070. Additionally, Broward County is proposing to require an elevation of 4 feet NAVD88 before 2035, but must accommodate 5 feet NAVD88 by 2050. Substantial repairs trigger compliance based on 50 percent of seawall length or 50 percent of seawall value. These ordinances also set other design standards, including materials, but promote living shorelines and other means of ecosystem and habitat enhancements.

Once a seawall inventory and draft proposed seawall elevation are established, a limited desktop analysis can be performed to identify location and magnitude of expected impacts at various

minimum seawall elevations. Additionally, statistical breakdown of impacted seawall owners (private, public, etc.) and other beneficial datasets quantifying expected benefits can be provided. This effort will require coordination with City legal team as well as stakeholder input.

6.3 Stormwater Outfall Inventory and Improvements

The City has an existing stormwater inventory in geodatabase format that allows for detailed attributes to be assigned to each stormwater feature in the City. Some locations have feature attributes assigned, while other areas in the City have less information available. Unfortunately, many of the tidal outfalls are missing critical attribute information necessary to provide accurate and detailed vulnerability assessment as well as identify viable mitigation opportunities.

As identified in the vulnerability analysis task, 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. 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.

The outfalls can be surveyed and inventoried in conjunction with the seawall inventory, which would result in efficiency and cost savings. The City should plan, budget, and implement the seawall and outfall inventory collection as such. Fore execution, the City should development shoreline segments that can be inventoried and processed on an annual basis, to fit into capital planning budgets. Additionally, this can assist with grant application efforts.

6.4 Minimum Roadway Elevation Criteria

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.

A citywide impact analysis should be performed to identify how many roadway segments fall below specific elevation thresholds, which also looks into road classification (e.g. local, collector, arterial, evacuation) and ownership (e.g. City versus FDOT). The desktop analysis can select the most viable elevation and roadway classification that provides the most benefit to the City. Consideration to adverse impacts to adjacent properties and cost-benefit analysis should be factored.

6.5 Public Outreach Efforts and Professional Education Workshops

As an NFIP and CRS (Class 5) Community the City is required to and rewarded for providing routine public outreach. It is recommended that as the City continue these activities, they consider incorporating information regarding SLR to improve general public awareness. Pertinent information conveyed through public outreach should contain SLR projections, areas of impacts, and types of impacts. The City can also regularly update the public on capital projects and other

mitigation measures that are being performed to protect the City from flood risk and other affects from SLR. In addition to annual mailers, routine social media posts, information on City websites, other targeted outreach efforts and workshops should be considered. The City will also continue to emphasize the importance of obtaining and maintaining flood insurance coverage on their structures (building and contents coverage). Additionally, property owners should look to other floodproofing measures, where appropriate. Examples include elevation of structure or equipment, and floodproofing measures such as flood gates, shields, flood walls, and hydraulic pumping. A key to public engagement is to also provide an opportunity to collect feedback on what concerns public stakeholders have and what priority's they value.

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. These efforts will directly benefit the City by ensuring design professionals have the tools and resources to perform responsible and resilient development and redevelopment activity within the coastal areas of the City of Tampa.

6.6 Strategic Land Acquisition

As identified in the City's Repetitive Loss Area Analysis (RLAA), the City should continue to perform strategic acquisition and demolition mitigation of high-risk flood-prone properties. The highest priorities are properties at the greatest flood risk and where drainage improvements will not provide an adequate level of protection, which are often identified through the NFIP as repetitive Loss properties (multiple flood loss claims on their Flood Insurance Policy). The City's Real Estate Division of the Planning and Development Department will work in conjunction with the Department of Transportation and Stormwater Services to continue to target properties for acquisition-demolition. The acquisition and demolition will be funded through FEMA mitigation grants, SWFWMD cooperative funding initiatives, or other eligible grant programs. Staff time to develop the list of target properties will require funds from the City's operating budget.

6.7 Comprehensive Watershed Modeling Strategy

The City of Tampa does not currently have hydrologic and hydraulic (watershed) models in many areas of the City. It is recommended that the City incorporate budget and implementation strategy to develop and maintain a comprehensive hydrologic and hydraulic model(s) of the city, with a priority on areas with tidal outfalls. For example, the Lower Hillsborough River watershed is not represented in any existing model. This effort would provide benefit by improving the City's understanding of current flood risk as well as future flood risk when accounting for SLR Conditions. Additionally, watershed models allow for the identification and prioritization of flood prone areas that are ideal candidates for capital improvement projects. The models allow for quantifying flood reduction benefits of stormwater projects for both with and without future SLR conditions.

6.8 Future Adaptation Planning

It is recommended the City consider budgeting and implementing other planning efforts to build upon this study, such as a more comprehensive look at resiliency and adaptation as it pertains to

protection of all residents, assets, and infrastructure. Adaptation Planning is a series of steps a community takes to become more resilient to the impacts from chronic and acute disasters and changes in environment, such as sea level rise. There are four categories of strategies a community may use to mitigate existing infrastructure at risk while adapting to rising seas, which were taken from the Florida Department of Economic Opportunity (DEO) Adaptation Action Area Guidebook (2015): a) Protection, b) Accommodation, c) Managed Retreat, and d) Avoidance.

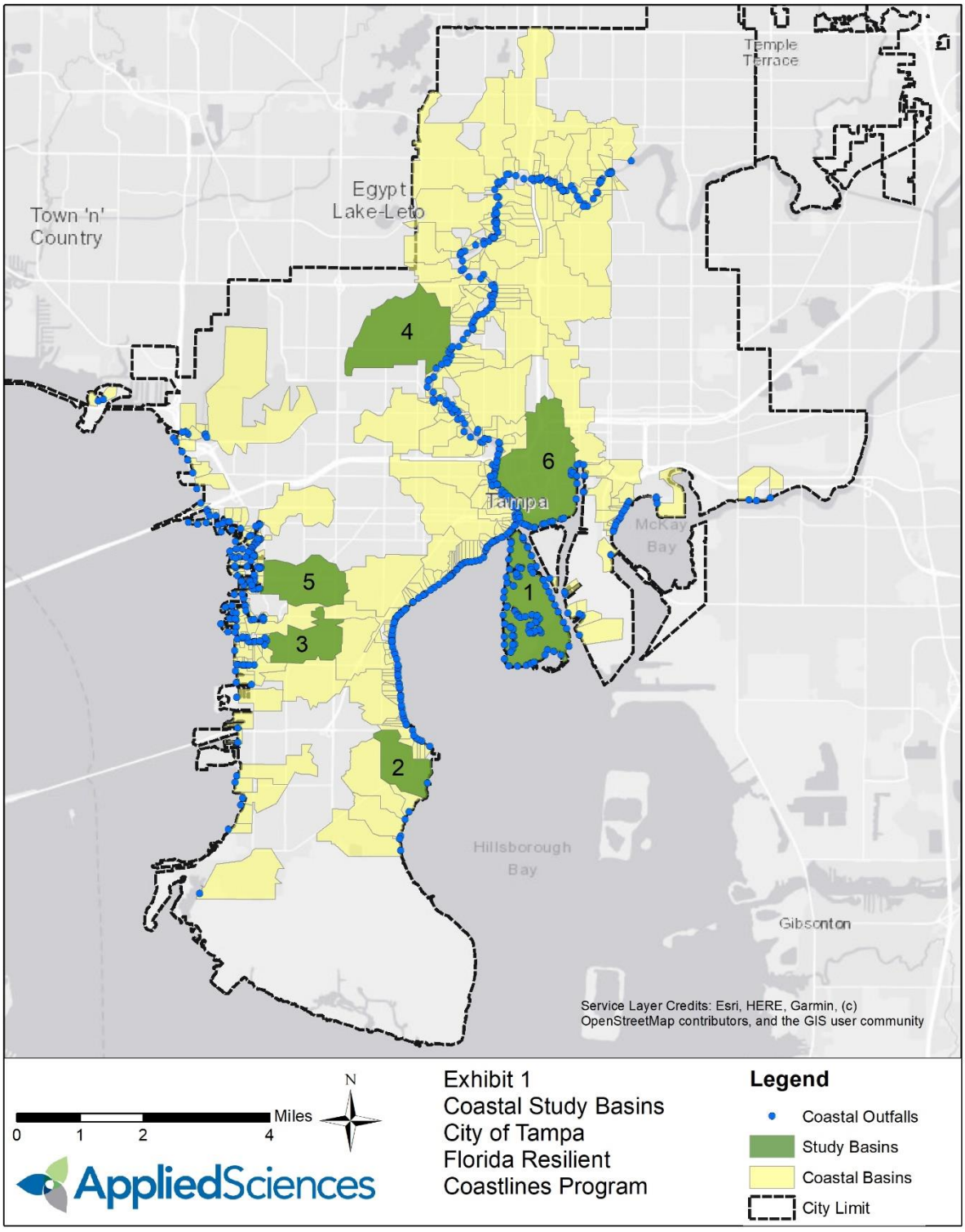
With an Adaptation Plan, the City should consider adopting designated Adaptation Action Areas (AAAs), which is an optional but highly recommended tool for adaptation strategies. AAAs are defined as one or more areas that experience coastal flooding due to extreme high tides and storm surge and that are vulnerable to the related impacts of rising sea levels for the purpose of prioritizing funding for infrastructure needs and adaptation planning. AAAs lend themselves to a flexible form of zoning overlay that delineates the physical areas where certain measures, restrictions, or prioritized funding would apply.

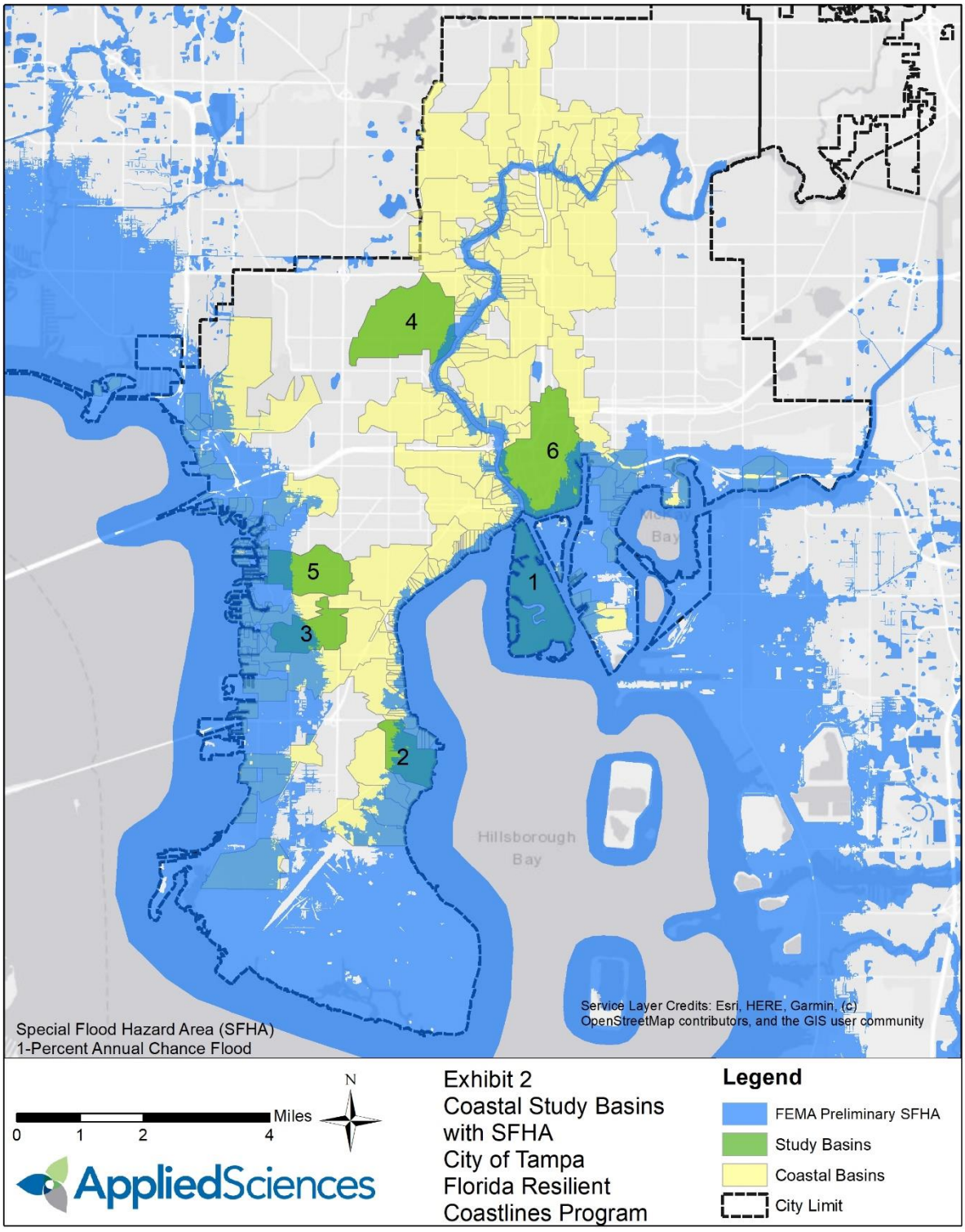
7 SUMMARY AND CONCLUSIONS

The City intends to apply the resiliency strategy towards long range planning for accounting for sea level rise challenges into stormwater improvement projects and potentially incorporating the framework into the overall Capital Improvement Program. This task identified some resilience strategy concepts regarding Stormwater infrastructure and flood risk reduction, which should be incorporated into City Annual Budgets moving forward. It is also important to mention that the City Planning and Development Department has performed some limited internal Sea Level Rise analysis in the past that assisted with securing the funds for this study. Continued inter-departmental collaboration is the best approach for conducting successful resiliency and adaptation plans and projects. The City should also plan to revisit and adjust any adopted strategies based on current climate studies and trends.

Additionally, there are State, Federal, and Non-profit funding opportunities that the City can leverage to implement some of these strategies. These funding programs are identified in Section 6.2 of the Florida Adaptation Planning Guidebook developed by FDEP Florida Coastal Management Program (2018). It is important to note that FEMA has recently implemented the Building Resilient Infrastructure and Communities (BRIC) program as a new FEMA pre-disaster hazard mitigation program that replaces the existing Pre-Disaster Mitigation (PDM) program, and is expected to have increased funds and flexibility for mitigation projects. Also not included in the Funding Opportunities Table is the FDEP Resilience Implementation Grant (RIG) to assist coastal communities in implementing their adaptation/resilience plans by supporting nature-based options for erosion and flood control, elevation of public structures, and projects. RIG awards will be up to $500,000. These funding opportunities and more should be explored by the City for future plan and project implementation.

