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SOUTH HOWARD FLOOD RELIEF & STREETSCAPE PROJECT PRELIMINARY ENGINEERING REPORT - DRAFT

Certification

South Howard Flood Relief & Streetscape Project

Preliminary Engineering Report (PER) - DRAFT

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Client signoff

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Glossary of Terms and Acronyms

AADT	Average Annual Daily Traffic
AR	AtkinsRéalis
AREHNA	AREHNA Engineering, Inc.
BCA	Benefit-Cost Analysis
BCR	Benefit-Cost Ratio
CN	Curve Number
DBH	Diameter at Breast Height
DEM	Digital Elevation Model
ECHO	ECHO UES, Inc.
EOP	Edge of Pavement
ERP	Environmental Resource Permit
FAA	Federal Aviation Administration
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FFE	Finished Floor Elevation
FPLOS	Flood Protection Level of Service
GIS	Geographic Information System
GMP	Guaranteed Maximum Price
GPR	Ground Penetrating Radar
GWIS	Geographic Watershed Information System
H&H	Hydrologic and Hydraulic
HCA	Hospital Corporation of America
HCEPC	Hillsborough County Environmental Protection Commission
HGL	Hydraulic Grade Line
JMT	Johnson, Mirmiran, & Thompson, Inc.
LABINS	Land Boundary Information System
LiDAR	Light Detection and Ranging
MHHW	Mean Higher-High Water

NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NCAT	NGS Coordinate Conversion and Transformation Tool
NEXRAD	Next Generation Weather Radar
NGS	National Geodetic Survey
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
PBS&J	Post, Buckley, Schuh & Jernigan
PCM	Proposed Conditions Model
PER	Preliminary Engineering Report
RCP	Reinforced Concrete Pipe
RECM	Revised Existing Conditions Model
ROW	Right of Way
SHFR	South Howard Flood Relief
SWFWMD	Southwest Florida Water Management District
THEA	Tampa Hillsborough Expressway Authority
UCM	Ultimate Conditions Model
USACE	United States Army Corps of Engineers
UPWM	Upper Peninsula Watershed Model
USDA	United States Department of Agriculture

Executive Summary

The Parkland Estates and Palma Ceia Pines neighborhoods of South Tampa have experienced severe and widespread flooding for decades due to the area's topography and antiquated stormwater infrastructure which conveys excess runoff produced by rainfall several miles to both Old Tampa Bay and Hillsborough Bay. **This flooding results in significant property damage and renders roadways impassable, jeopardizing the health, safety, and welfare of the public during heavy rainfall events.** The Palma Ceia Pines neighborhood includes Hospital Corporation of America (HCA) Florida South Tampa Hospital and medical offices, which are severely impacted by flooding conditions that temporarily eliminate access to these services, jeopardizing the lives of patients.

This topographically depressional low area, which can be visualized as a large bowl, includes the central and eastern portions of Parkland Estates and Palma Ceia Pines, bounded to the north and south by W Kennedy Blvd and W Morrison Ave, respectively, and to the east and west by S Howard Ave and S MacDill Ave, respectively. This topographic bowl's existing stormwater infrastructure (primarily underground pipes and structures) currently drains through three separate outfalls into the bays that surround the South Tampa peninsula. **The stormwater infrastructure is aging and severely undersized by current design standards to handle the present-day development density.** Due to these deficiencies, low-lying roadways and land within these two neighborhoods, and within adjacent neighborhoods, flood when the stormwater infrastructure is overwhelmed by heavy rainfall.

The South Howard Flood Relief (SHFR) project is a City of Tampa (the City) progressive design-build project that aims to alleviate the severe flooding that occurs in these neighborhoods by providing a new large stormwater conveyance system that uses gravity to efficiently move millions of gallons of stormwater runoff into Hillsborough Bay. **The goal of this project is to ensure that roadways are passable during the 5-year/8-hour design storm event, which has a total rainfall accumulation of 5.3 inches** within an 8-hour period. For reference, this design storm event is very similar to what was observed in this area on August 1st, 2015. A photo of that event, taken at W Parkland Blvd (looking northeast toward W Swann Ave) is shown in **Figure 1** and illustrates the magnitude of flooding due to rainfall that this project will be designed for.

Unfortunately, providing enough storage within stormwater vaults or ponds to mitigate flooding for this magnitude of rainfall event is not a feasible solution. After many hydrologic and hydraulic (H&H) model iterations, a recommended solution was developed that uses the most direct and hydraulically efficient route to move stormwater runoff into the bay. This includes the construction of approximately 6,000 linear feet of large box culvert trunkline, which functions as a primary artery for stormwater conveyance and will receive runoff from smaller secondary stormwater collection systems that will alleviate flooding at peripheral locations.

