SEA LEVEL RISE VULNERABILITY ANALYSIS REPORT

FDEP Agreement Number R1916
Task Number 3

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Prepared for:

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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 results of the vulnerability analysis at each selected location, per Task Number 3 in the Florida Department of Environmental Protection (FDEP) Grant Agreement Number R1916. This task was updated from the original September 26th deliverable.

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 is 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**).

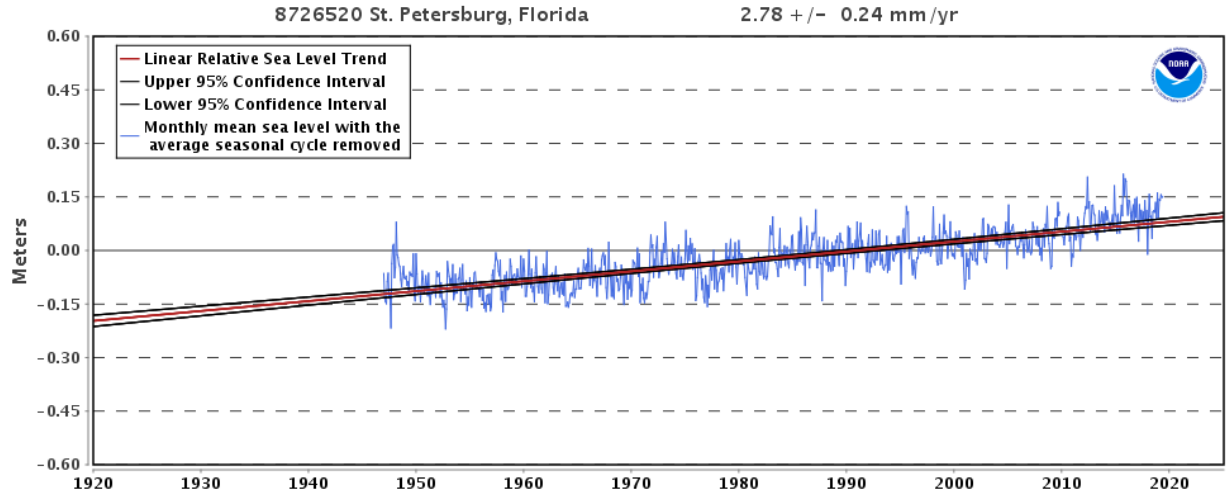


Figure 1. 1946-2018 Monthly Mean Sea Level Trend in St. Petersburg, FL, NOAA Tide Gauge 8726520

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.

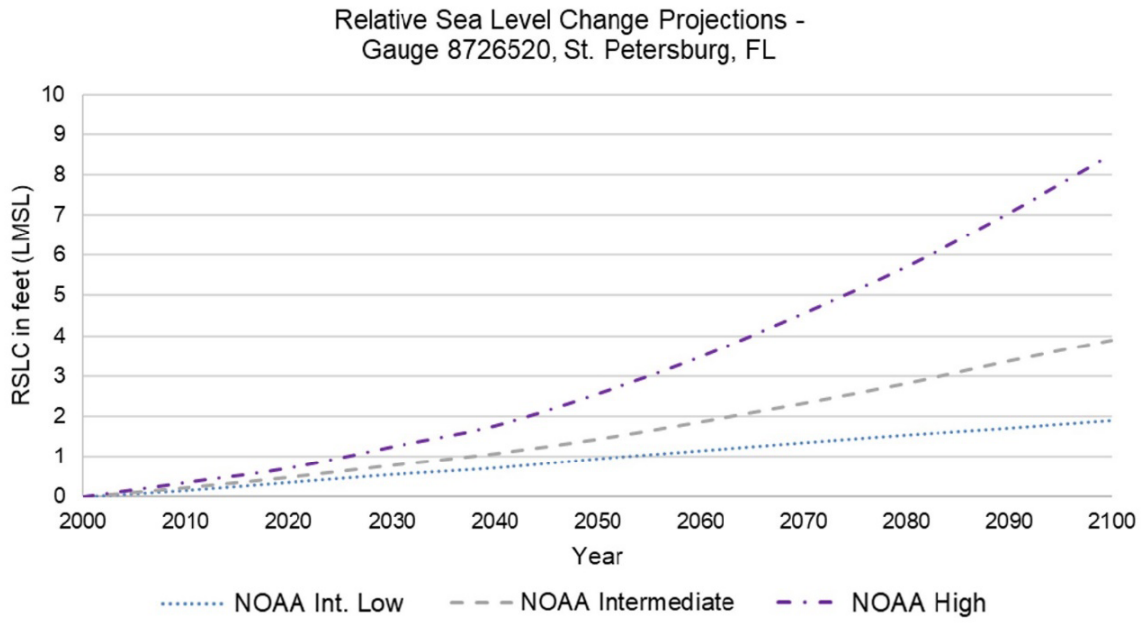


Figure 2. Relative Sea Level Change (RSLC) Scenarios for St. Petersburg, Florida, as calculated using the regionally corrected NOAA 2017 curves. (USACE 2019)

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, Commerce Street, 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 are 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 SUMMARY AND NEXT STEPS

The next phase of this study is to identify viable mitigation options and outline a stormwater outfall resiliency strategy. 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.