Exhibits


Temple Terrace
Egypt Lake-Leto
Town 'n' Country
4
6
Tampa
McKay Bay
5
1
3
2
Hillsborough Bay
Gibsonton
Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
N
Miles
0 1 2 4
AppliedSciences
Exhibit 1
Coastal Study Basins
City of Tampa
Florida Resilient
Coastlines Program
Legend
Coastal Outfalls
Study Basins
Coastal Basins
City Limit


4
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Hillsborough Bay
Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Special Flood Hazard Area (SFHA)
1-Percent Annual Chance Flood
N
Miles
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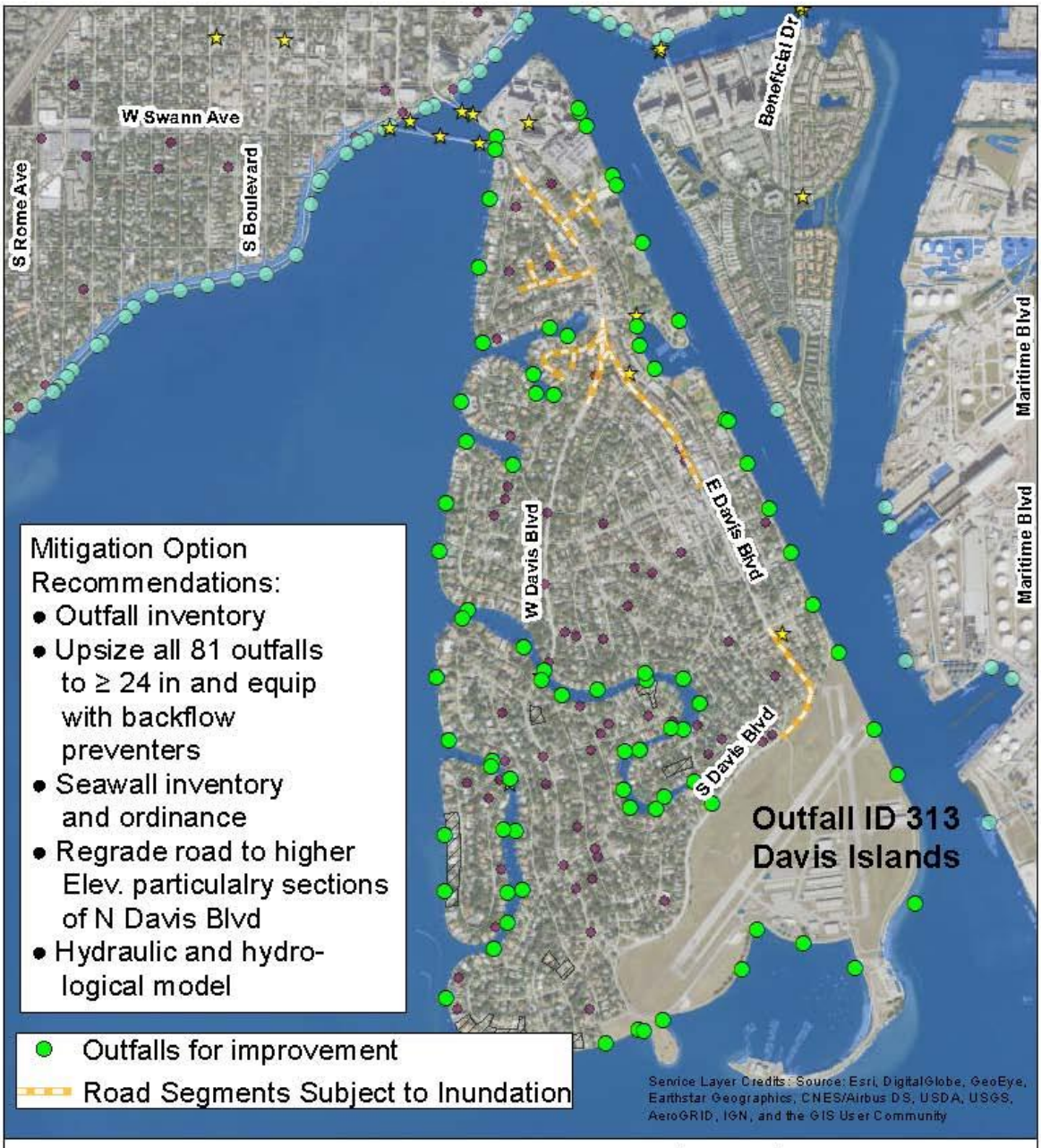
AppliedSciences
Exhibit 2
Coastal Study Basins
with SFHA
City of Tampa
Florida Resilient
Coastlines Program
Legend
FEMA Preliminary SFHA
Study Basins
Coastal Basins
City Limit



0 0.125 0.25 0.5 Miles

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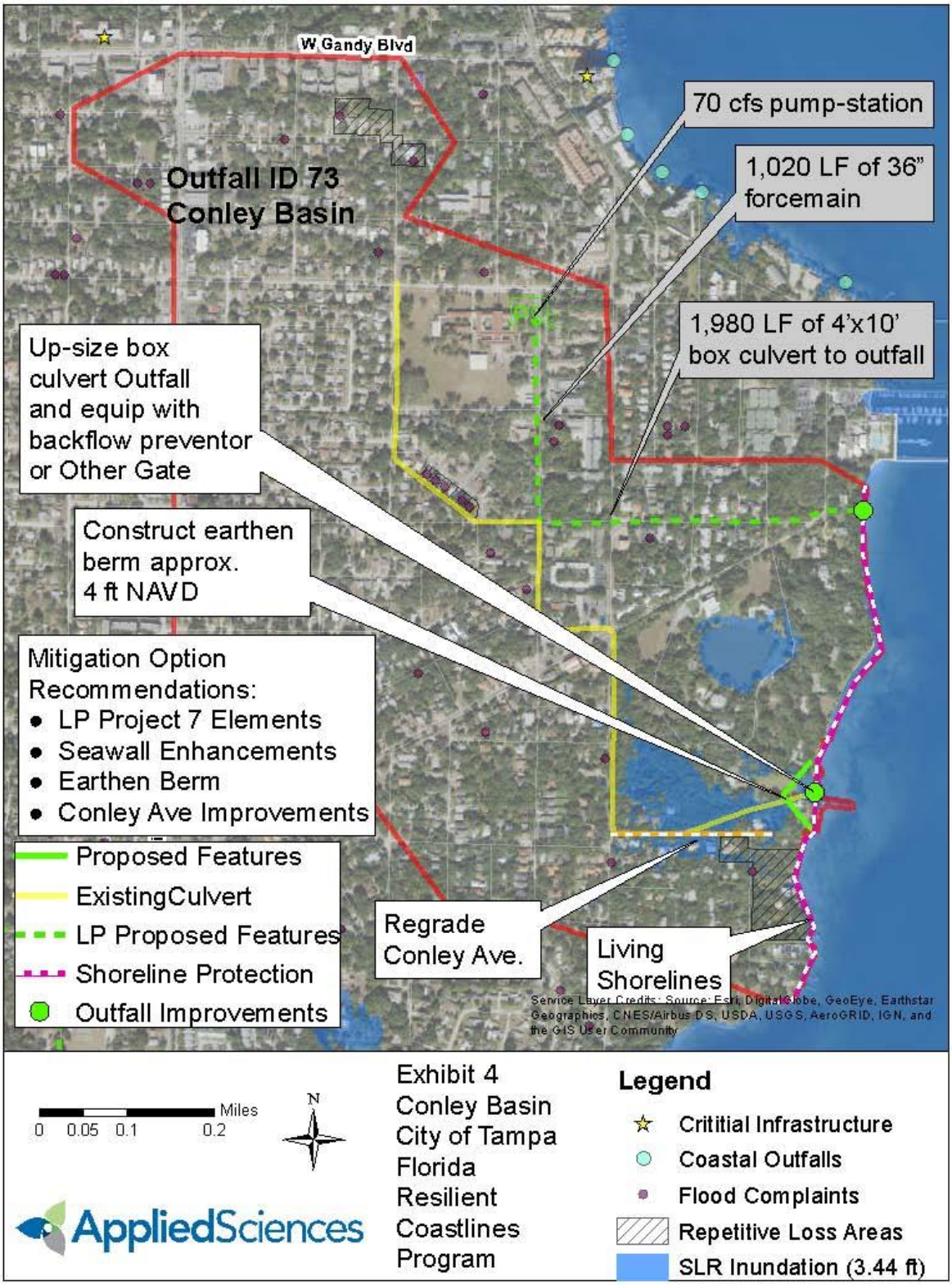
AppliedSciences

Exhibit 3
Davis Islands
City of Tampa
Florida
Resilient
Coastlines
Program

Legend

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


W Gandy Blvd
Outfall ID 73
Conley Basin
70 cfs pump-station
1,020 LF of 36" forcemain
1,980 LF of 4'x10' box culvert to outfall
Up-size box culvert Outfall and equip with backflow preventor or Other Gate
Construct earthen berm approx. 4 ft NAVD
Mitigation Option Recommendations:
• LP Project 7 Elements
• Seawall Enhancements
• Earthen Berm
• Conley Ave Improvements
Proposed Features
ExistingCulvert
LP Proposed Features
Shoreline Protection
Outfall Improvements
Regrade Conley Ave.
Living Shorelines
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Miles
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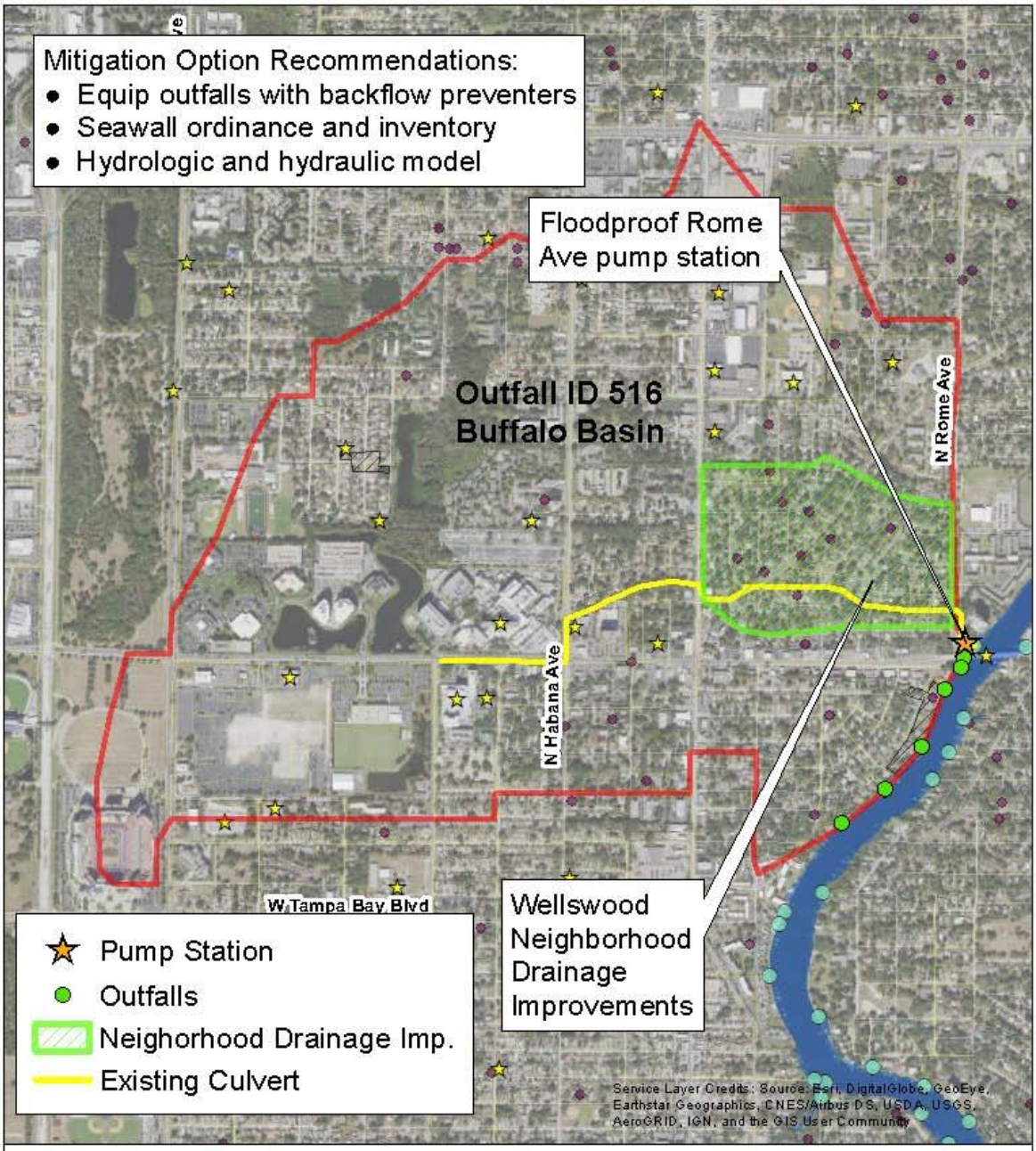
AppliedSciences
Exhibit 4
Conley Basin
City of Tampa
Florida
Resilient
Coastlines
Program
Legend
Critiitial Infrastructure
Coastal Outfalls
Flood Complaints
Repetitive Loss Areas
SLR Inundation (3.44 ft)