Figure 1 – Flooding in Parkland Estates on August 1, 2015 after approximately 5.4 inches of rainfall

Existing Conditions Model Analysis

Before analyzing potential alternative solutions, ensuring that the existing conditions H&H model simulates known flooding events associated with the current stormwater collection system is essential. A detailed H&H model update was performed by this project's design-build team, Kimmins Contracting (builder) and AtkinsRéalis (designer). This effort began by building upon the City's Upper Peninsula Watershed model (UPWM) and the planning-level feasibility study performed by an engineering consulting firm, JMT. AtkinsRéalis reviewed in detail both the UPWM and the JMT feasibility study, along with the area's current H&H conditions, to develop a comprehensive and updated revised existing conditions model (RECM) that accurately reflects flooding within Parkland Estates and Palma Ceia Pines along with surrounding neighborhoods within the study area.

This RECM serves as an appropriate tool to analyze the new conveyance system needed to meet the project's flood reduction goals. The model was calibrated and verified by simulating two actual rainfall events observed in 2024 and comparing the model results to observed flooding documented during and after those respective events. The model results aligned extremely closely with what was observed and documented. The development, calibration and verification of the RECM is discussed in detail in **Section 4** of this report. **Figure 2** below provides a map that depicts the following:

1. **SHFR RECM Extents –** approximately 3,500 acres – the geographic limits of the project's H&H model, which performs H&H calculations to predict flood stages (water surface elevations) and flood durations during simulated rainfall events.
2. **SHFR Model Update Area –** approximately 1,000 acres – the area that was thoroughly evaluated for accuracy to ensure the project design is based on a defensible model. H&H conditions were updated throughout this area to reflect the latest available data, which is discussed in **Sections 2 through 4** of this report.
3. **JMT Feasibility Study Drainage Area –** approximately 260 acres – as defined by the JMT report, *"the drainage area likely to see the most significant benefits from the selected alternative"* (selected alternative refers to the JMT feasibility study's recommended alternative).
4. **SHFR Flood Reduction Focus Area** – approximately 225 acres – "The bowl". It is the basis of the project's detailed focus and design. The box culvert trunkline was sized to achieve the flood reduction goal within this area, as this is the most severe concentration of flooding within the model limits.

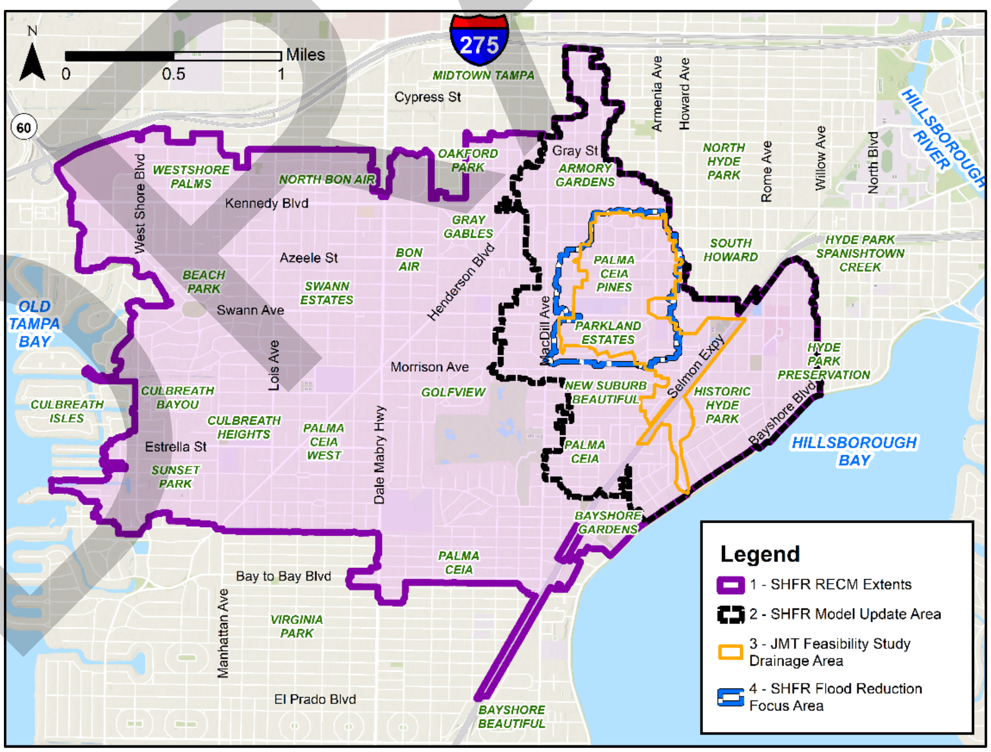

Figure 2 – H&H Model Update Area Map

The drainage basins that make up the SHFR Flood Reduction Focus Area have been studied for decades, and conceptual solutions to flooding issues have been developed as part of these studies, which are discussed in **Section 2.1** of this report. However, what the previous studies lack is a complete understanding of the interaction of stormwater between drainage basins, which creates a larger and more complicated flooding issue than previously thought. The SHFR project's preliminary engineering study documented in this report has identified this complex problem and has developed a comprehensive solution.