5.1 Mitigation Options

Mitigation and 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). Some categories may not directly apply to stormwater mitigation alternatives but are included for future general planning purposes. These four categories are included below:

a) Protection: Strategies that involve "hard" and "soft" structurally defensive measures to mitigate impacts of rising seas in order to decrease vulnerability while allowing structures and infrastructure to remain unaltered. Two examples are shoreline armoring (bulkhead or seawalls)

as well as beach and dune renourishment. Protection strategies may be targeted for areas of a community that are location-dependent and cannot be significantly altered or relocated, such as downtown centers, areas of historical significance, or water dependent uses. Other protection measures may be non-physical, consisting ofmore robust development and construction codes.

b) Accommodation: Strategies that do not act as a barrier, but rather alter the design through measures such as elevation or stormwater improvements to allow the structure of an infrastructure system to stay intact. Rather than preventing flooding or inundation, these strategies aim to reduce potential risks.

c) Managed Retreat: Strategies that involve the actual removal of existing development, their possible relocation to other areas, and/or the prevention of future development in high risk areas. Retreat strategies usually involve the acquisition of vulnerable land for public ownership, but may include other strategies such as transfer of development rights, purchase of development right, rolling and conservation easements.

d) Avoid: involves ensuring development does not take place in areas subject to coastal hazards associated with sea level rise or where the risk is low at present but will increase over time. This may involve identifying future "limited development" areas within local government planning documents. A wide range of planning tools may be involved, leading to a decision to avoid development in areas subject to moderate to high risk. Regulatory tools may include the designation or zoning of lands for limited development or uninhabitable uses. An avoid strategy may include land acquisition or restriction tools such as a land trust, or the transfer of development potential to areas with low or no risk due to sea level rise.

There are also opportunities to nurture the balance between the unique mosaic of ecosystems, public infrastructure, and private property. Natural resources have historically served to buffer storm waves, filter pollutants, and facilitate habitat migration. There are innovative solutions to coastal hazards that both protect ecosystems and leverage ecosystem services for protection. When planning for sea level rise impacts, it is most beneficial to maintain a balance of both engineering and natural solutions. With these challenges have arisen opportunities and possibilities to help keep communities resilient.

Priority locations to consider within each basin for mitigation are naturally low-lying areas, locations with low or no seawall, and critical facilities at risk.

- Low spots/depressions within basin;
- no or low seawall;
- Repetitive Loss Areas; and
- Flood prone critical facilities.

Preliminary Stormwater Mitigation options:

- Increased pipe sizes and other collection systems improvements;

- Elevated sea walls;
- Backflow preventers;
- Convert or restore to land to Natural Floodplain Functions that will align with SLR (living shorelines);
- Relocate Critical Infrastructure; and
- Policy changes (Design for future conditions), building code & construction code updates; Capital Planning Guidance Document

Existing recommendations from the Upper Peninsula and Lower Peninsula Watershed Management plans will be considered during Mitigation Options recommendations.