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
Neighorhood 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
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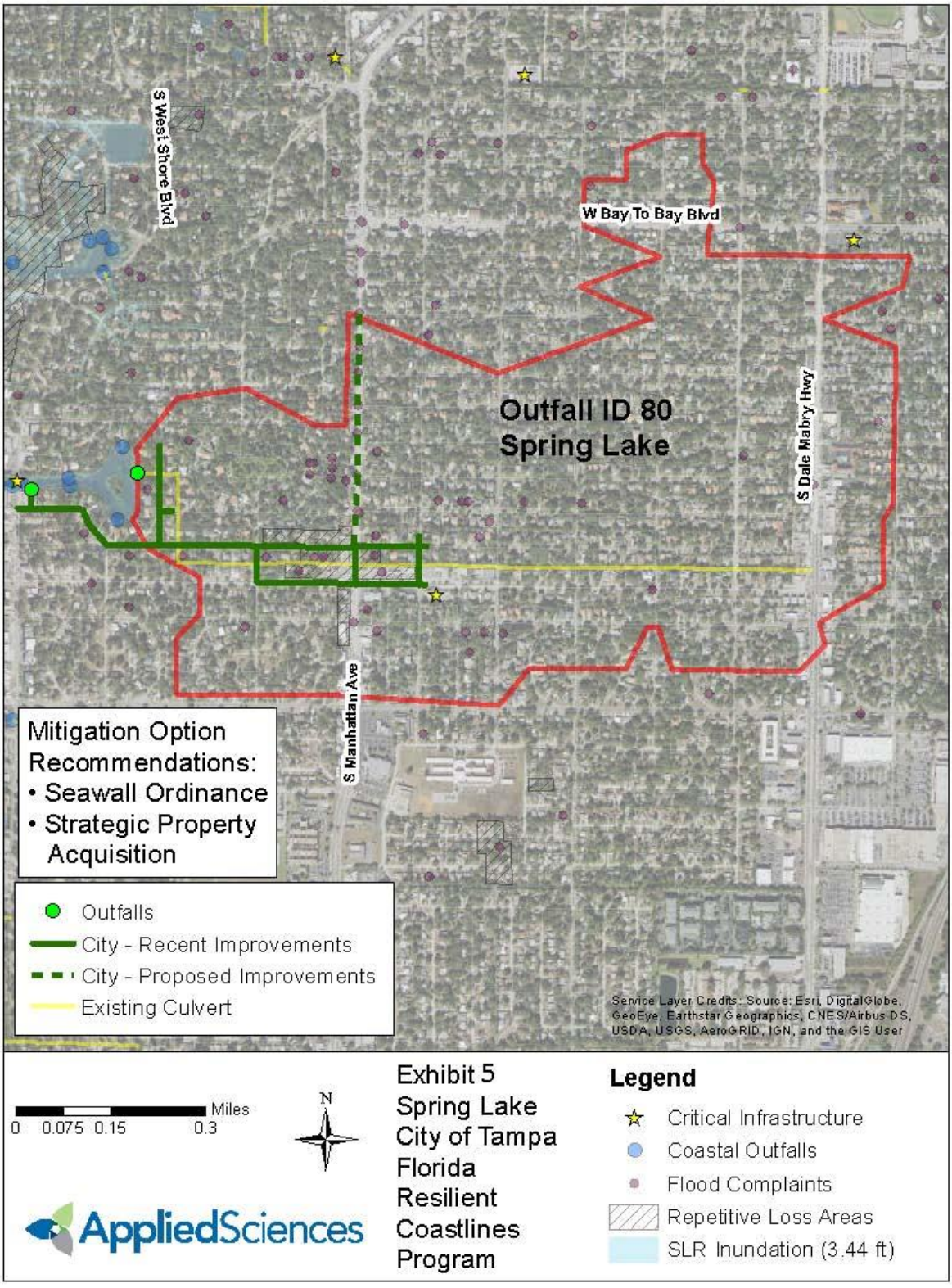
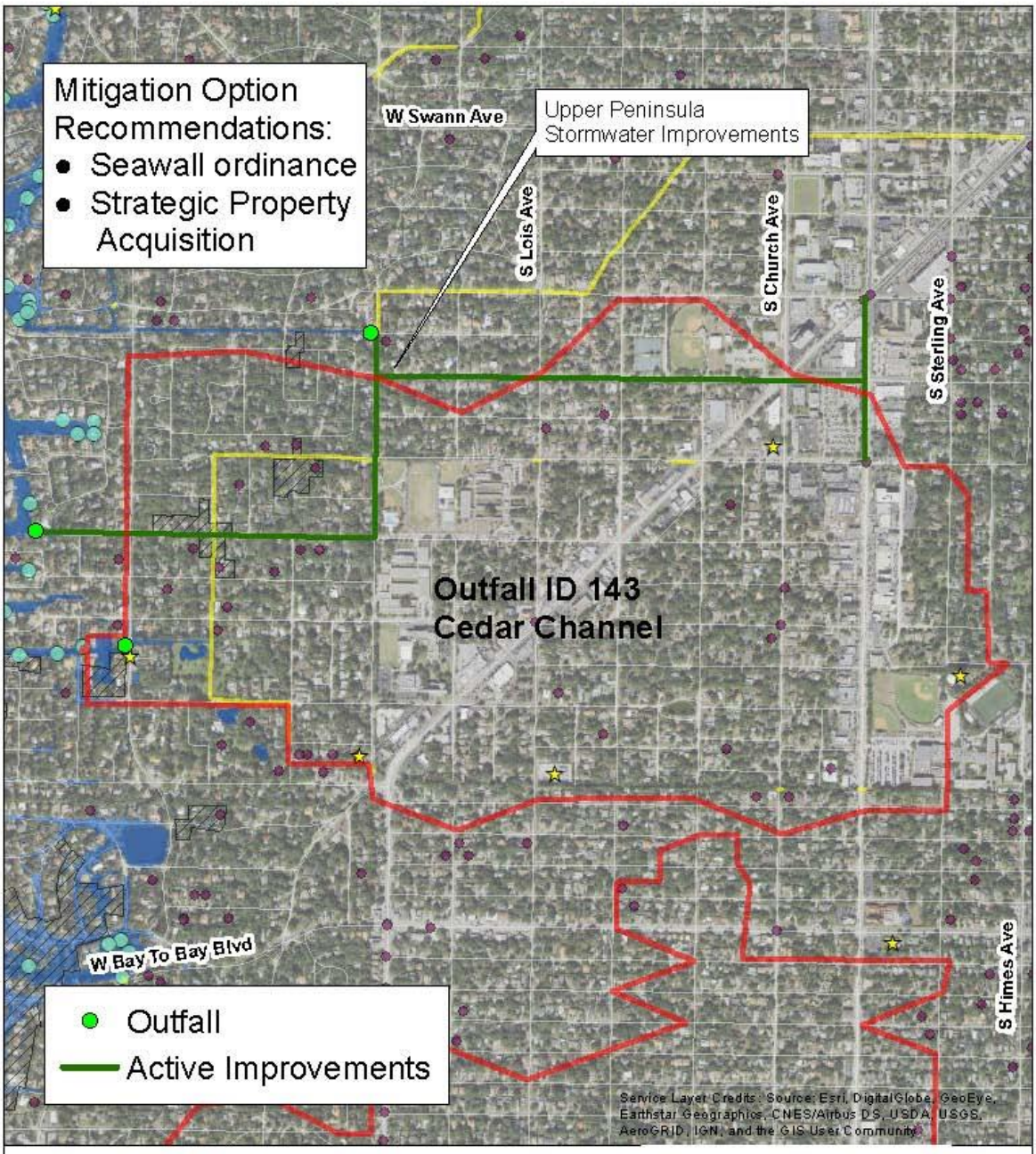
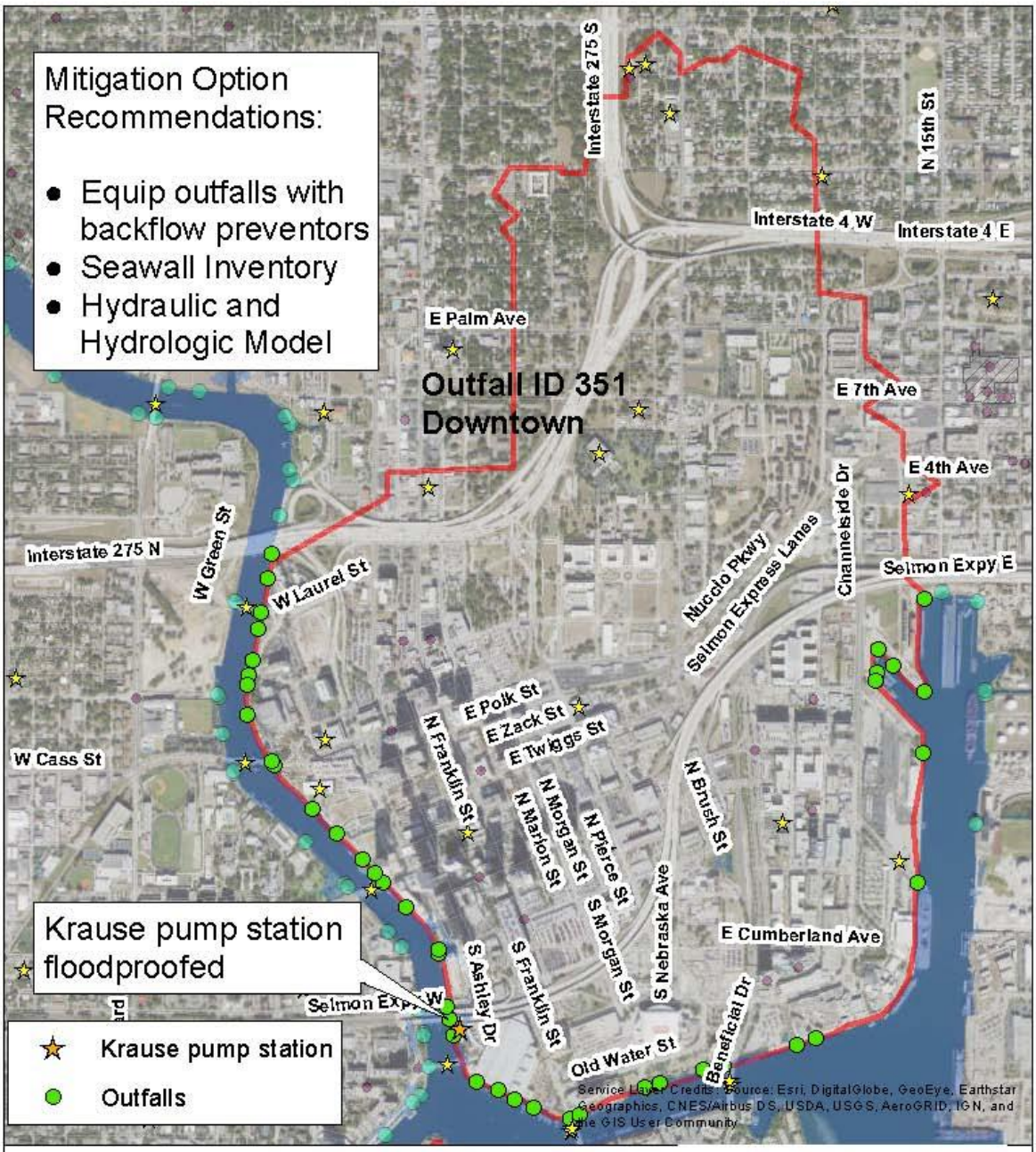
AppliedSciences
Exhibit 6
Buffalo Basin
City of Tampa
Florida
Resilient
Coastlines
Program
Legend
Crit. Infrastr.
Coastal Outfalls
Flood Complaints
Repetitive Loss Areas
SLR Inundation (3.44 ft)


S West Shore Blvd
W Bay To Bay Blvd
Outfall ID 80
Spring Lake
S Dale Mabry Hwy
S Manhattan Ave
Mitigation Option Recommendations:
• Seawall Ordinance
• Strategic Property Acquisition
Outfalls
City - Recent Improvements
City - Proposed Improvements
Existing Culvert
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User
0 0.075 0.15 0.3 Miles
N
AppliedSciences
Exhibit 5
Spring Lake
City of Tampa
Florida
Resilient
Coastlines
Program
Legend
Critical Infrastructure
Coastal Outfalls
Flood Complaints
Repetitive Loss Areas
SLR Inundation (3.44 ft)

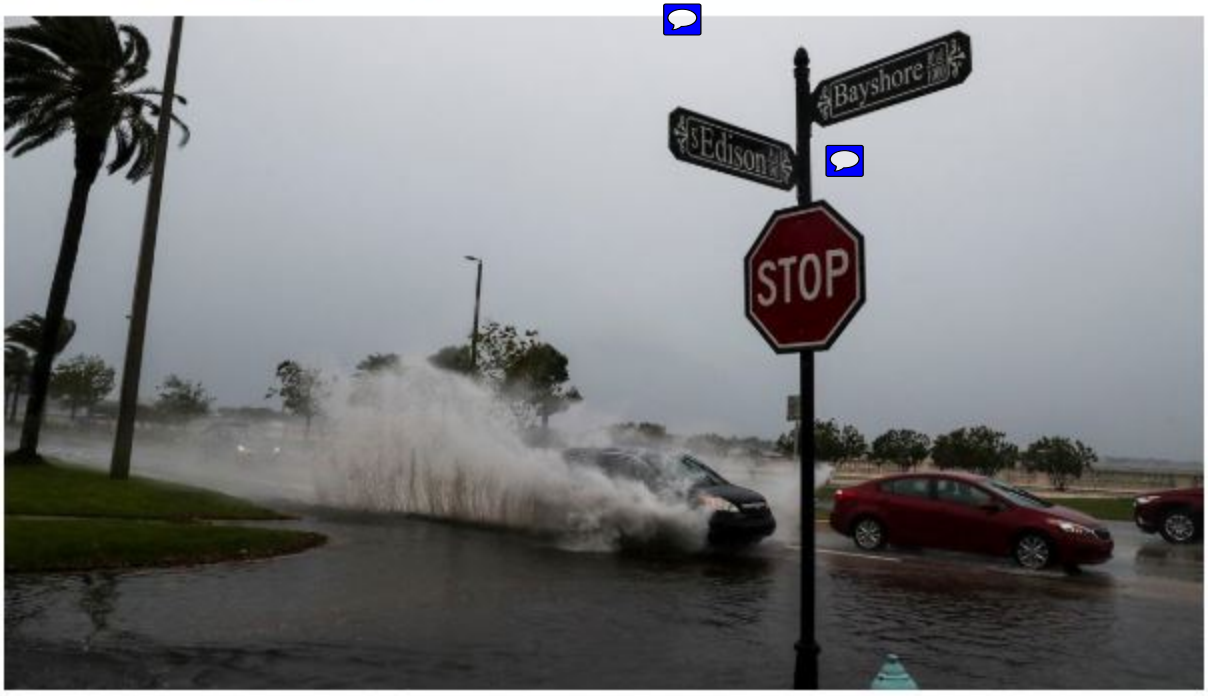

Mitigation Option Recommendations:
• Seawall ordinance
• Strategic Property Acquisition
W Swann Ave
Upper Peninsula Stormwater Improvements
S Lois Ave
S Church Ave
S Sterling Ave
Outfall ID 143
Cedar Channel
W Bay To Bay Blvd
S Himes Ave
Outfall
Active Improvements
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
0 0.1 0.2 0.4 Miles
N
Exhibit 7
Cedar Channel
City of Tampa
Florida
Resilient Coastlines
AppliedSciences
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
Outfall ID 351 Downtown
Krause pump station floodproofed
Krause pump station
Outfalls
Interstate 275 S
N 15th St
Interstate 4 W
Interstate 4 E
E Palm Ave
E 7th Ave
E 4th Ave
Channelside Dr
Selmon Expy E
Nuccio Pkwy
Selmon Express Lanes
Interstate 275 N
W Green St
W Laurel St
W Cass St
E Polk St
E Zack St
E Twiggs St
N Franklin St
N Marion St
N Morgan St
N Pierce St
S Morgan St
S Nebraska Ave
N Brush St
E Cumberland Ave
S Ashley Dr
S Franklin St
Old Water St
Beneficial Dr
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
0 0.125 0.25 0.5 Miles
N
AppliedSciences
Exhibit 8
Downtown
City of Tampa
Florida
Resilient
Coastlines
Program
Legend
Critical Infrastructure
Coastal Outfalls
Flood Complaints
RLA
SLR Inundation (3.44 ft)

PUBLIC OUTREACH

Tampa studies how to make its stormwater system handle rising seas

A pilot study showing potential flooding caused by sea level rise is underway.