Figure 3 below shows the RECM's predicted flood extents for the 5-year/8-hour design storm in today's existing condition. **It is important to note that the flood extents shown below assume that the existing stormwater infrastructure is in a fully maintained condition.** Even in this maintained condition the depth of water over the roadways reaches up to 4 feet in places within Palma Ceia Pines and Parkland Estates.

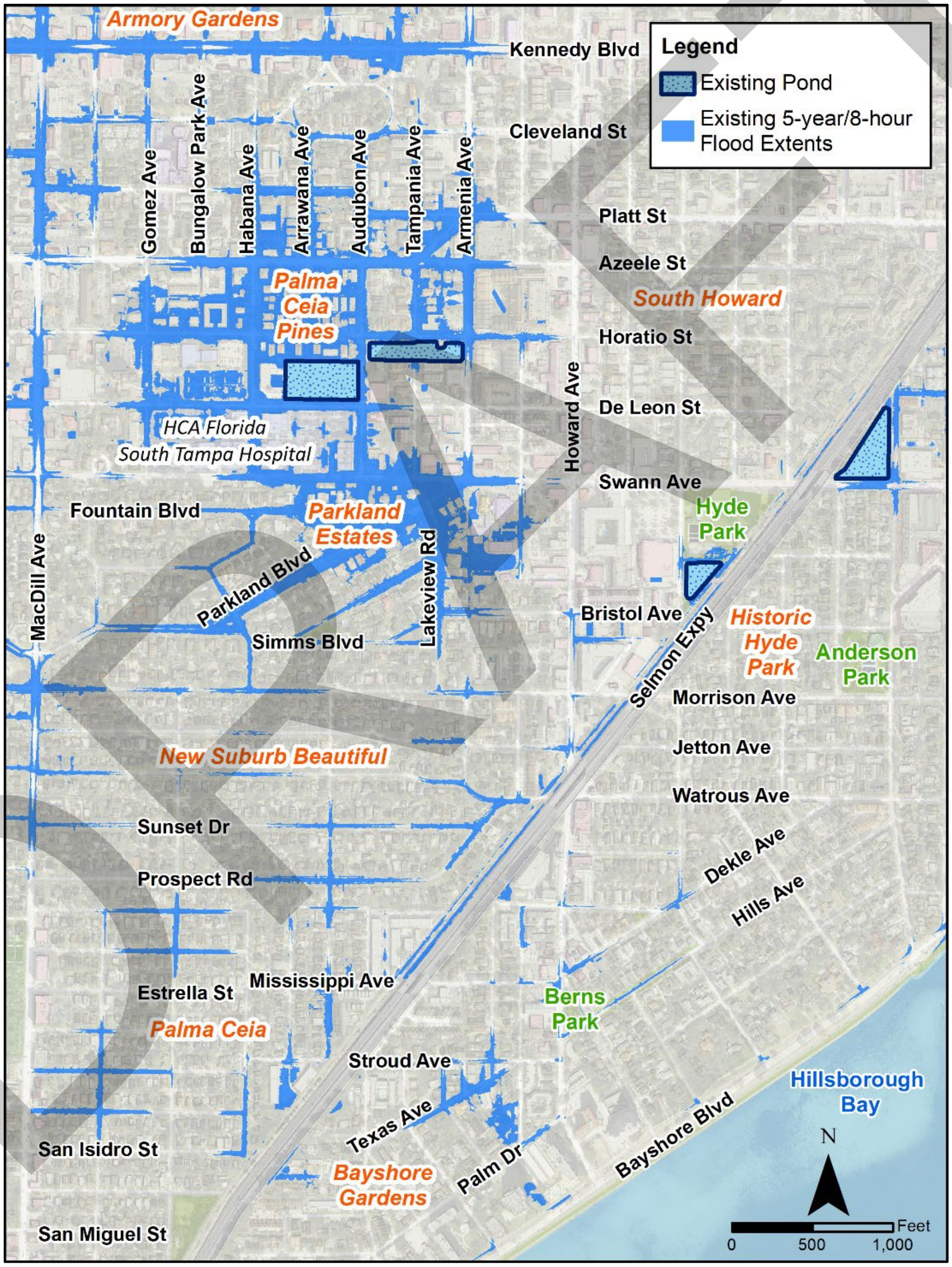

Figure 3 – Existing 5-year/8-hour Flood Extents

Proposed Conditions Model Analysis and Flood Reduction Benefits

The RECM serves as a base model to develop numerous iterations of proposed conditions models that optimize the configuration of new stormwater infrastructure so that the project's flood reduction goals can be met in a hydraulically efficient, cost-effective manner. These alternative flood reduction solutions began with the proposed system recommended in the project's Design Criteria Package (a 5'x10' box culvert terminating at W Swann Ave & S Audubon Ave, based on the JMT feasibility study) and progressed into larger box culvert sizes that extended further north, providing equity of flood reduction benefits between Parkland Estates and Palma Ceia Pines. Through this analysis, the design team arrived at a solution that will significantly reduce rainfall-induced flooding in both Parkland Estates and Palma Ceia Pines, along with other neighborhoods like South Howard, Historic Hyde Park, New Suburb Beautiful, Palma Ceia, and Bayshore Gardens.