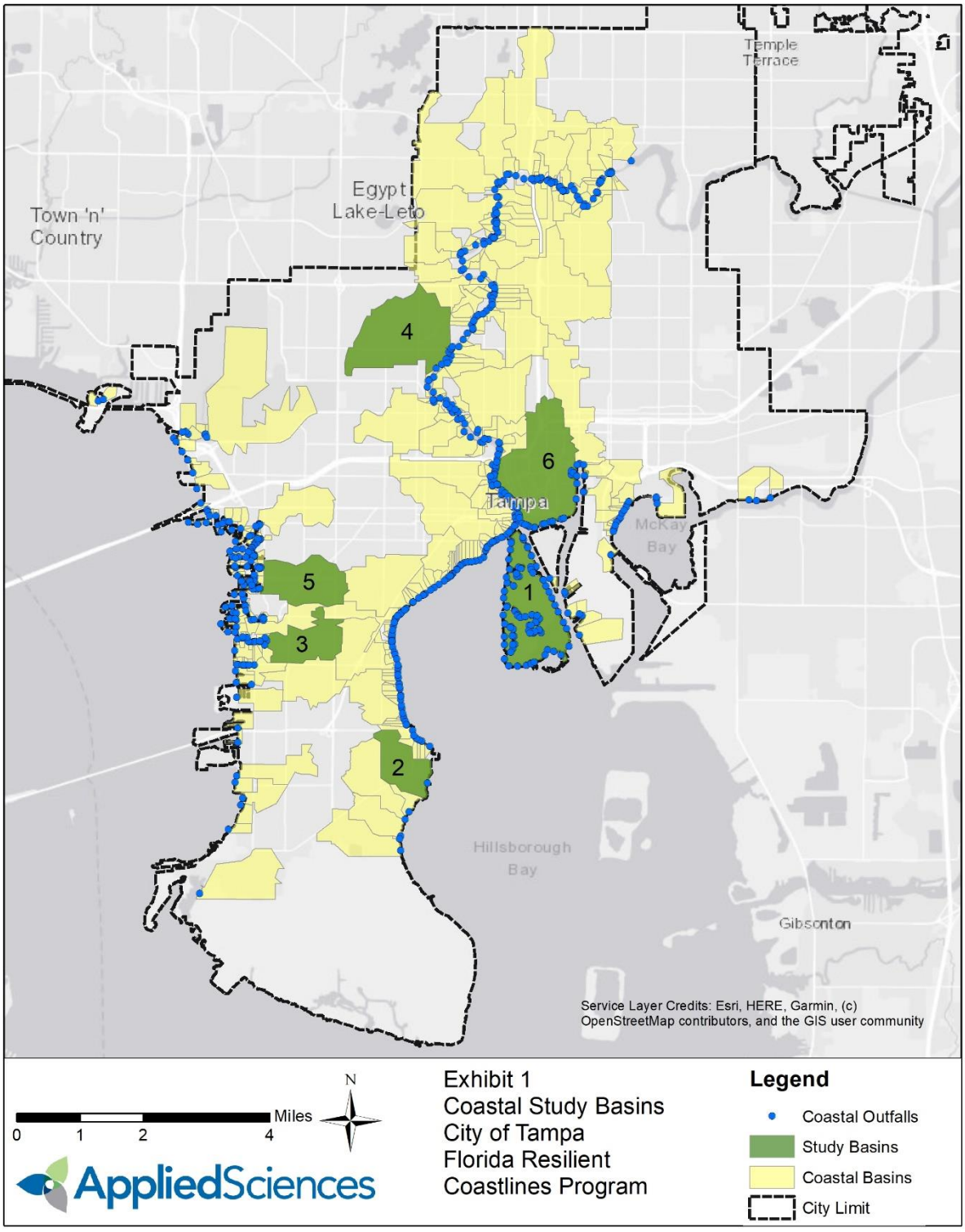
5.2 Stormwater Outfall Resiliency Strategy

The initial considerations for the Long Range Strategy will include, but not be limited to, the following recommendations:

1. Improve stormwater inventory in Coastal area, including survey of tidal stormwater outfalls (Inverts, condition, size);
2. Develop model of the Lower Hillsborough River, Downtown, and Davis Islands Areas;
3. Engage Community Participation, encourage Stakeholder involvement, and stay current with other regional strategies;
4. Update policies to incorporate Sea Level Rise Planning;
5. Developed Adaptation and Capital Planning Process, consider establishing Adaptation Action Areas;
6. Identify Funding to Accomplish Goals;
7. Integrate resiliency and adaptation strategies into all programs; and
8. Revisit and adjust Strategies based on current climate studies and trends.

These strategies will be expanded upon further as part of the next project phase.