Traffic moves through some street flooding near Edison Ave and Bayshore Blvd. as severe storms reach the area in April 2019. [MONICA HERNDON | Tampa Bay Times]

By **Charlie Frago**

Published Mar. 16
Updated Mar. 16

TAMPA — Tampa has been plagued by flooding for decades, a problem made worse by its inadequate system of pipes, valves and vaults that take rainwater off city streets and into the Hillsborough River and the bays.

Enter climate change. Rising seas threaten to turn a chronic nuisance into a nightmare for many areas of the city. Think Davis Islands, South Tampa, and large swaths of riverfront-adjacent neighborhoods like

City of Tampa
1 hr ·

The City of Tampa Stormwater Engineering Division will be holding a live virtual public outreach meeting on June 24 from 10:30 – 11:00 AM to present the results of our sea level rise study.
The City of Tampa received a $75,000 grant from the Florida Department of Environmental Protection to develop a vulnerability analysis for critical stormwater systems located in areas susceptible to sea level rise.
Please join us for this live presentation to learn more about how sea level rise may impact the City of Tampa. Meeting link and additional information can be found here: tampagov.net/sea-level-rise

2

Like Comment Share

City of Tampa
@CityofTampa

Want to learn how sea level rise may impact our City? 🌊

We received a $75k grant from the FL DEP to develop a sea level rise study. Join our Stormwater Engineering Division for a live virtual meeting on June 24 (10:30–11:00AM) to hear the results.

Info: tampagov.net/sea-level-rise

Florida DEP News and 9 others

10:59 AM · Jun 22, 2020 · Twitter Web App

Website: https://www.tampagov.net/sea-level-rise

DEPT - TSS-STORMWATER

HOME
STORMWATER SERVICES HOME
CONTACT US
INFORMATION RESOURCES
CAPITAL PROJECTS
DOCUMENT LIBRARY
ENVIRONMENT & WATER QUALITY
FLOODING
GIS UTILITY LAYER
MONTHLY WORK AREAS
ORDINANCE CH. 21 - STORMWATER MANAGEMENT
STORMWATER ADVISORY LIST PROPERTIES
RELATED LINKS
STORMWATER PERFORMANCE METRICS
SEA LEVEL RISE
PROGRAMS AND SERVICES +

QUICK LINKS

SOUTHEAST SEMINOLE HEIGHTS FLOODING RELIEF
CYPRESS STREET OUTFALL REGIONAL STORMWATER IMPROVEMENT
DALE MABRY HIGHWAY TRUNKLINE
LAKE ROBERTA STORMWATER IMPROVEMENTS
STORMWATER QUARTERLY REPORTS

Sea Level Rise

The City of Tampa and the Stormwater Engineering Division are actively involved in studying and addressing the future impacts of sea level rise on our stormwater system.

In August 2019, the Stormwater Engineering Division received a $75,000 grant from the Florida Department of Environmental Protection to develop a vulnerability analysis for critical stormwater systems located in areas susceptible to sea level rise. The analysis focuses on stormwater outfalls around the City of Tampa. Other components of the grant include determining mitigation options to address the impacts of rising sea levels on our stormwater system as well as developing a long-range strategy for incorporating sea level rise into the City of Tampa's annual Capital Improvement Program.

Public Meeting:
Watch our recorded virtual presentation from June 24, 2020

For more information on this grant, please visit our Fact Sheet.

- Stormwater Outfall Sample Selection
- Sea Level Rise Vulnerability Analysis Report
- Mitigation Options

Name (Optional)

Email (Optional)

Image Upload - If you would like to share a picture of flooding or attach a file you may do so here.

Add a new file

Choose File No file chosen UPLOAD

More Information

Comments - Please type any comments or questions you may have regarding the Sea Level Rise study in this box and the City of Tampa will post responses by June 30, 2020

SUBMIT

STORMWATER SEA LEVEL RISE VULNERABILITY ANALYSIS

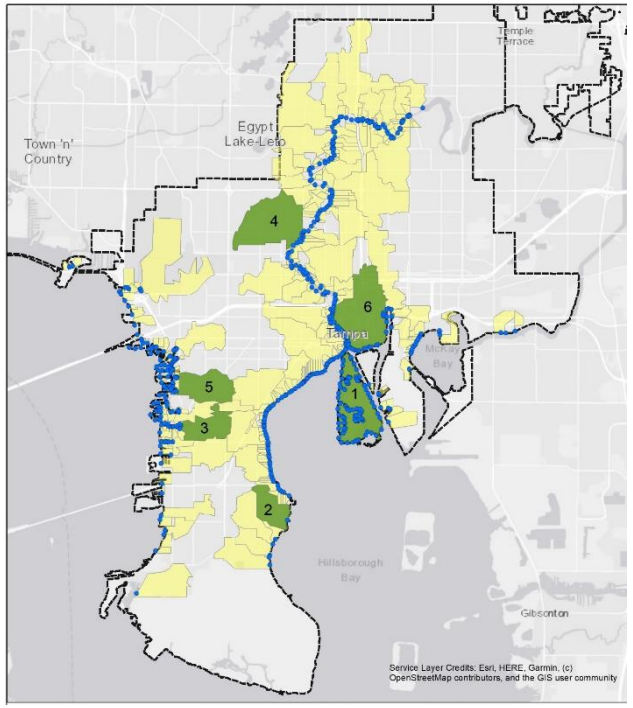
FDEP RPG AGREEMENT NUMBER R1916

APPLIED SCIENCES

City of Tampa Florida

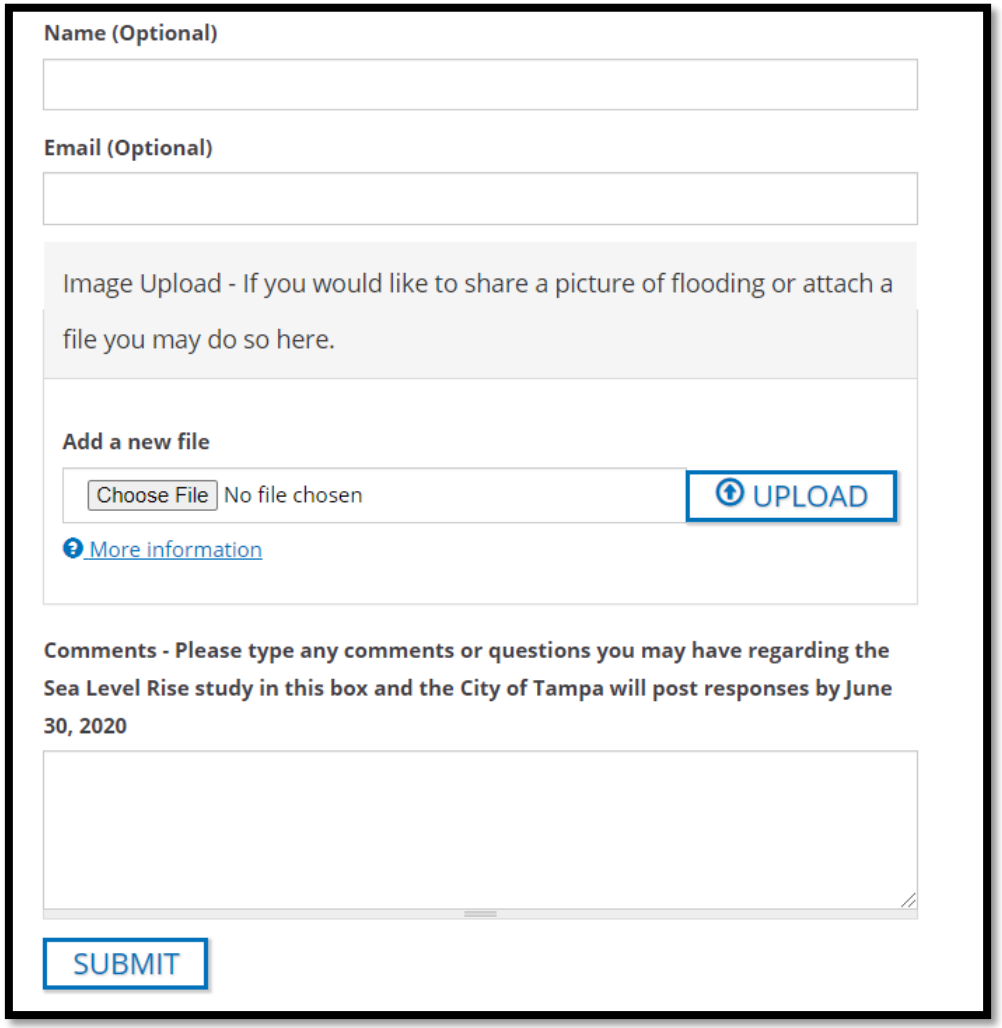
AGENDA

1. Meeting Objectives and Logistics
2. Project Background and Grant Program
3. Sea Level Rise (SLR) and Vulnerability Problem Definition
4. Methodology
5. Study Areas
6. Findings and Recommendations



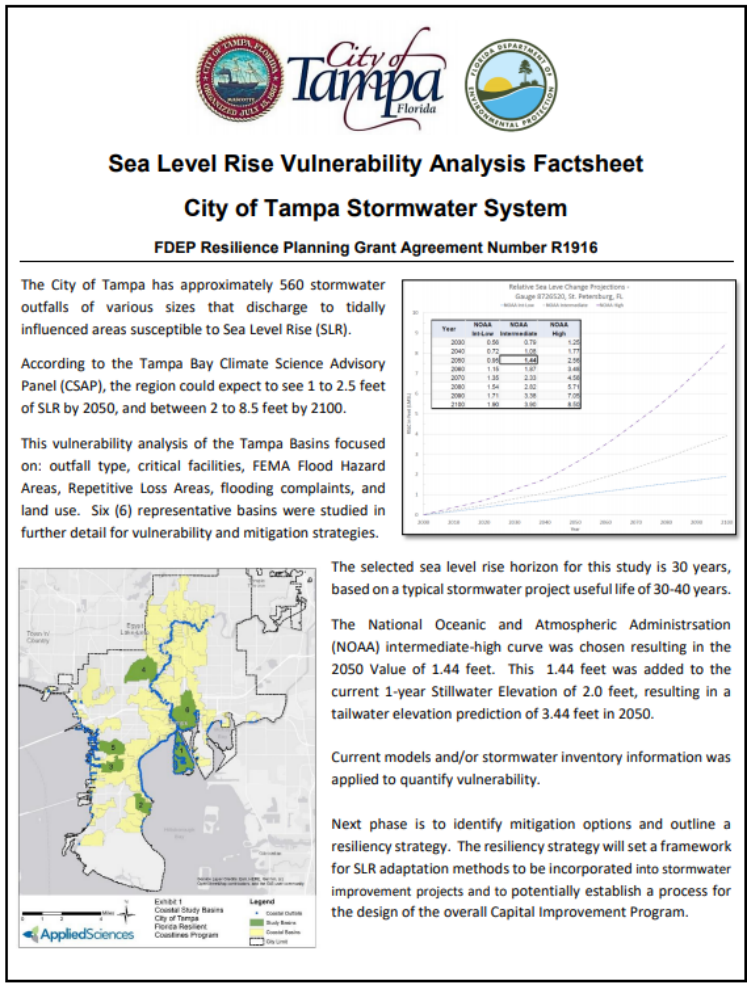
Questions, Comments, and Information

https://www.tampagov.net/sea-level-rise



Questions, Comments, and Information

https://www.tampagov.net/sea-level-rise



Sea Level Rise Vulnerability Analysis Factsheet

City of Tampa Stormwater System

FDEP Resilience Planning Grant Agreement Number R1916

The City of Tampa has approximately 560 stormwater outfalls of various sizes that discharge to tidally influenced areas susceptible to Sea Level Rise (SLR).

According to the Tampa Bay Climate Science Advisory Panel (CSAP), the region could expect to see 1 to 2.5 feet of SLR by 2050, and between 2 to 8.5 feet by 2100.

This vulnerability analysis of the Tampa Basins focused on: outfall type, critical facilities, FEMA Flood Hazard Areas, Repetitive Loss Areas, flooding complaints, and land use. Six (6) representative basins were studied in further detail for vulnerability and mitigation strategies.

The selected sea level rise horizon for this study is 30 years, based on a typical stormwater project useful life of 30-40 years.

The National Oceanic and Atmospheric Administrsation (NOAA) intermediate-high curve was chosen resulting in the 2050 Value of 1.44 feet. This 1.44 feet was added to the current 1-year Stillwater Elevation of 2.0 feet, resulting in a tailwater elevation prediction of 3.44 feet in 2050.

Current models and/or stormwater inventory information was applied to quantify vulnerability.

Next phase is to identify mitigation options and outline a resiliency strategy. The resiliency strategy will set a framework for SLR adaptation methods to be incorporated into stormwater improvement projects and to potentially establish a process for the design of the overall Capital Improvement Program.

Florida Resilient Coastlines Program (FRCP)

- Financial assistance aimed at preparing coastal communities for current and future effects of rising sea levels, including coastal flooding, erosion, and ecosystem changes.

- Resilience Planning Grants (RPGs):
  - Complying with “Peril of Flood” statute;
  - Vulnerability assessment; Adaptation/resilience plans; and
  - Regional collaboration efforts

“Peril of Flood” Statute (Sec. 163.3178(2)(f) F.S.)