The goal of this project is a flood reduction solution that limits flood depths for the 5-year/8-hour design storm event (5.3 inches of rainfall) to a maximum of 4 inches of water depth over the lowest edge of pavement (EOP) – a condition where roadways are considered passable for vehicles, and most notably emergency response vehicles. This goal is referred to as the project's flood protection level of service (FPLOS) and has been applied throughout the project's 225-acre Flood Reduction Focus Area, among other flood-prone areas adjacent to the project route. **Although the proposed infrastructure has been sized to reduce roadway flooding for the 5-year design storm, it will also significantly reduce structure flooding and duration of roadway flooding for a range of more severe rainfall events.** In fact, the model simulations documented in this report suggest that the project will provide the additional benefit of substantial flood reduction during higher precipitation events up to and beyond the 100-year/24-hour design storm (important for insurance and regulatory considerations). This includes storms like Hurricane Milton, which devastated the area in 2024. The project will also provide noticeable flood reduction benefits to adjacent areas within the model's geographic limits that are outside of the SHFR Flood Reduction Focus Area.

Table 1 and **Table 2 below summarize the predicted existing flood impacts and anticipated reduction in roadway and structure flooding provided by all phases of the project** for a wide range of potential rainfall events. These values are predicted using the project's detailed H&H models, recently surveyed finished floor elevations for over 200 buildings (which include over 400 individual first floor homes and businesses) within Parkland Estates and Palma Ceia Pines, and the latest available (2017) Light Detection and Ranging (LiDAR)-based digital elevation model (DEM). The data in the table includes all proposed infrastructure shown in **Figure 4**. Although Hurricane Milton's rainfall totals and flood stages were greater than those of the 100-year/24-hour design storm (synthetic rainfall event used for insurance and regulatory considerations), the Hurricane Milton proposed conditions model results show greater flood protection due to an overall less intense distribution of rainfall.

Table 1 – Summary of Existing Condition Flood Impacts

Flood Impact	2.33-year/ 24-hour Design Storm (4.5 inches)	5-year/ 8-hour Design Storm (5.3 inches)	10-year/ 24-hour Design Storm (7.0 inches)	25-year/ 24-hour Design Storm (8.0 inches)	50-year/ 24-hour Design Storm (10.0 inches)	100-year/ 24-hour Design Storm (11.0 inches)	Hurricane Milton (13-14.5 inches*)
Existing Number of Homes/Businesses Inundated**	0	96	123	203	255	272	333
Existing Duration of Roadway Flooding on W Swann Ave at S Audubon Ave (hours)	6	8	10	12	14	15	19
Existing Max. Depth of Roadway Flooding, Parkland Estates (feet)	3.2	4.0	4.3	4.6	4.9	5.1	5.4
Existing Max. Depth of Roadway Flooding, Palma Ceia Pines (feet)	1.9	2.5	2.9	3.2	3.5	3.7	4.0

*Hurricane Milton rainfall totals vary across the model's geographic limits, and were estimated by radar (source: NEXRAD)
**Includes total number of ground floor dwellings, including single family homes, businesses, and individual apartment or townhome units, within the 206 specific buildings surveyed in 2025 by the design-build team, as predicted by the RECM, and has not been otherwise verified.
Note: All values in the table are predicted using H&H model results and have not been field verified after observed rainfall events.

Table 2 – Summary of SHFR Project's Flood Reduction Benefits

Flood Reduction Benefit	2.33-year/ 24-hour Design Storm (4.5 inches)	5-year/ 8-hour Design Storm (5.3 inches)	10-year/ 24-hour Design Storm (7.0 inches)	25-year/ 24-hour Design Storm (8.0 inches)	50-year/ 24-hour Design Storm (10.0 inches)	100-year/ 24-hour Design Storm (11.0 inches)	Hurricane Milton (13-14.5 inches*)
Proposed **Reduction** of Inundated Homes/Businesses**	N/A	96	123	198	197	164	235
% Reduction of Inundated Homes/Businesses**	N/A	100%	100%	98%	77%	60%	71%
Proposed Duration of Roadway Flooding on W Swann Ave at S Audubon Ave (hours)	0	0	1	2	3	4	4
Proposed **Reduction** of Roadway Inundation (miles)	6.0	8.1	5.0	4.6	3.9	3.3	4.6

*Hurricane Milton rainfall totals vary across the model's geographic limits, and were estimated by radar (source: NEXRAD)
**Includes predicted total number of ground floor dwellings, including single family homes, businesses, and individual apartment or townhome units, within the 206 specific buildings surveyed in 2025 by the design-build team.
Note: Benefits reflect all proposed improvements in **Figure 4** below. Additional future projects that reduce runoff to this area could further increase these benefits. All values in the table are predicted using H&H model results and have not been field verified after observed rainfall events.