Exhibits


Temple Terrace
Egypt Lake-Leto
Town 'n' Country
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Gibsonton
Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
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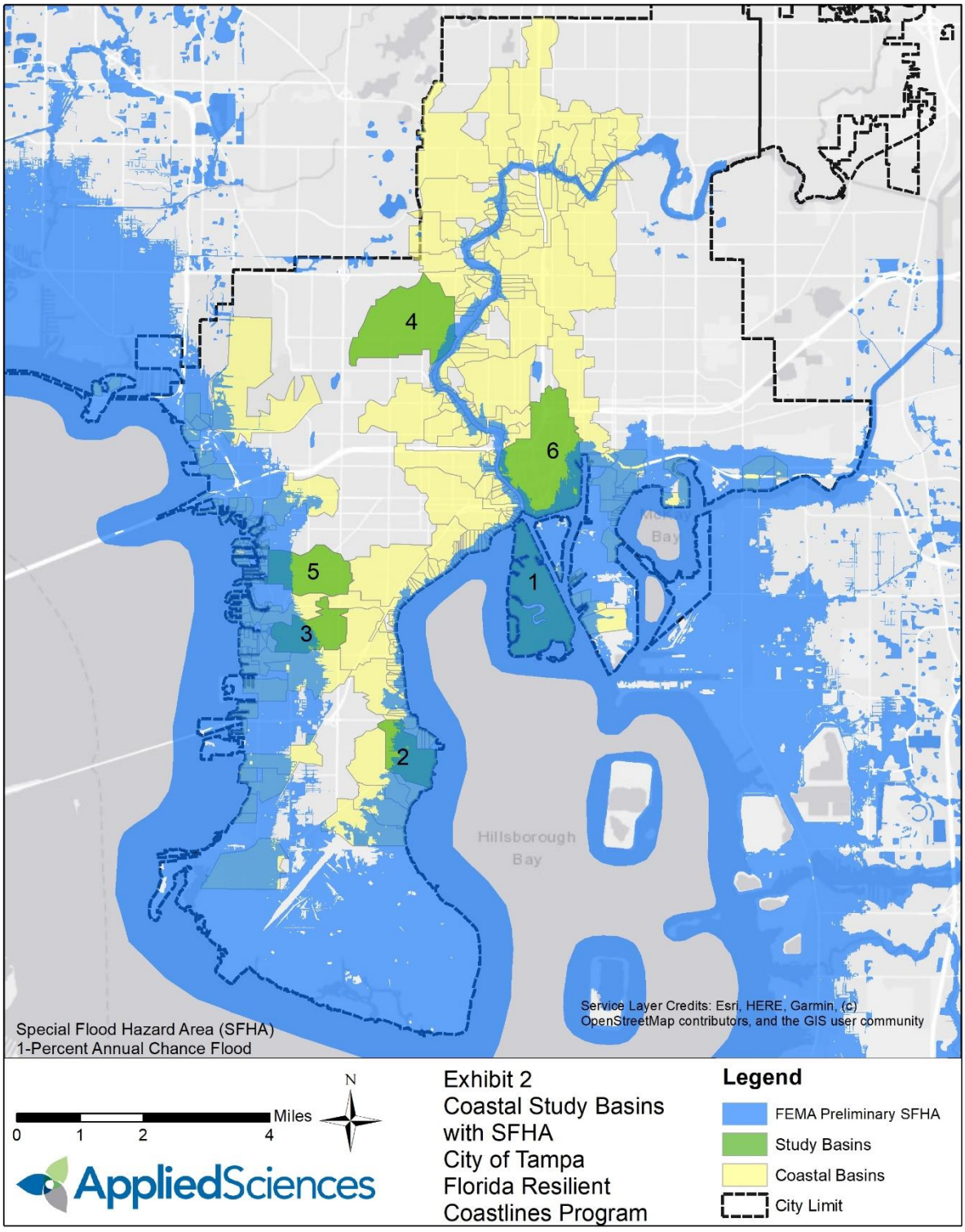
Exhibit 1
Coastal Study Basins
City of Tampa
Florida Resilient
Coastlines Program
Legend
Coastal Outfalls
Study Basins
Coastal Basins
City Limit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Hillsborough Bay
Special Flood Hazard Area (SFHA)
1-Percent Annual Chance Flood
Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
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Exhibit 2
Coastal Study Basins
with SFHA
City of Tampa
Florida Resilient
Coastlines Program
Legend
FEMA Preliminary SFHA
Study Basins
Coastal Basins
City Limit