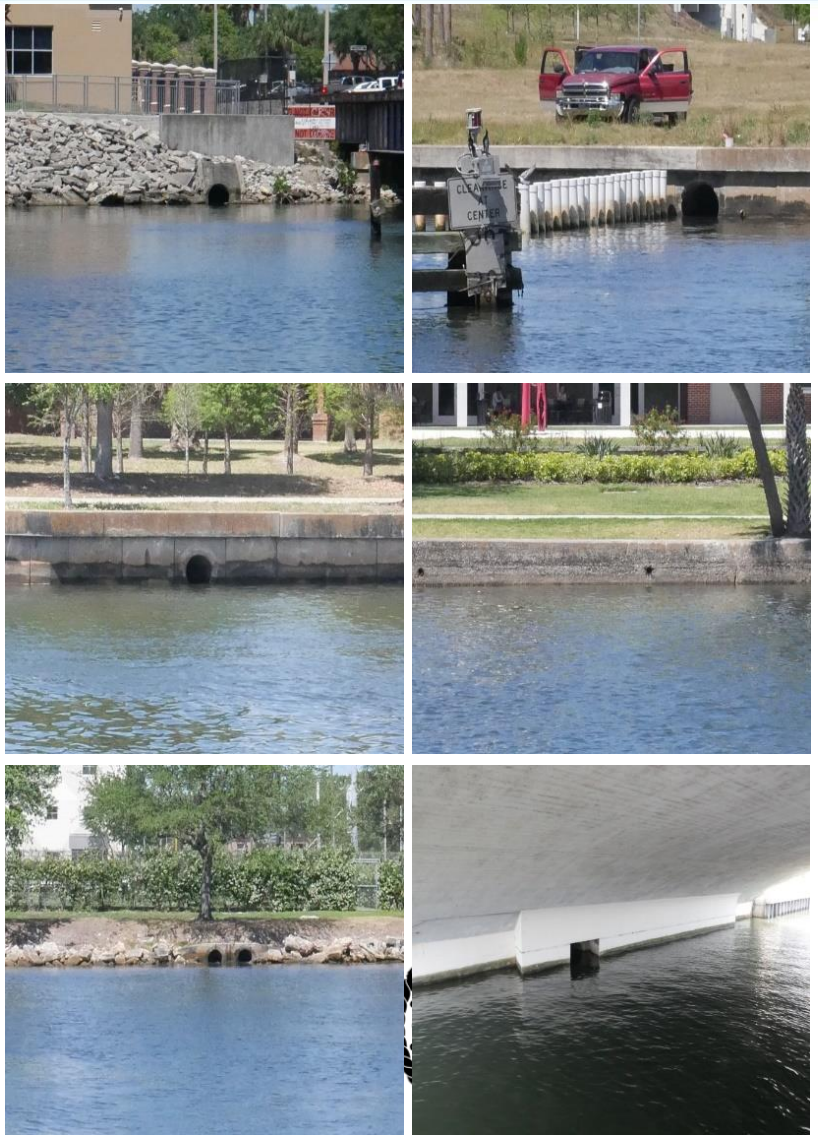
- Effective July 1, 2015

- New requirements for the coastal management element of a local government’s comprehensive plan related to coastal flooding and impacts of sea level rise.

- Include development and redevelopment principles, strategies, and engineering solutions that reduce flood risk in coastal areas which results from high-tide events, storm surge, flash floods, stormwater runoff, and the related impacts of sea-level rise.

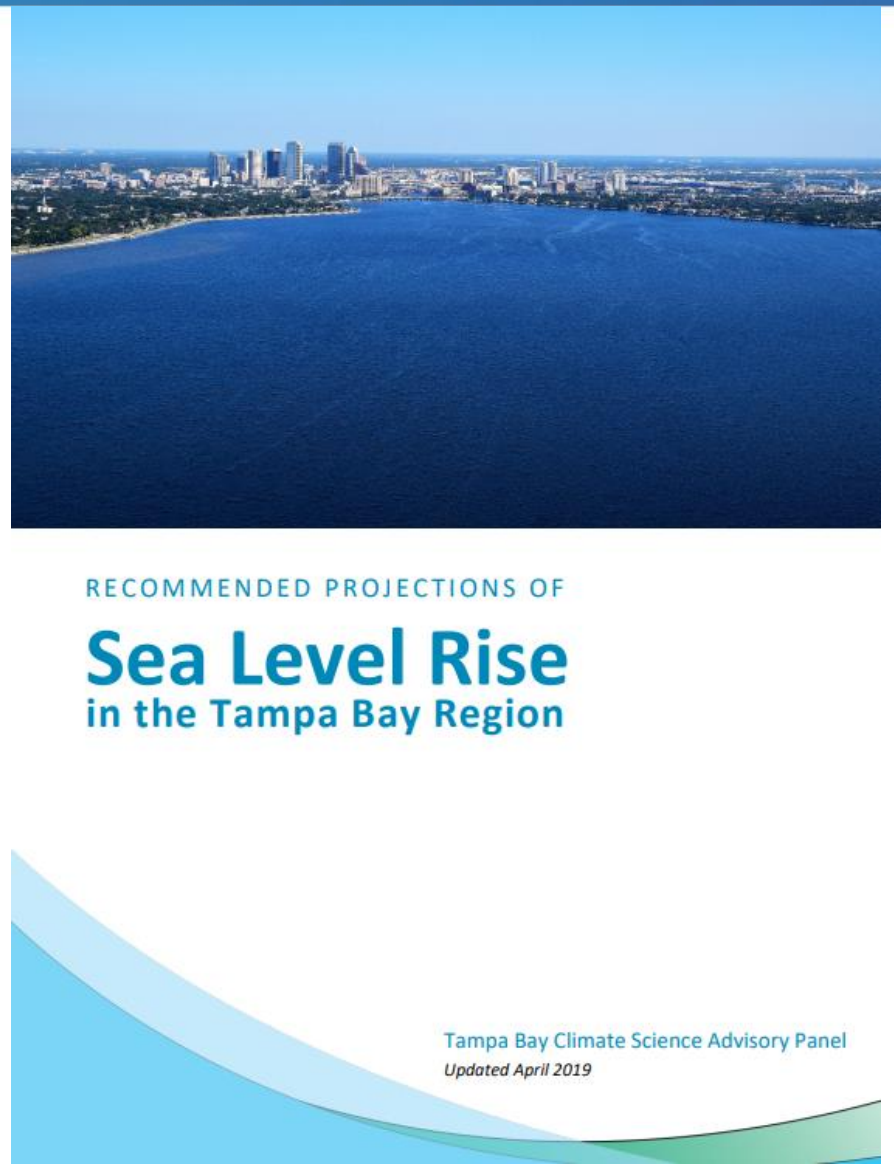
City of Tampa Grant Background

- August 2019, the Stormwater Engineering Division received the grant.
- Objective is to develop a vulnerability analysis for critical stormwater systems located in areas susceptible to sea level rise.
- Analysis focuses on stormwater outfalls around the City of Tampa.
- Includes mitigation options to address the impacts of rising sea levels as well as a long-range strategy for incorporating SLR into the City's annual Capital Improvement Program.

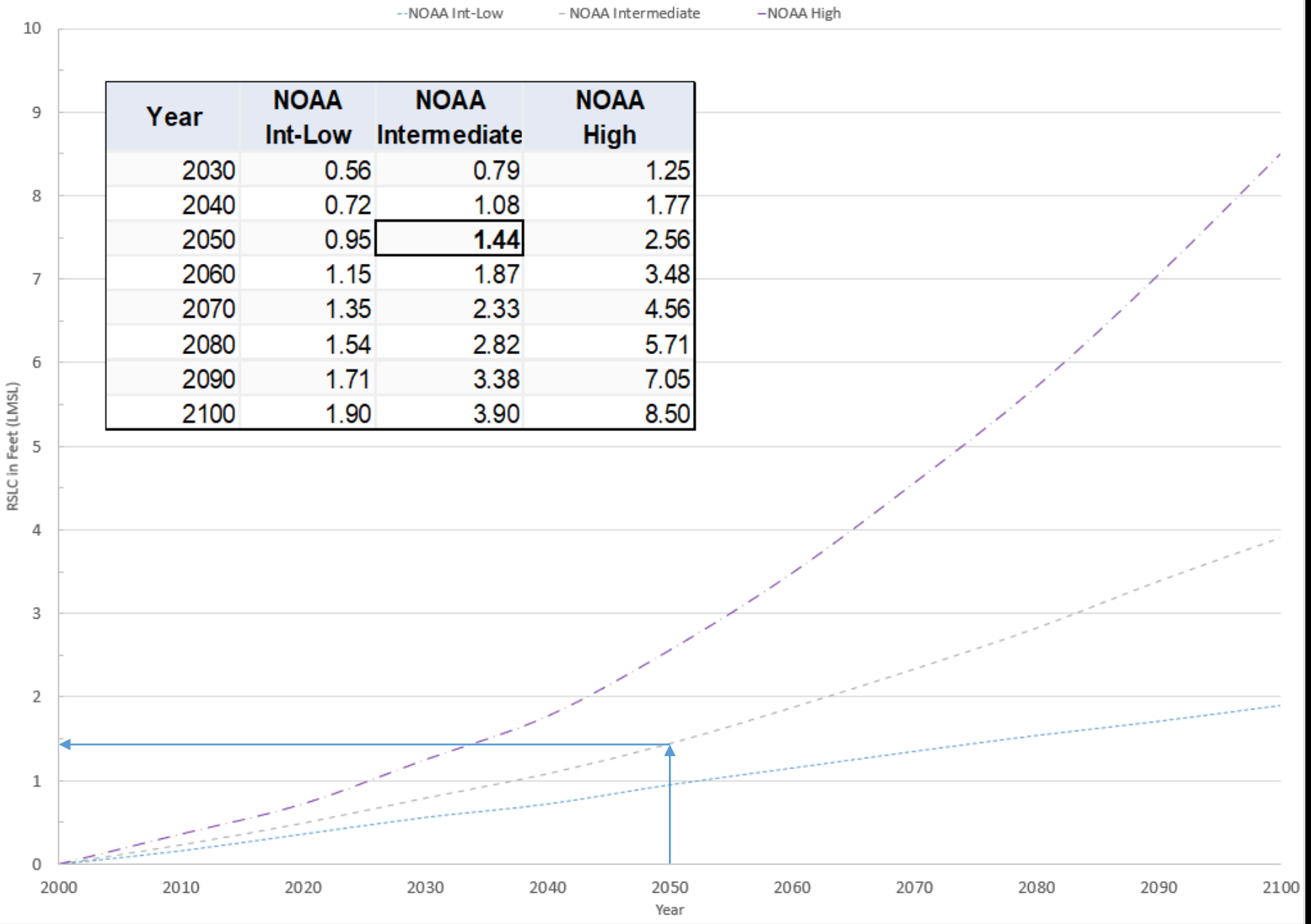


Tampa Bay Climate Science Advisory Panel

- Tampa Bay region can expect to see approximately 1 to 2.5 feet SLR by 2050 and between 2 to 8.5 feet by 2100
- NOAA “Low” scenario should not be used for planning purposes
- NOAA “Extreme” scenario (maximum ice sheet melt possible) not yet supported
- Adaptation planning should employ a scenario-based approach that, at minimum, considers location, time horizon, and risk tolerance.



Relative Sea Leve Change Projections -
Gauge 8726520, St. Petersburg, FL



Year	NOAA Int-Low	NOAA Intermediate	NOAA High
2030	0.56	0.79	1.25
2040	0.72	1.08	1.77
2050	0.95	**1.44**	2.56
2060	1.15	1.87	3.48
2070	1.35	2.33	4.56
2080	1.54	2.82	5.71
2090	1.71	3.38	7.05
2100	1.90	3.90	8.50

Vulnerability Assessment

- Basins vulnerability analysis characteristics include:
  - Outfall Type,
  - Critical Facilities,
  - SFHA basin coverage,
  - Repetitive Loss Areas,
  - Flood complaints, and
  - Land use.

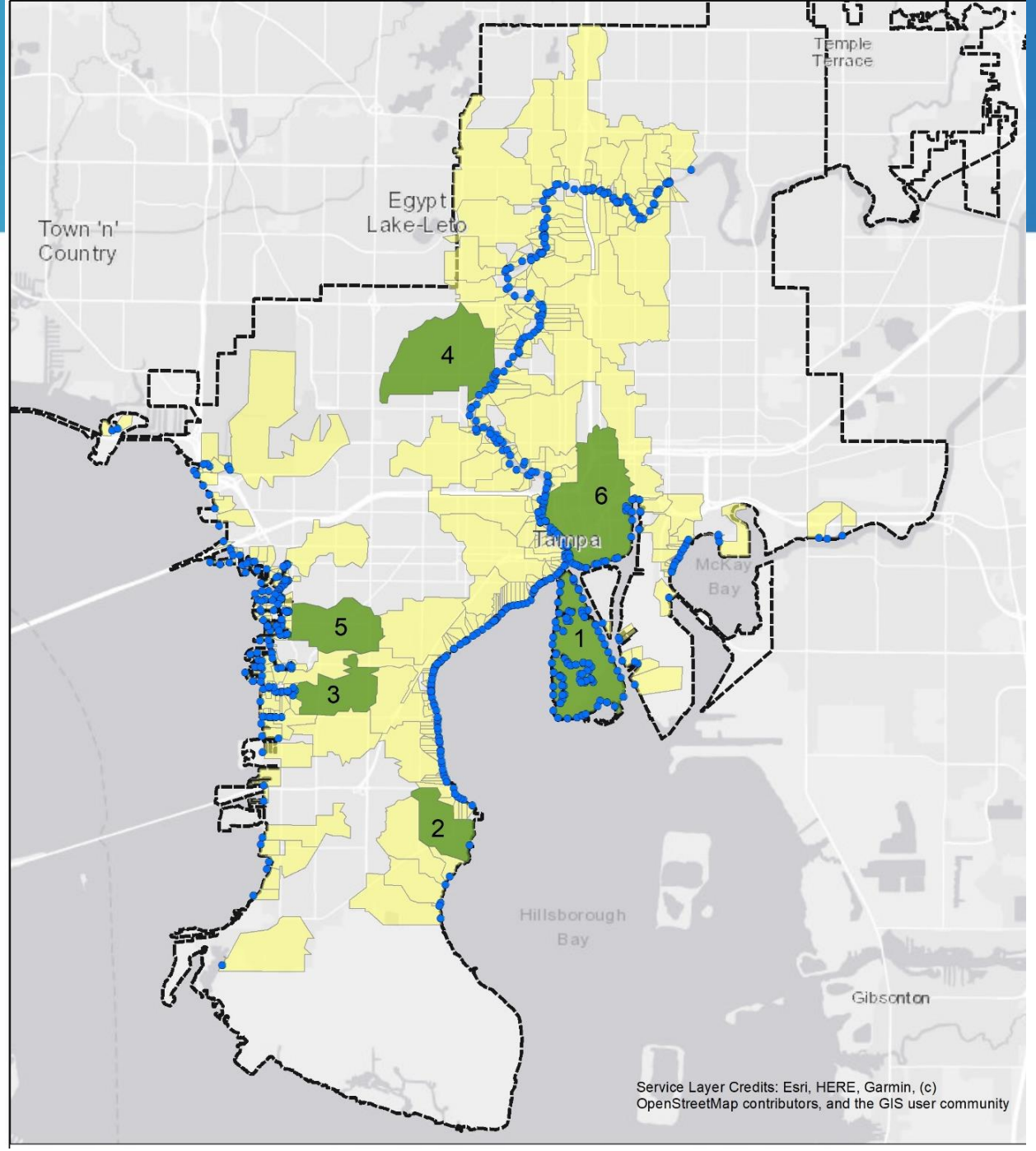
- Horizon selected for this study is 30 years, based on a typical stormwater project useful life of 30-40 years.