Figure 4 shows the project's reduction in flood extents for the 5-year/8-hour design storm. The purple shading represents existing flooding extents predicted by the model that would be eliminated during the same storm event once all phases of the project shown in the figure are complete.

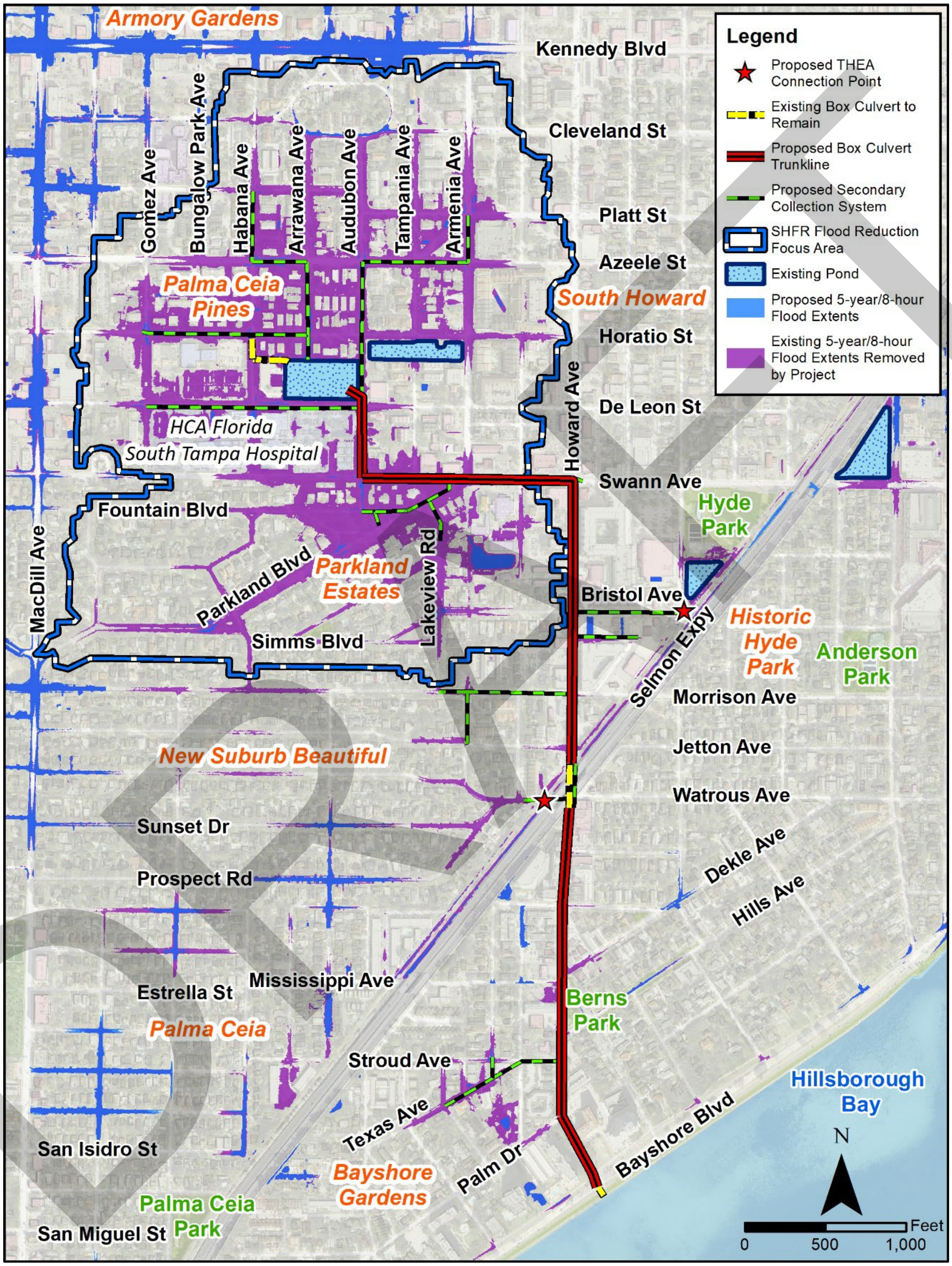

Figure 4 – 5-year/8-hour Proposed Flood Extents Reduction

Alternatives Analysis Findings

Although **Figure 4** on the previous page shows the recommended solution and associated flood reduction benefits, there were numerous potential alternatives evaluated as part of this study to ensure that the most hydraulically efficient, cost effective, and reliable solution is designed and constructed. The design-build team took into consideration input and suggestions from the community while evaluating potential options. All other potential alternatives evaluated were deemed to not be as prudent as the selected alternative for reasons such as increased construction cost and construction duration, constructability concerns, inability to meet the project's flood reduction goal, and lack of available real estate. **Section 5.4** of this report provides a more detailed discussion of all the alternatives reviewed for this project.