Knights Run Ave
W Davis Blvd
E Davis Blvd
S Davis Blvd
Maritime Blvd
Outfall ID 313
Davis Islands
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Exhibit 3
Davis Islands
City of Tampa
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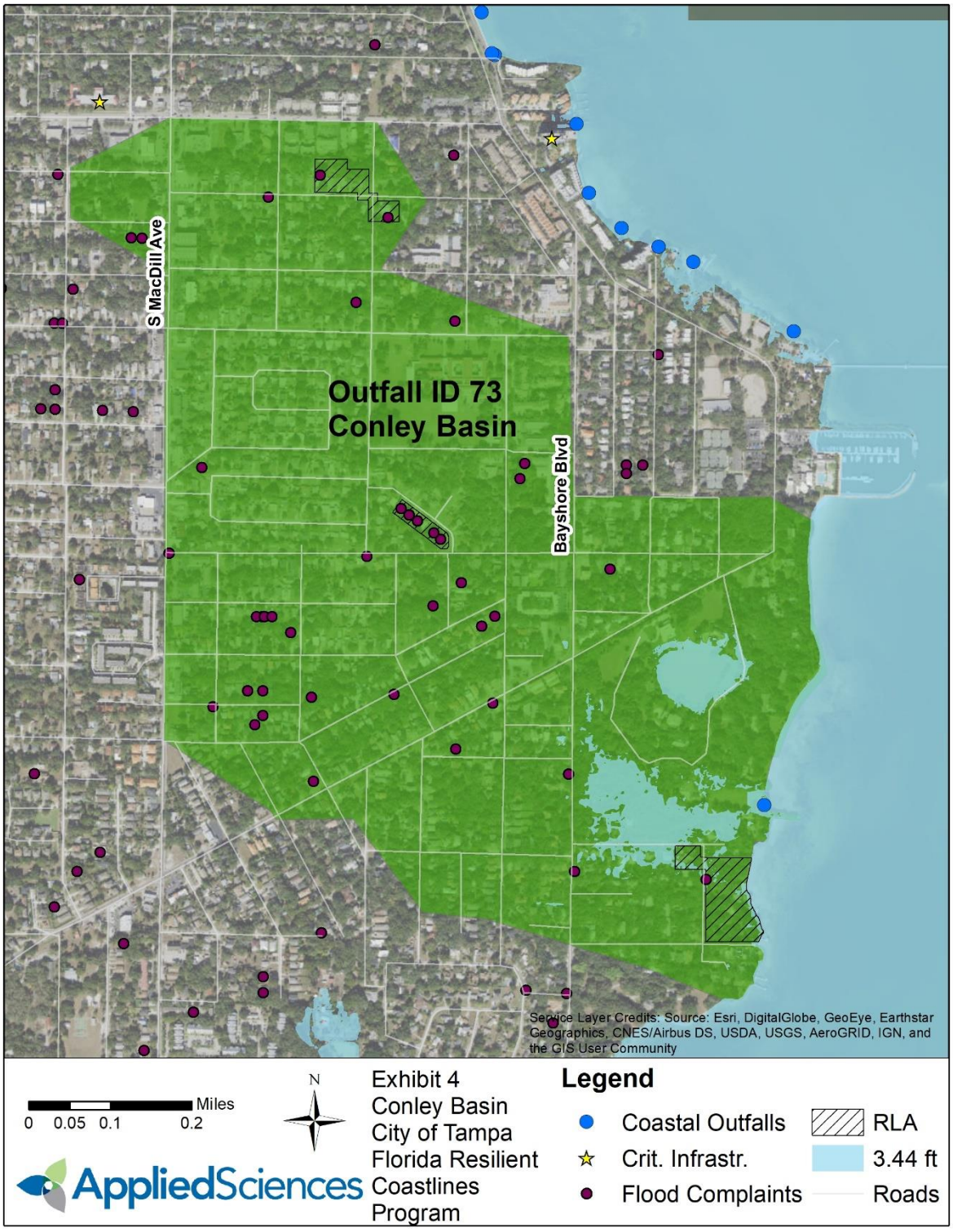
Roads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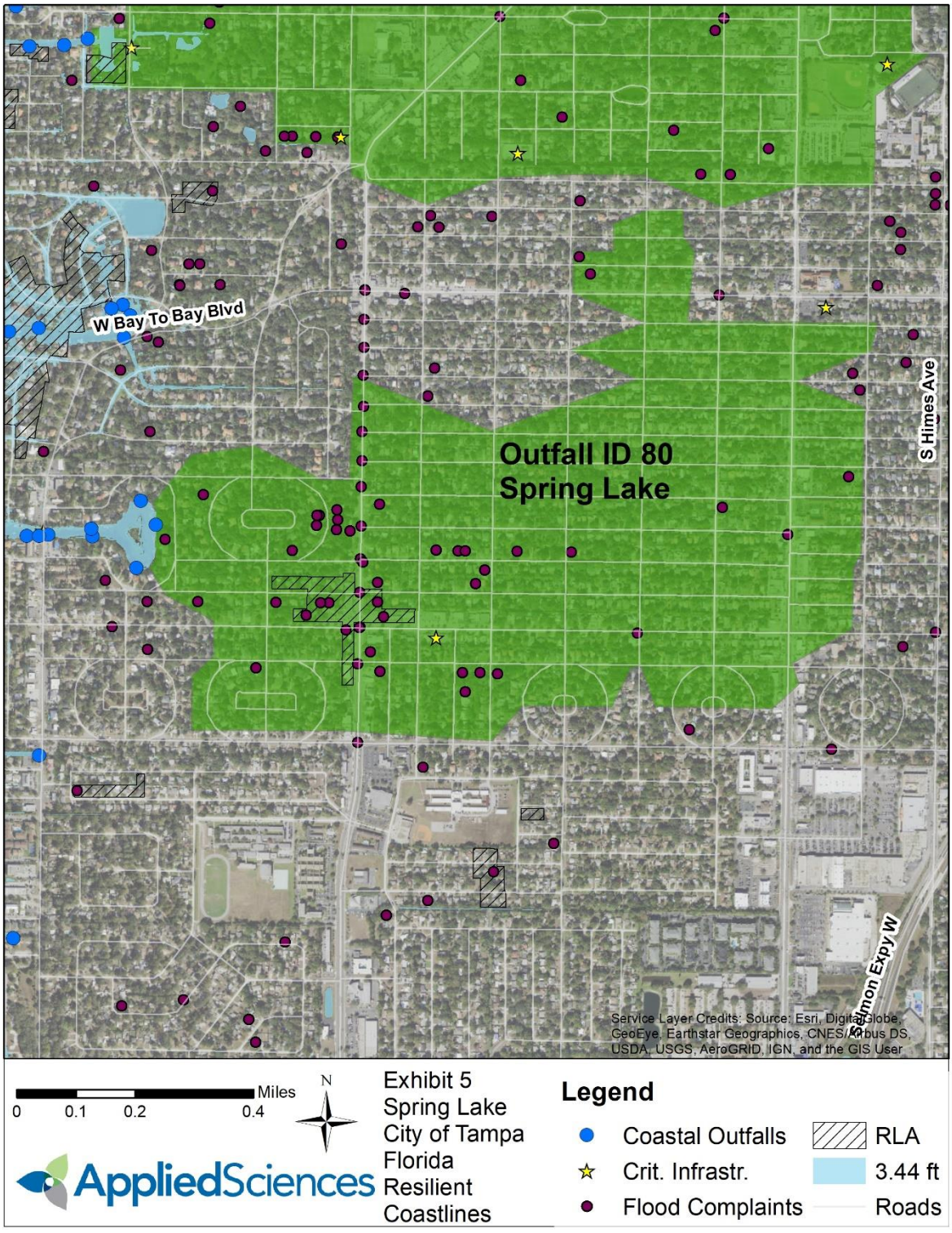
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Exhibit 5
Spring Lake