- NOAA 2050 Intermediate-High Value of 1.44 ft.

- The relative change of 1.44 feet was added to the 1-year Stillwater elevation of 2.0 ft, resulting in a SLR elevation scenario of 3.44 ft.

Year	NOAA Int-Low	NOAA Intermediate	NOAA High
2030	0.56	0.79	1.25
2040	0.72	1.08	1.77
2050	0.95	**1.44**	2.56
2060	1.15	1.87	3.48
2070	1.35	2.33	4.56
2080	1.54	2.82	5.71
2090	1.71	3.38	7.05
2100	1.90	3.90	8.50

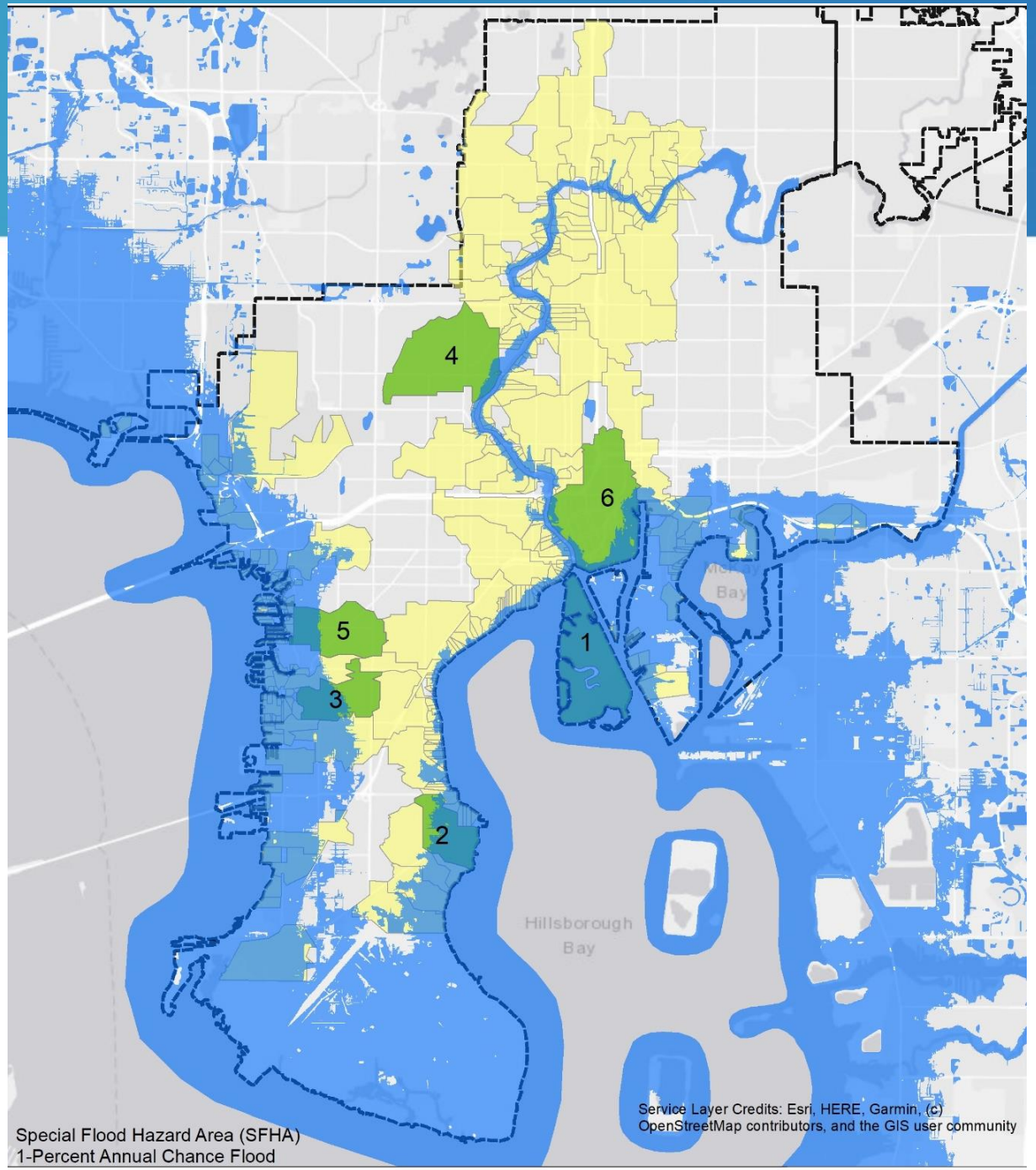
Study Basins



Legend

- Coastal Outfalls
- Study Basins
- Coastal Basins
- City Limit

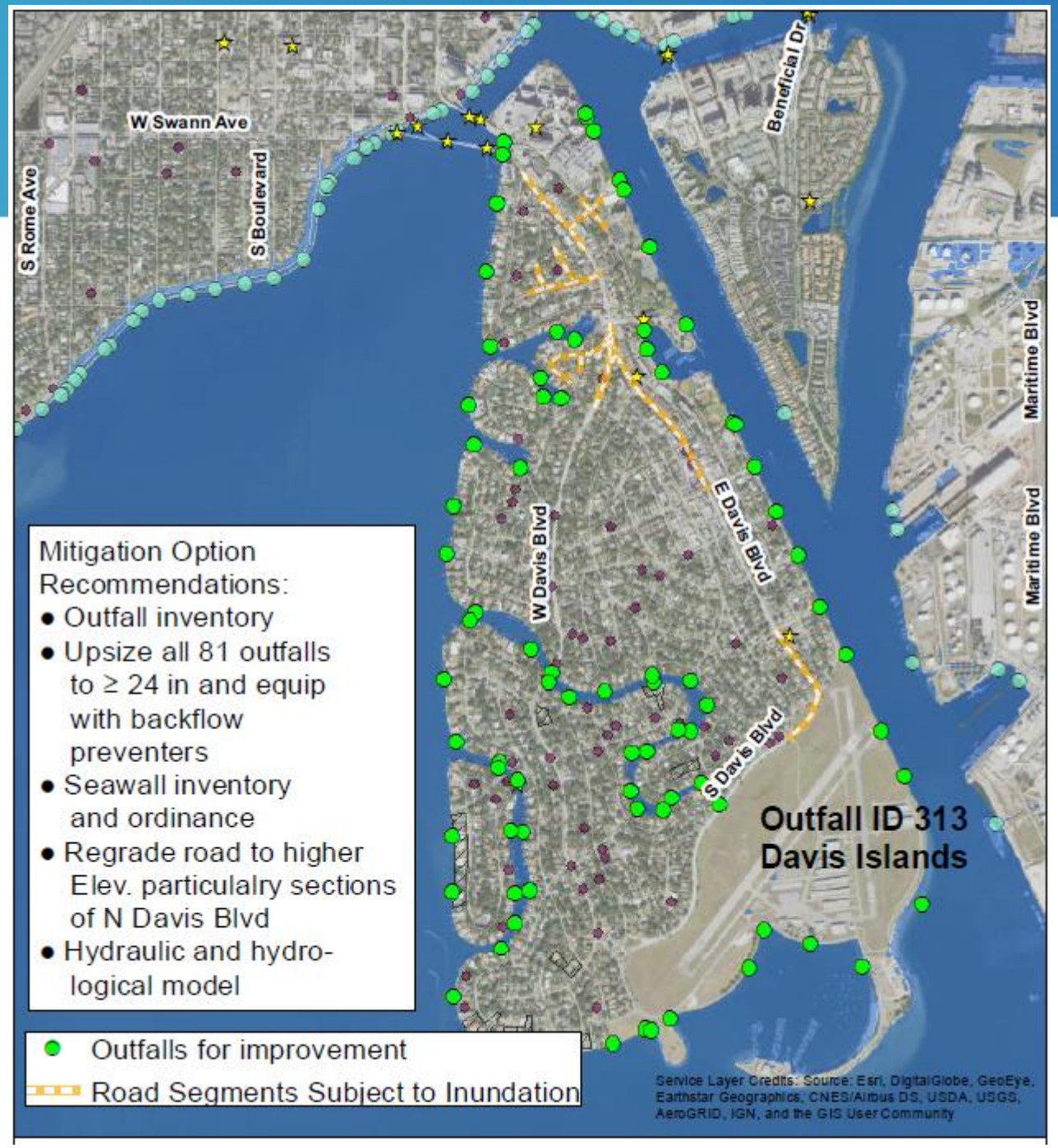
Study Basins



Legend

- FEMA Preliminary SFHA
- Study Basins
- Coastal Basins
- City Limit

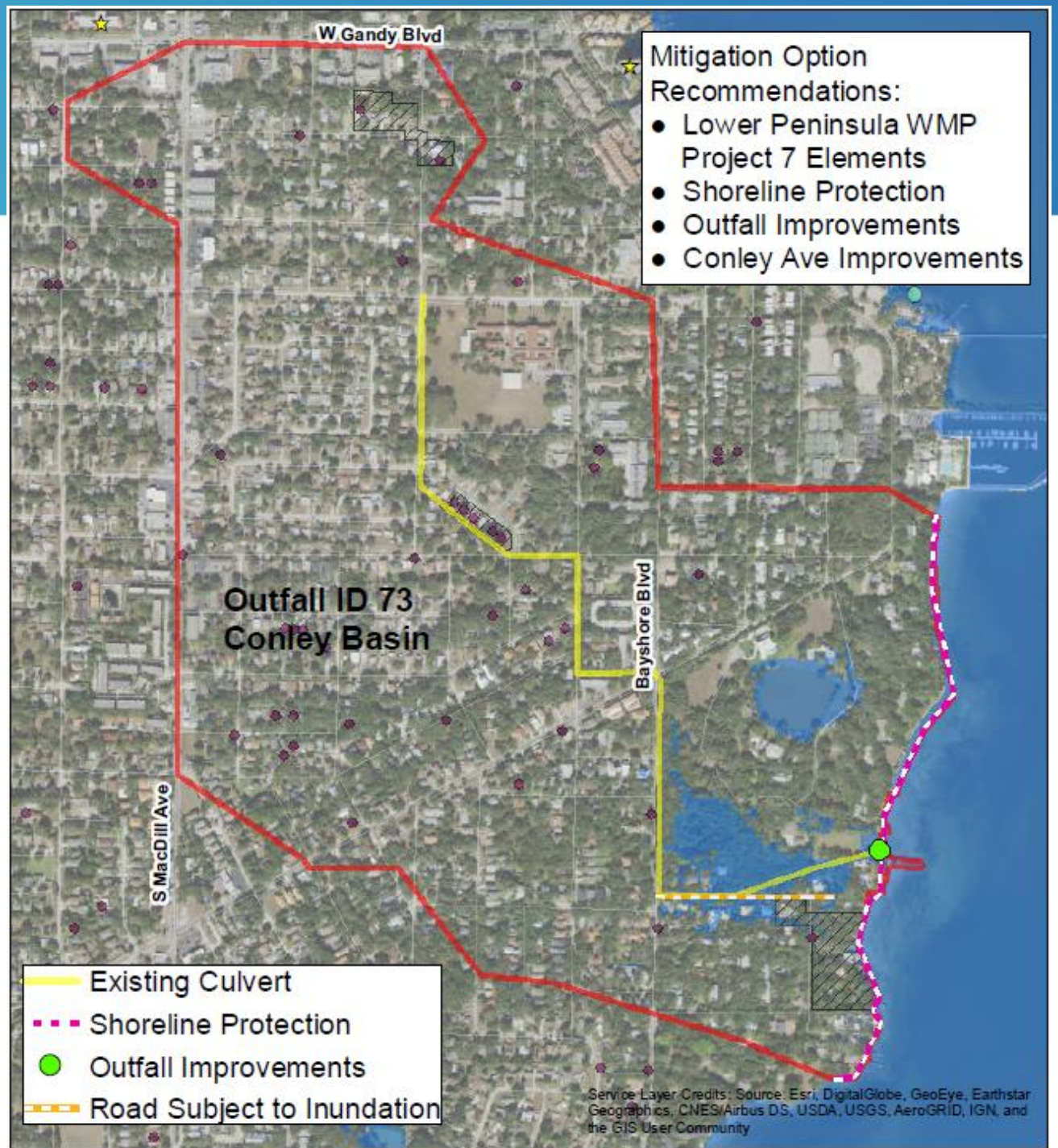
Coastal Study Basin 1



Legend

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

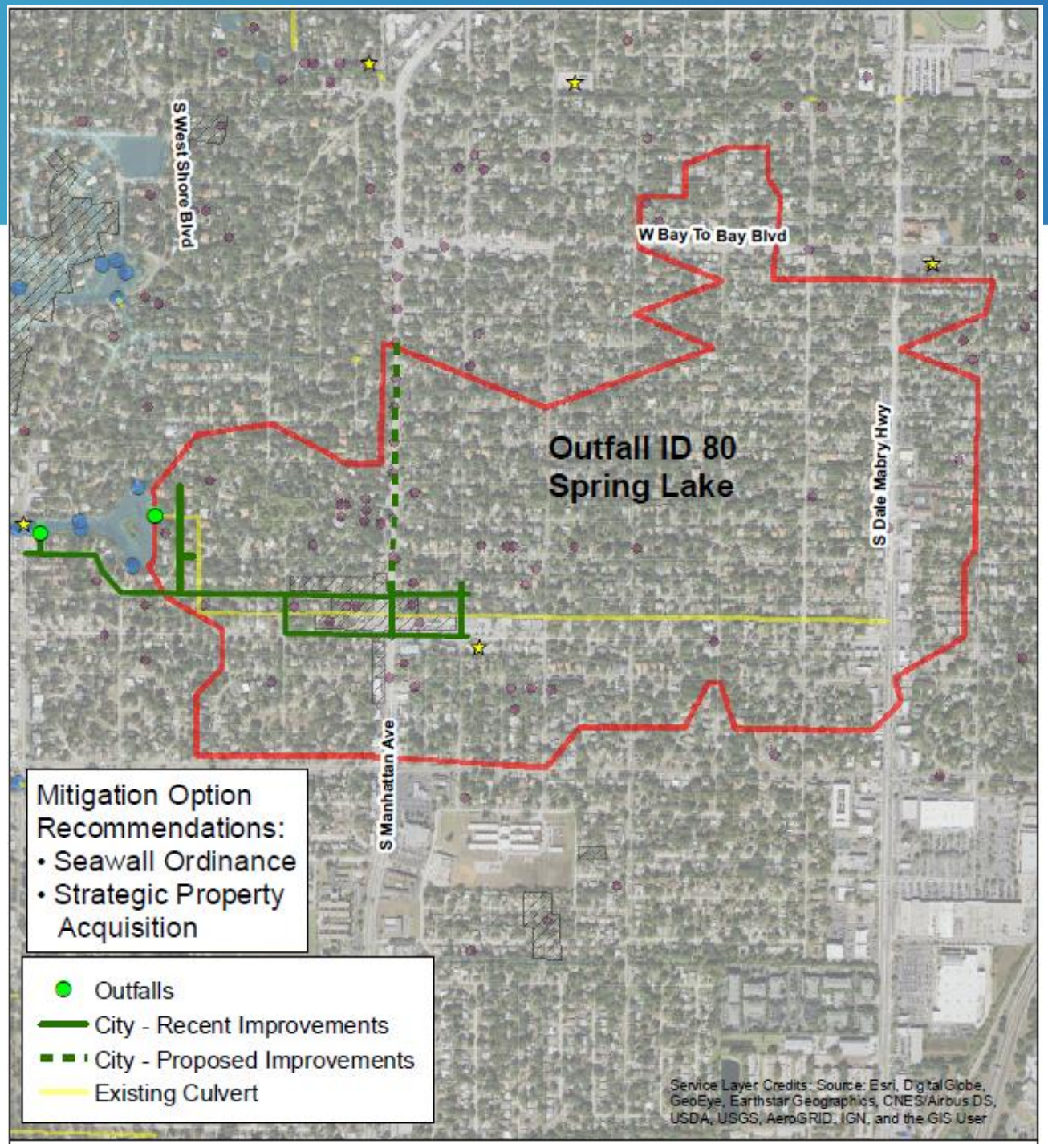
Coastal Study Basin 2