Based on the H&H model results and alternatives analysis, the following key conclusions have been drawn:

- While stormwater maintenance issues certainly can exacerbate flooding, **maintenance-based solutions alone will not fix the chronic flooding that occurs within Parkland Estates and Palma Ceia Pines – it is a conveyance capacity issue.** The calibrated RECM, which predicts flooding that very closely resembles what was observed and documented for actual recent rainfall events, assumes that existing stormwater pipes, ditches and ponds are clear and maintained so that proposed infrastructure can be sized adequately. Even under this assumption, severe flooding is still predicted, supporting the conclusion that **the existing stormwater infrastructure is simply antiquated and severely undersized for the current level of development.**

- **A regional storage alternative (stormwater pond or vault)** of adequate size and depth to manage the modeled flood volumes **is not feasible** given the region's natural topography, lack of available real estate, extremely large volumes of stormwater, and anticipated groundwater conditions. In addition, constructing an adequately sized regional storage facility would displace hundreds of residents and significantly reduce housing stock.

- **A new large stormwater conveyance system and connection to the bay is needed** to move millions of gallons of stormwater from the SHFR Flood Reduction Focus Area into Tampa Bay to effectively reduce flooding in Parkland Estates and Palma Ceia Pines.

- Even though its storage capacity is extremely inadequate, the **City-maintained AMI detention pond can serve as a massive stormwater inlet for Palma Ceia Pines**, directly discharging through the 10'x10' box culvert trunkline while using a new weir structure to maintain the pond's existing stormwater treatment capabilities. This reduces the number of additional inlets needed to receive the significant runoff rates anticipated during extreme rainfall events.

- **Sending stormwater runoff to Hillsborough Bay is a shorter (~ 1 mile) and more direct and hydraulically efficient route than continuing to send water west into Old Tampa Bay (~ 2.5 miles)** through a densely developed area that already experiences flooding due to overburdened and antiquated stormwater infrastructure.

- **A gravity system is preferred over a pump station and force main outfall** because it significantly reduces operation and maintenance costs. A gravity system would also mitigate the risk of a pump-based alternative system failing due to power outage or storm damage when it is needed most – during severe storm events, such as Hurricane Milton. In addition, it is extremely difficult for pumping systems to keep up with the large volume of runoff anticipated in high-intensity rainfall events and a large pump station would bring permanent noise and aesthetic impacts to the surrounding residential area.

- **A pump station** would likely not reduce construction impacts to stakeholders along the project route since it **requires a pressurized outfall pipe that is similar in size to the selected gravity alternative** in order to safely discharge flow rates needed to achieve the project's goal.

- **A significant amount of stormwater runoff enters Palma Ceia Pines from Armory Gardens (north of Kennedy Blvd)** when undersized existing pipes designed to convey water to the west become overwhelmed, and the excess runoff flows south over several roadway corridors toward Kennedy Blvd.

- **Constructing a gravity system that reaches Hillsborough Bay to the east of South Howard Ave would have significant challenges** such as conflict with a 48-inch sanitary sewer force main, significant traffic impacts to Bayshore Blvd and Davis Islands due to construction of a new outfall, increased construction cost and duration due to longer route, and limited conveyance beneath the railroad and Selmon Expressway.

- Given the ground elevations within the project's corridors (generally 15 to 21 feet above sea level), **a gravity system will still be hydraulically effective during high tides and storm surge events**, such as that of Hurricane Helene in 2024. In fact, the project's models already assume a conservative and constant tidal stage of elevation 2.0 (ft, NAVD88) in the design storm simulations, which is about a foot higher than a normal high tide for Hillsborough Bay (per NOAA data for Ballast Point, Station 8726639).

To expand upon the key conclusion above, and to further demonstrate the hydraulic efficiency of the proposed project during storm surge events, the proposed conditions model was simulated with a constant Tampa Bay water surface elevation of 8.0 (ft, NAVD88), which is the estimated peak surge elevation observed in Hillsborough Bay and Old Tampa Bay during Hurricane Helene in 2024 according to NOAA tide gauge data. The flood reduction benefits observed in that model simulation are extremely significant, showing that even when Hillsborough Bay is at a surge elevation of 8 feet, the proposed project **still reduces peak stages in Parkland Estates by approximately 3 feet during a 5-year/8-hour rainfall event. This occurs even while Bayshore Blvd is fully submerged by the bay**. This is because 7 feet or more of hydraulic head, which can be thought of as energy available to push water through the culvert, is enough to force a large volume of stormwater runoff from Parkland Estates into the elevated bay in a relatively short amount of time.