City of Tampa
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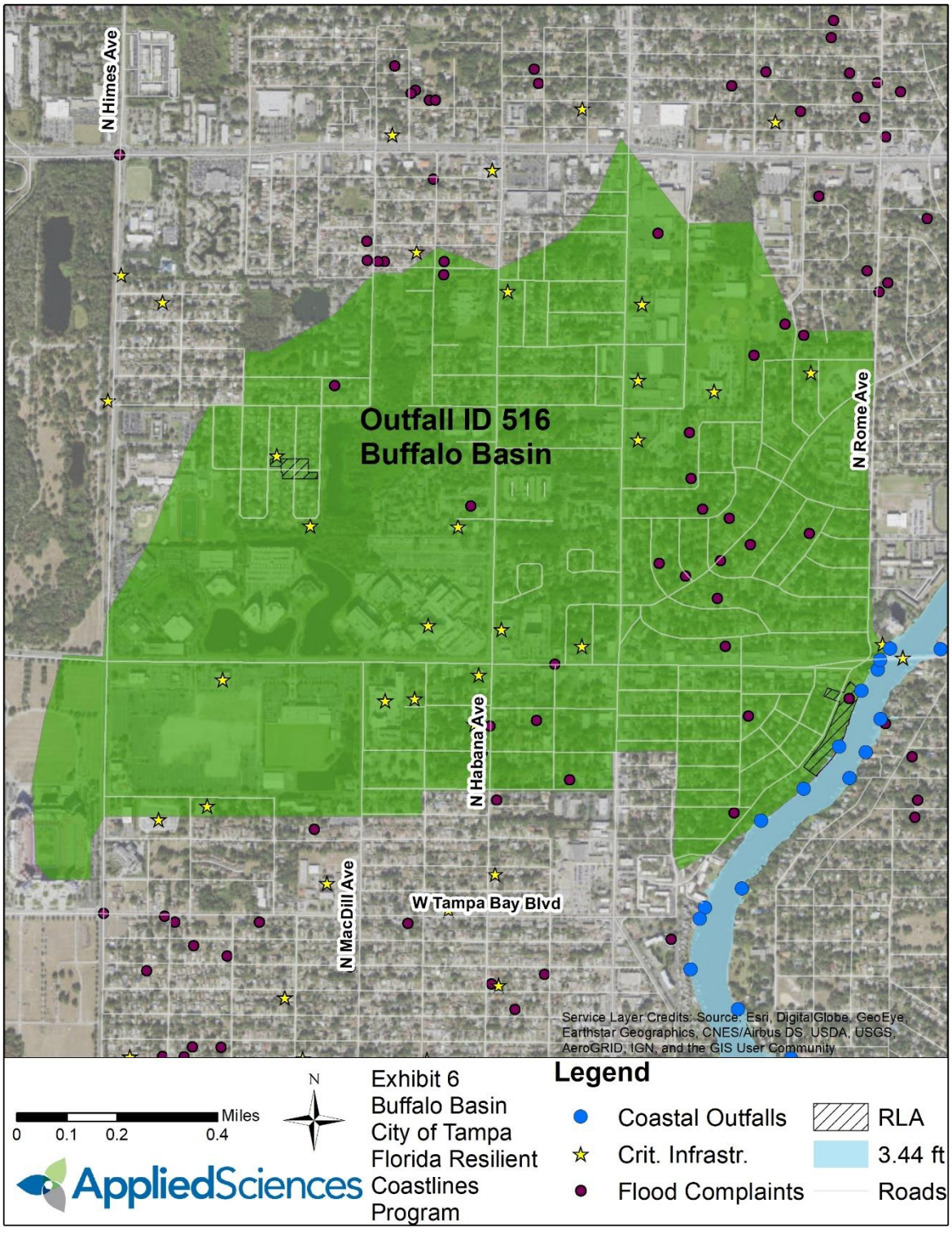
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Exhibit 6
Buffalo Basin
City of Tampa
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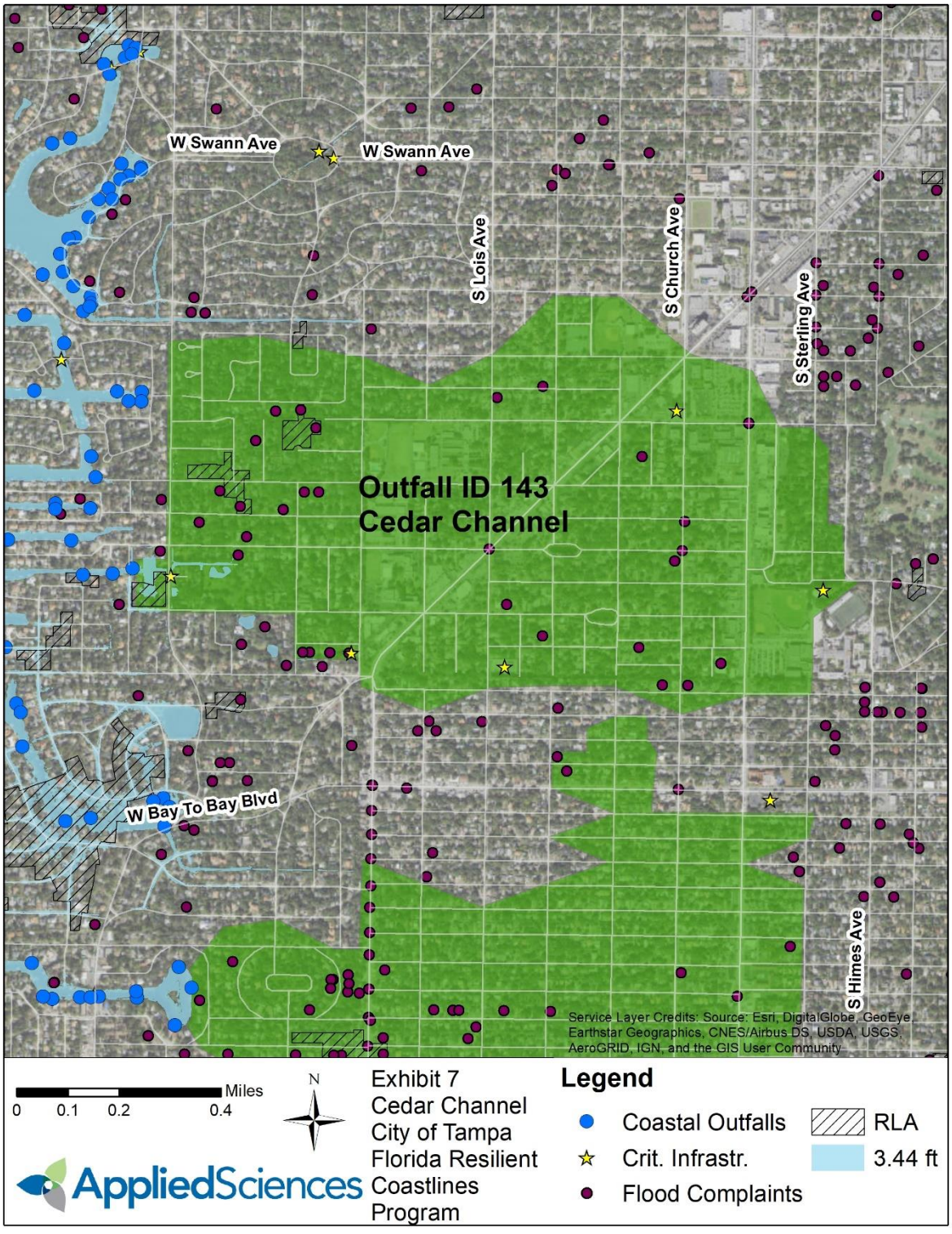
Roads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Cedar Channel
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AppliedSciences
Exhibit 7
Cedar Channel