Legend

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

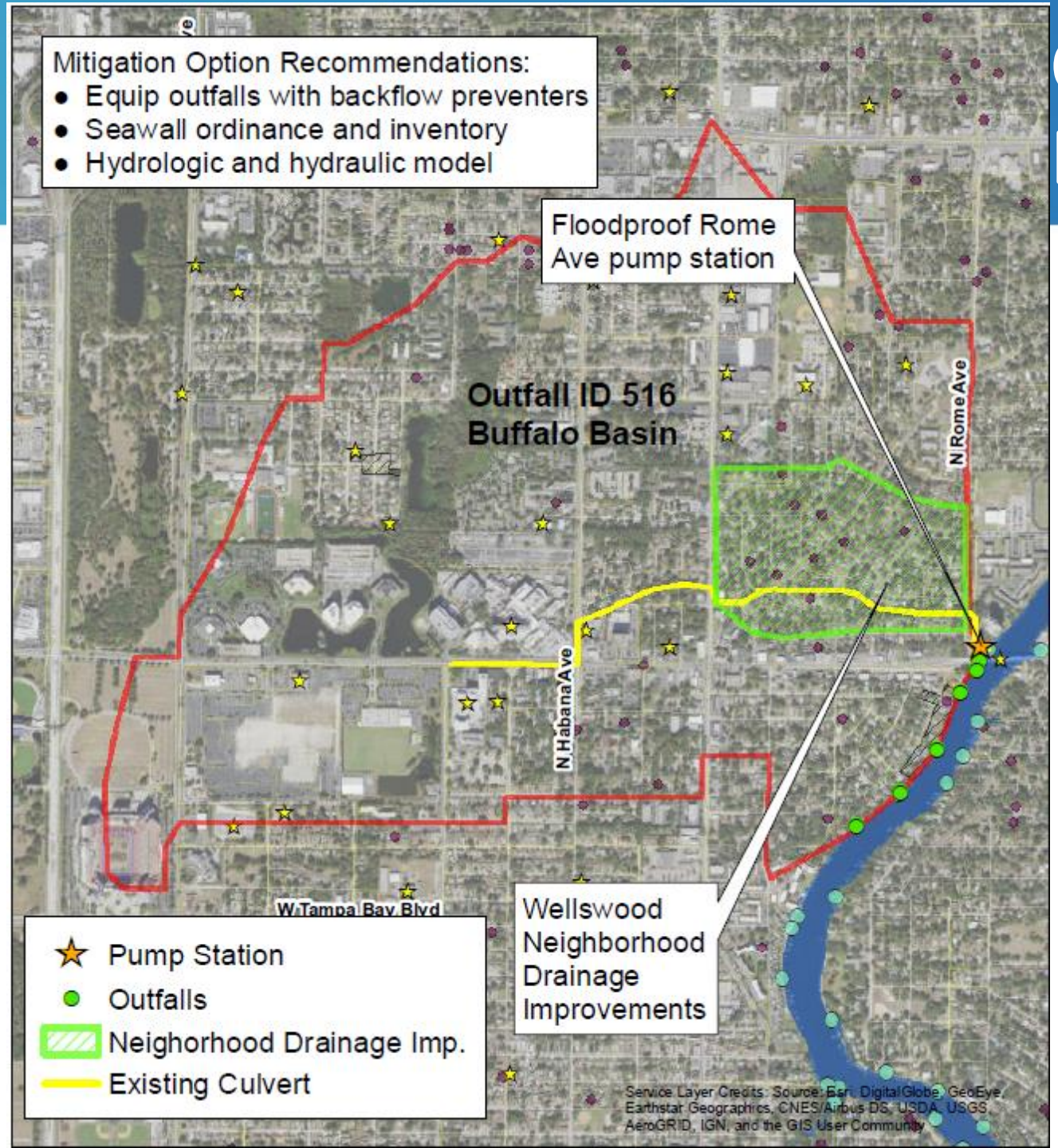
Coastal Study Basin 3



Legend

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

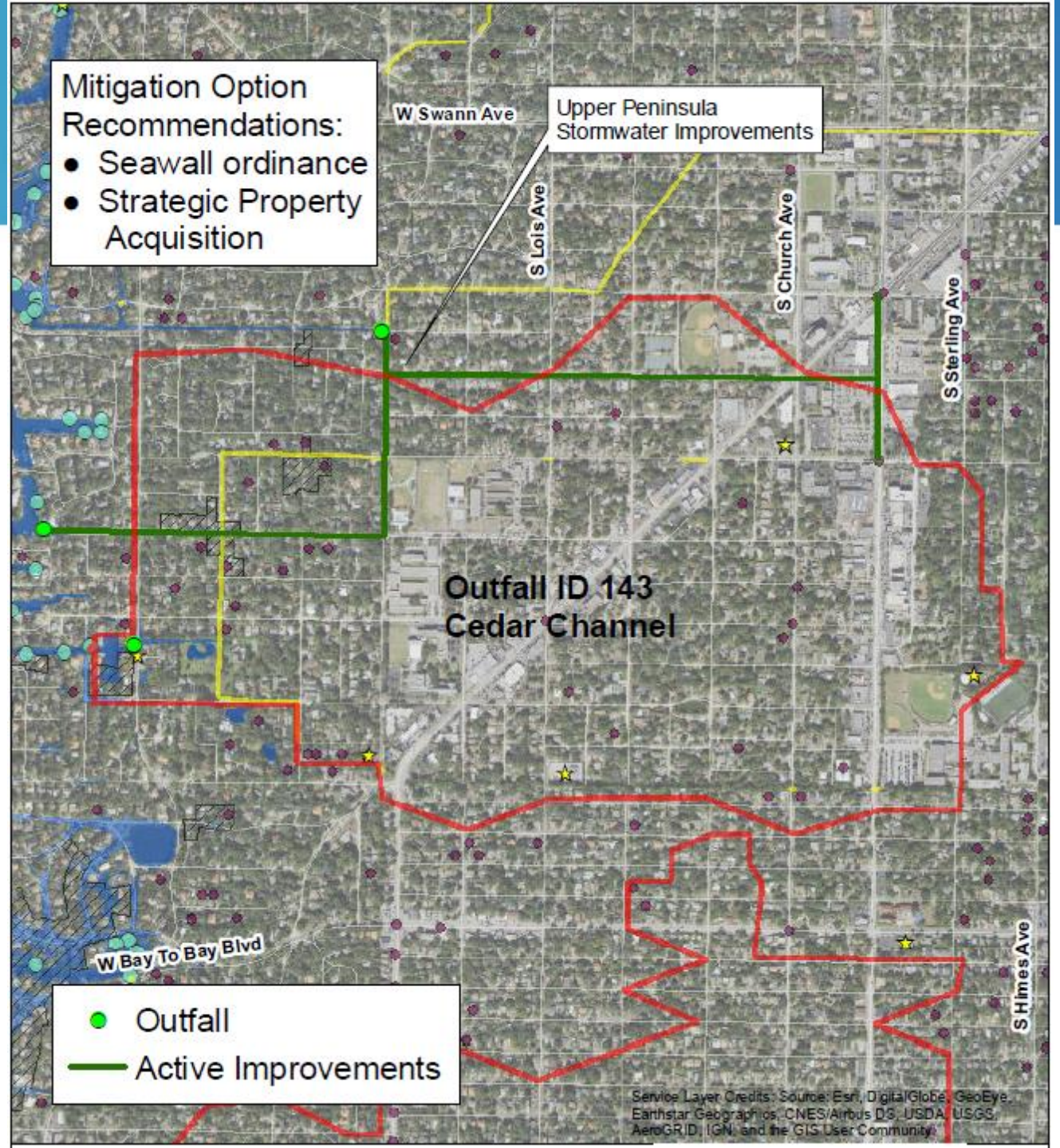
Coastal Study Basin 4



Legend

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

Coastal Study Basin 5

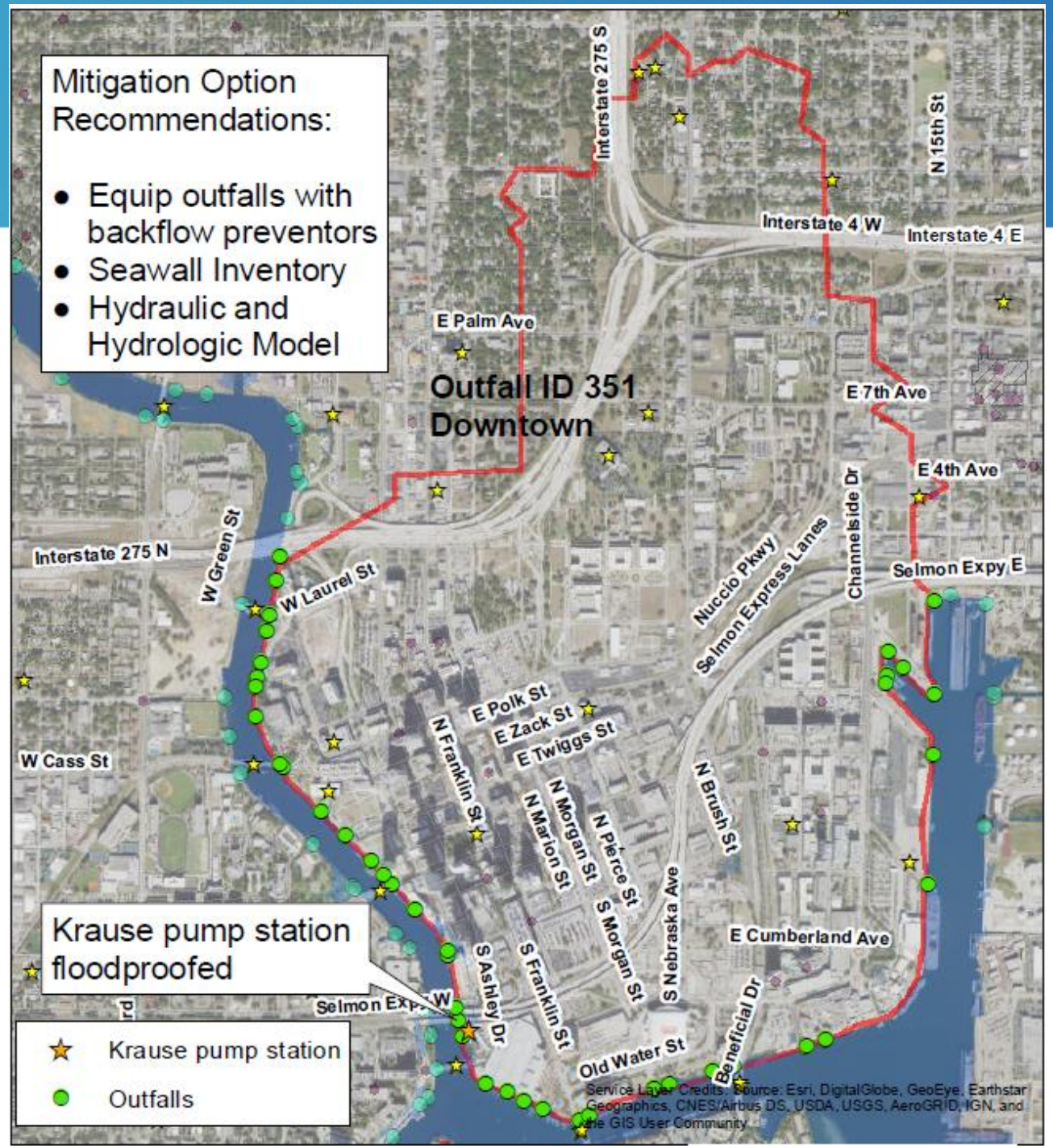


Legend

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

FDEP R1916

Coastal Study Basin 6



Legend

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

FDEP R1916

Citywide Guidelines and Recommendations

Seawall Inventory

- A comprehensive inventory that includes seawall ownership, material, condition, and elevation
- Assists in confirming vulnerability locations as well as permitting and regulation

[JAMES BORCHUCK | Tampa Bay Times]