This can be thought of as two separate bowls of water, connected by a straw (representing the proposed box culvert) at their bottoms – as long as the water surface in one bowl (Parkland Estates and Palma Ceia Pines) is higher than the water surface in the other (Hillsborough Bay), gravity is going to force water through the straw until the water levels in each bowl are equal. A catastrophic storm surge of 15 to 20 feet would have to occur for Hillsborough Bay to come back through the system and flood these neighborhoods. This would also happen in today's condition through the three existing stormwater trunklines that connect Palma Ceia Pines to Old Tampa Bay and Hillsborough Bay.

Evaluation of Alternatives

This Preliminary Engineering Report (PER) includes a comprehensive analysis of predicted flood stages and durations for a spectrum of rainfall events and evaluates alternative solutions that address FPLOS deficiencies within the study area. The report provides a comparative analysis of the three primary alternatives specified in the project scope that includes flood reduction benefit, project cost, and impacts to affected stakeholders. The report also comparatively evaluates the feasibility of numerous other solutions proposed as alternatives to the three primary alternatives. This is discussed in more detail in **Section 5** of this report.

The three primary alternatives analyzed in this report are listed below, in an order that does not reflect priority or ranking of the routes:

1. Alternative 1 – W Morrison Ave to S Howard Ave
2. Alternative 2 – W Bristol Ave to S Howard Ave
3. Alternative 3 – W Swann Ave to S Howard Ave

The three primary alternatives each use South Howard Avenue for several reasons:

- Minimize total length of box culvert needed between the area of flooding concern and Hillsborough Bay – this not only significantly reduces cost but provides a more direct and hydraulically efficient pathway to move runoff from Palma Ceia Pines and Parkland Estates to Hillsborough Bay, in comparison to other potential alternatives.
- Use existing box culverts already in place beneath the CSX railroad, Selmon Expressway, and Bayshore Boulevard – this reduces cost and duration of permitting and construction. It also avoids construction of a new discharge point into Hillsborough Bay that would require a temporary shutdown of the northeast bound lanes of Bayshore Boulevard, along with a costly vertical relocation of a 48” sanitary sewer force main.

Other alternatives suggested by various community members and evaluated by the design-build team – further discussed in Section 5.4 and Appendix M – include the following:

- **W Swann Ave Gravity System** – a large box culvert system that uses W Swann Ave only to reach Bayshore Blvd and Hillsborough Bay. **This alternative is 30% longer** than the selected route and comes with hurdles that would **significantly increase construction costs and duration**, such as the need to relocate an existing 48-inch diameter sanitary sewer force main and the need for a new outfall into Hillsborough Bay, which would result in significant traffic impacts on vehicles entering Davis Islands. **This alternative simply shifts temporary construction impacts to another group of businesses and residents and requires much more money to achieve the same flood reduction goal, lowering the project’s benefit-cost ratio substantially.**
- **Stormwater Detention Ponds only (no new conveyance system)** – This alternative converts the lowest portions of Parkland Estates and Palma Ceia Pines into stormwater ponds which use existing pipe systems to discharge excess stormwater to the bay, eliminating the need for a new conveyance system. This alternative is not realistic, as **it would displace hundreds of residents and would require eminent domain to purchase over 200 properties**, which have an estimated combined value of over $150 million.
- **Parkland Estates Stormwater Pump Station –** A pump alternative located within the green space along W Fountain Blvd and W Parkland Blvd (instead of a large box culvert) would require a massive pump station with a discharge capacity of 600 cubic feet per second (CFS), and a 10-foot diameter force main pipe that connects Parkland Estates to Hillsborough Bay, resulting in **similar construction impacts along S Howard Ave** (or an alternative route). Along with an increase in construction costs, this alternative would result in **permanent noise impacts, higher operation and maintenance costs (including power consumption) and would have a much higher risk of failure due to loss of power when it is most needed** – during severe storms like Hurricane Milton.
- **Hyde Park Softball Field Stormwater Pump Station –** Even if this City-owned park were to be converted into a massive 3-acre underground storage vault at depths over 20 feet below ground, a large stormwater pump station with a 300 CFS capacity pump station would be needed, along with a new 7-foot diameter force main pipe that somehow reaches Hillsborough Bay. Concerns with the Parkland Estates pump station alternative apply here

as well. **Another downside of a pump alternative is that no additional drainage improvements can be included along the force main route downstream of the pump station, while a gravity system provides opportunity for smaller projects to "tap in" later.**