City of Tampa
Florida Resilient
Coastlines
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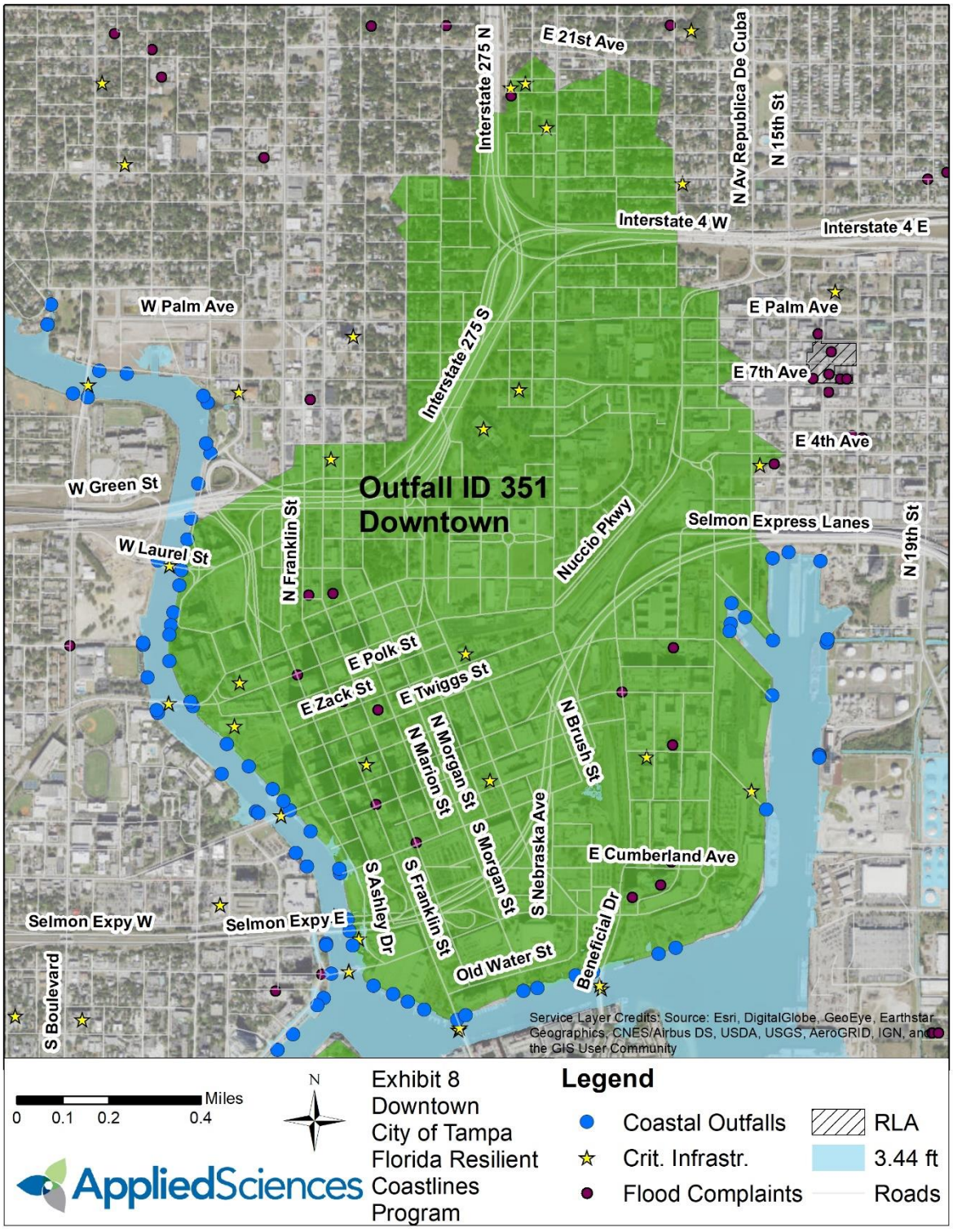
Outfall ID 351
Downtown
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Interstate 275 N
N Av Republica De Cuba
N 15th St
Interstate 4 W
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W Palm Ave
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E 7th Ave
E 4th Ave
W Green St
N Franklin St
Nuccio Pkwy
Selmon Express Lanes
N 19th St
W Laurel St
E Polk St
E Zack St
E Twiggs St
N Marion St
N Morgan St
N Brush St
S Morgan St
S Nebraska Ave
E Cumberland Ave
S Ashley Dr
S Franklin St
Selmon Expy W
Selmon Expy E
Old Water St
Beneficial Dr
S Boulevard
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Exhibit 8
Downtown
City of Tampa
Florida Resilient
Coastlines
Program
AppliedSciences
Legend
Coastal Outfalls
Crit. Infrastr.
Flood Complaints
RLA
3.44 ft
Roads