Citywide Guidelines and Recommendations

Seawall Ordinance

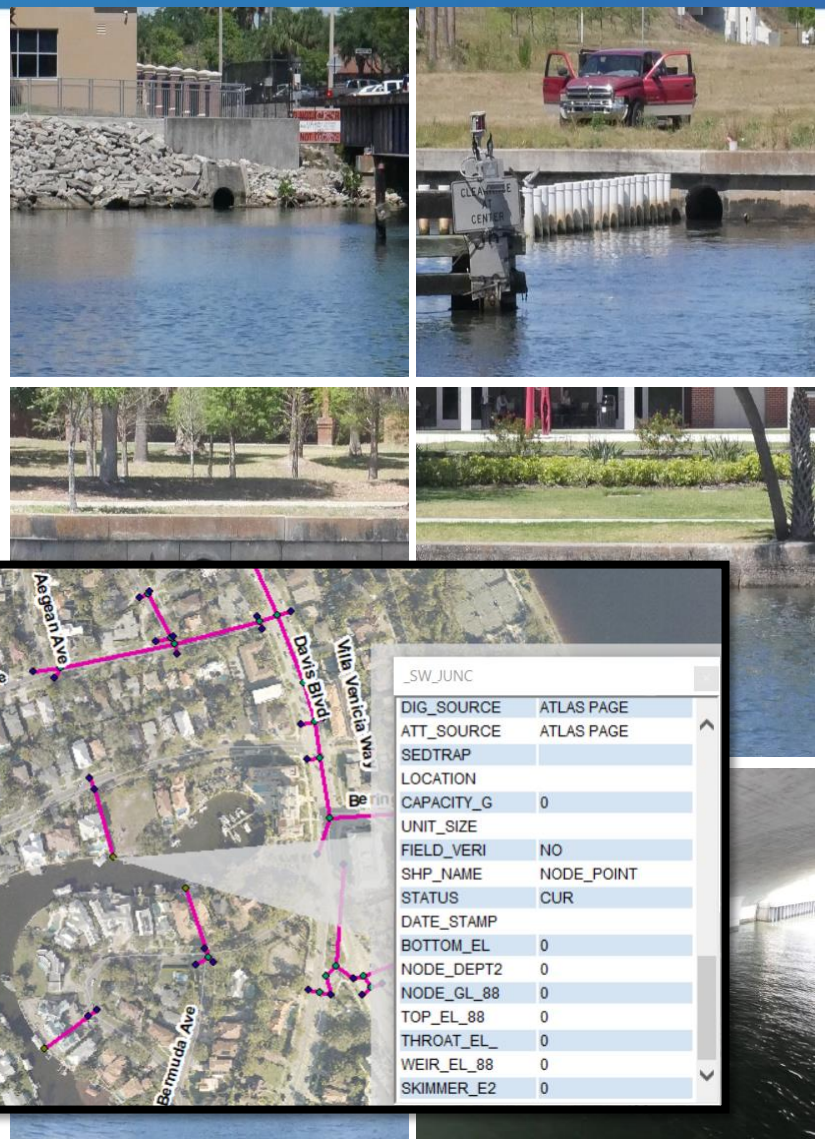
- Review and evaluate benefits of a seawall ordinance that accounts for future SLR conditions and sets consistent city-wide standards.
- Assess current and proposed Seawall Ordinances from similar communities.

City of Miami	Broward County
6'NAVD and 8' NAVD SLR by 2070	Prior to 1/1/2035 = 4' but must accommodate 5' by 1/1/2050
Substantial Repairs can trigger compliance; 50% length, repairs > 50% cost of new seawall or BH or elev. change > than 50% length	Substantial Repairs can trigger compliance; > 50% length or appurt. structure > 50% value
Defines disrepair	Defines disrepair
Specifies materials; Promote living shorelines	Promote enhancing habitat
POs are prohibited from tidal water entering property to flow to adjacent properties or public ROW	POs are prohibited from tidal water entering property to flow to adjacent properties or public ROW (trespass of water = public nuisance)
Code enforcement + initiate abatement w/in 180 days and begin repairs w/in 265 days; complete in 18 months	Failure to maintain = violation; progress within 60 days and complete w/in 265
	Allows automatically elevated structure not dependent on human intervention
Source: Erin L. Deady, PA	Disclosure on tidally influence area and meeting min. barrier elevation stds.

Citywide Guidelines and Recommendations

Stormwater Outfall Inventory

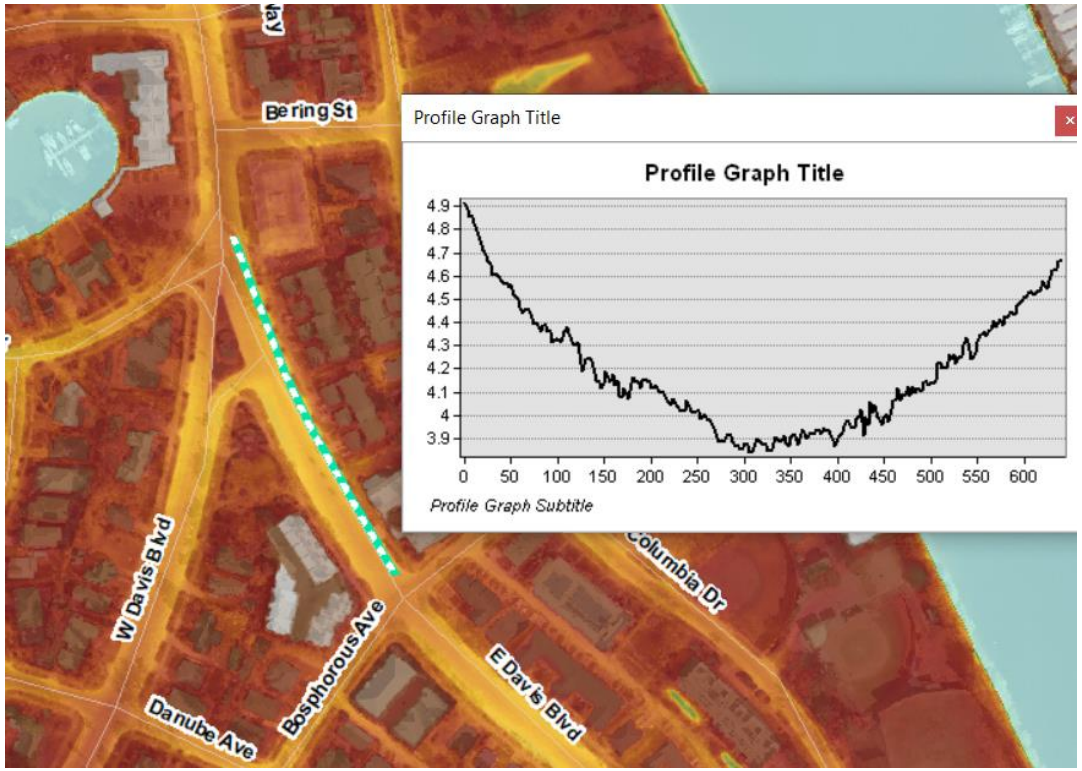
- A more robust inventory with verified outfall sizes, material, and condition
- Assists in confirming vulnerable locations where backflow preventors may assist with meeting stormwater and roadway level of service



Citywide Guidelines and Recommendations

Minimum Roadway Elevation Criteria

- Minimum roadway elevation Design Criteria for future transportation capital projects
- protect both road surfaces and subbase from damages due to elevated water table conditions
- Meet level of service by keeping roads fully operational and safe for traffic.



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Citywide Guidelines and Recommendations

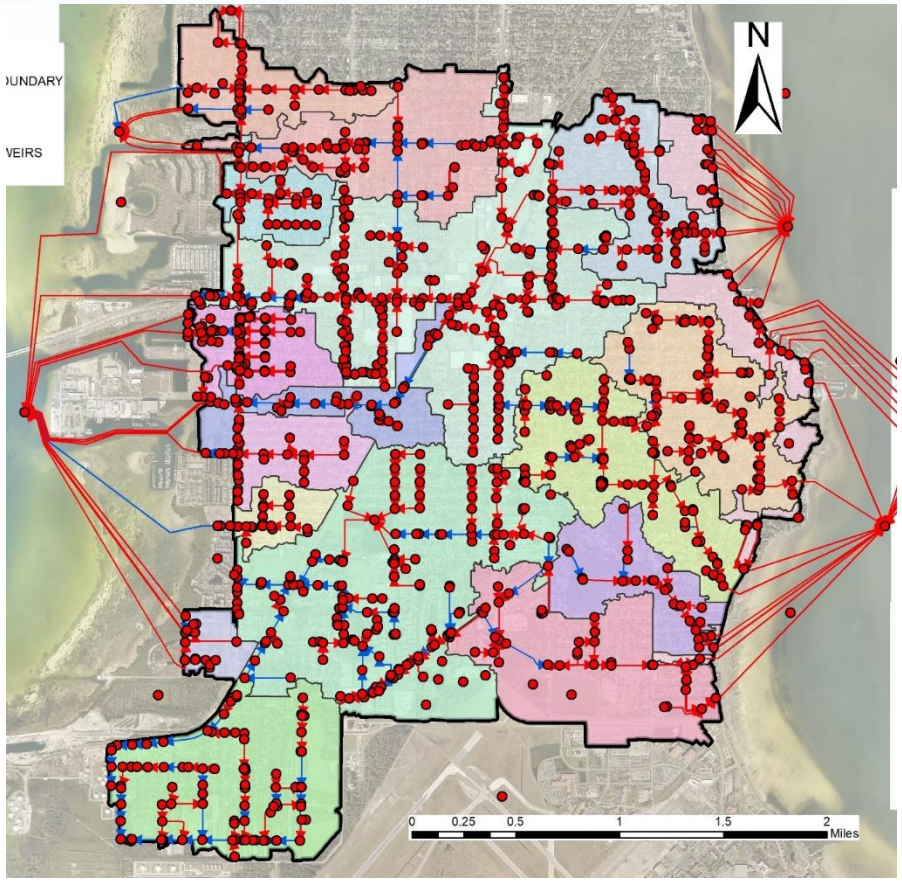
Outreach Efforts and Educational Workshops

To improve general public awareness and assist design professionals with adherence to flood resistant design and construction practices

Citywide Guidelines and Recommendations

Continue Development of Hydrologic and Hydraulic Models

Continue the development of Citywide comprehensive hydrologic and hydraulic models with a priority on areas with tidal outfalls subject to SLR.



Lower Peninsula Watershed Model, City of Tampa

Questions, Comments, and Information

https://www.tampagov.net/sea-level-rise

Name (Optional)

Email (Optional)

Image Upload - If you would like to share a picture of flooding or attach a file you may do so here.

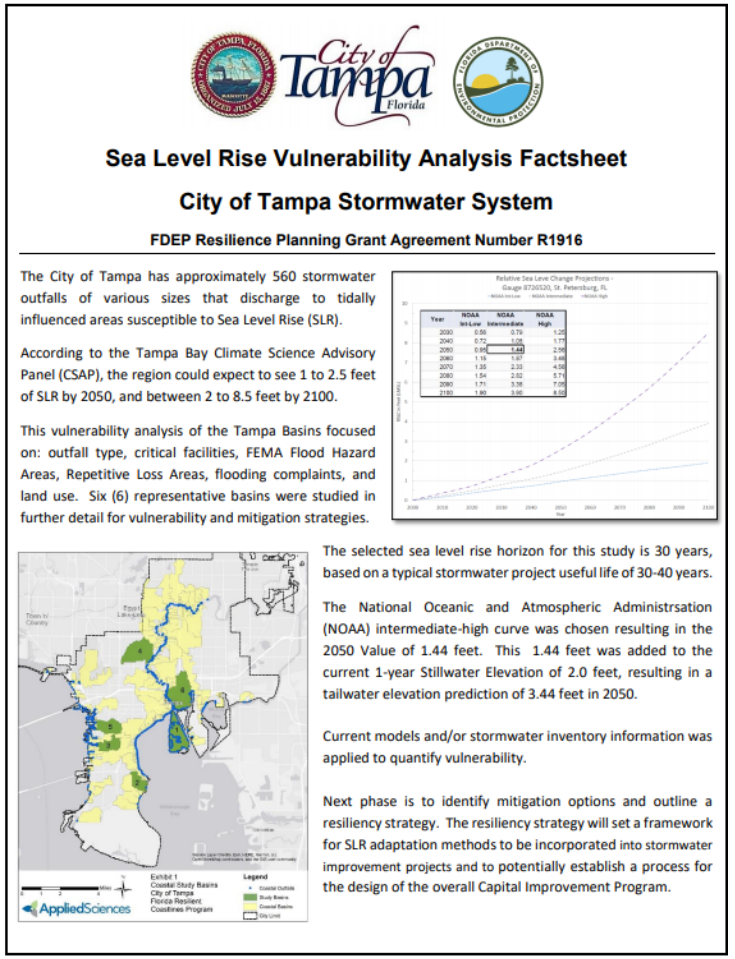
Add a new file

Choose File No file chosen UPLOAD

More information

Comments - Please type any comments or questions you may have regarding the Sea Level Rise study in this box and the City of Tampa will post responses by June 30, 2020

SUBMIT



City of Tampa Florida

Sea Level Rise Vulnerability Analysis Factsheet

City of Tampa Stormwater System

FDEP Resilience Planning Grant Agreement Number R1916

The City of Tampa has approximately 560 stormwater outfalls of various sizes that discharge to tidally influenced areas susceptible to Sea Level Rise (SLR).

According to the Tampa Bay Climate Science Advisory Panel (CSAP), the region could expect to see 1 to 2.5 feet of SLR by 2050, and between 2 to 8.5 feet by 2100.

This vulnerability analysis of the Tampa Basins focused on: outfall type, critical facilities, FEMA Flood Hazard Areas, Repetitive Loss Areas, flooding complaints, and land use. Six (6) representative basins were studied in further detail for vulnerability and mitigation strategies.

The selected sea level rise horizon for this study is 30 years, based on a typical stormwater project useful life of 30-40 years.

The National Oceanic and Atmospheric Administrsation (NOAA) intermediate-high curve was chosen resulting in the 2050 Value of 1.44 feet. This 1.44 feet was added to the current 1-year Stillwater Elevation of 2.0 feet, resulting in a tailwater elevation prediction of 3.44 feet in 2050.

Current models and/or stormwater inventory information was applied to quantify vulnerability.

Next phase is to identify mitigation options and outline a resiliency strategy. The resiliency strategy will set a framework for SLR adaptation methods to be incorporated into stormwater improvement projects and to potentially establish a process for the design of the overall Capital Improvement Program.

THANK YOU

JUNE 24, 2020

STORMWATER SEA LEVEL RISE VULNERABILITY ANALYSIS

FDEP RPG AGREEMENT NUMBER R1916

APPLIED SCIENCES

City of Tampa Florida