- **Box Culvert or Force Main along CSX railroad and Selmon Expressway –** There is simply **not enough space available between the railroad and the Selmon Expressway** to construct a conveyance system large enough to meet the project's flood reduction goal. If there were enough space (if CSX were to donate their right of way, for example), this would still **increase the project length by 80%,** resulting in a much more expensive and less hydraulically efficient system when compared to the selected alternative.
- **S Georgia Ave to W Mississippi to S Howard Ave Gravity System –** This route is 30 percent longer than the selected alternative, increasing construction costs and duration substantially. It also has significant constructability challenges due to large and deep box culvert installation through narrow, residential streets within the Parkland Estates, New Suburb Beautiful, and Palma Ceia neighborhoods.
- **W Morrison Ave to S Rome Ave -** This route is 20 percent longer than the selected alternative, increasing construction costs and duration substantially. Like the S Georgia Ave/Mississippi alternative, it also has significant constructability challenges due to large and deep box culvert installation through narrow, residential streets within the Parkland Estates and Historic Hyde Park neighborhoods. Like the W Swann Ave gravity alternative, this would also require temporary shutdown and relocation of the large 48-inch diameter sanitary sewer force main along S Rome Ave.
- Other project alternatives that were previously studied by the City (as documented in the 2022 JMT report) were evaluated at a high level to assess feasibility. None of these options are considered both feasible **AND** adequately sized to meet the project's flood reduction goal.

Based on the detailed analysis of the three primary alternative routes, along with evaluation of feasibility and constructability of other alternative routes proposed by both previous studies and the community, **Alternative 3 has been selected because it has the lowest capital costs, the shortest duration of construction, and is the least impactful to the environment while meeting the project's flood reduction goal within Parkland Estates, Palma Ceia Pines, and areas adjacent to the project limits**. A comparative analysis of the three primary alternatives can be found in **Section 5.3.**

Project Phasing

The overall conceptual design has been sized to meet the flood reduction goal for the entire SHFR Flood Reduction Focus Area, as well as other specific areas adjacent to the project route that have localized flooding issues, as shown in **Figure 4 and Figure 5**. However, due to current funding limitations, the current project scope does not include formal design and construction of all secondary stormwater collection systems needed to achieve that goal. **Therefore, for the purposes of this report, components of the overall solution will be separated into two phases, as shown in Figure 5:**

1. **Phase I** – 10'x10' primary box culvert trunkline between Bayshore Blvd and the AMI stormwater detention pond, secondary stormwater collection system within Parkland Estates and at each intersection along the project route, and connection points for the Selmon Expressway project. Pipe stub-outs from the Phase I system will be provided at specific locations where a future secondary collection system extension has been modeled, as discussed in **Section 5.1.**
2. **Future Phases** – Secondary stormwater collection systems needed to achieve FPLOS goal for specific roadways and intersections. This includes Palma Ceia Pines and identified flood-prone areas adjacent to South Howard Ave between W Swann Ave and Bayshore Blvd.

The future phase collection systems have been sized through H&H modeling to meet the FPLOS goal, and their locations are shown in green in **Figure 5** below. These secondary systems will be reevaluated and refined based on detailed survey, geotechnical investigations, and subsurface utility exploration in a subsequent evaluation and design phase.

During this later design phase, it is anticipated that opportunities to intercept the overland stormwater flows that currently enter Palma Ceia Pines from north of W Kennedy Blvd will be evaluated to reduce flooding along W Kennedy Blvd and within Palma Ceia Pines. Intercepting these flows could significantly reduce the size and extents of the secondary collection systems needed in Palma Ceia Pines to meet the project's FPLOS goal throughout the SHFR Flood Reduction Focus Area. **However, even if all overland flows are intercepted north of W Kennedy Blvd before reaching Palma Ceia Pines, it will not eliminate the need for the SHFR project.**

This, along with additional value engineering, alternative construction delivery methods, and other potential future conditions resulting from other stormwater improvements projects, will likely affect the construction costs of future phase projects.

A map of the phased recommended project is shown in **Figure 5**. Key project details, findings, and assumptions are listed below:

- Includes new 10'x10' box culvert trunkline from Bayshore Blvd to the AMI detention pond, along S Audubon Ave between W De Leon St and W Horatio St.
- Existing box culverts remain in place beneath Bayshore Blvd, Selmon Expressway, and the CSX railroad.
- Additional parallel 60" pipe is to be installed beneath Selmon Expressway and CSX railroad via microtunnel.
- The route includes S Howard Ave, W Swann Ave, and S Audubon Ave corridors.
- Includes new weir that uses gravity to control water levels within and discharges from the City-maintained AMI Pond between W Horatio St, W De Leon St, S Audubon Ave, and S Habana Ave, eliminating the need for the existing pump that recovers the pond's available storage and treatment volume. The pond's primary existing outfall – a 4'x8' box culvert along W Horatio St – will remain to function as a secondary outfall.
- **Estimated Phase I Construction Cost: $92,136,452** (cost estimate is based on 30% design and can be found in **Appendix L**)
- Future project phases will include smaller stormwater trunklines throughout Palma Ceia Pines and local roads adjacent to the main trunkline's route to collect stormwater runoff and address FPLOS deficiencies.

Because the future phase systems will be smaller and shallower than the Phase I infrastructure, the City may be able to construct these systems using alternative delivery procurement methods, such as use of City construction crews and competitively bid construction contracts. A range of preliminary construction costs for these future phases, reflective of present-day dollars, have been developed by the City based on recently bid stormwater projects, and are included in **Table 5** and **Table 6.**

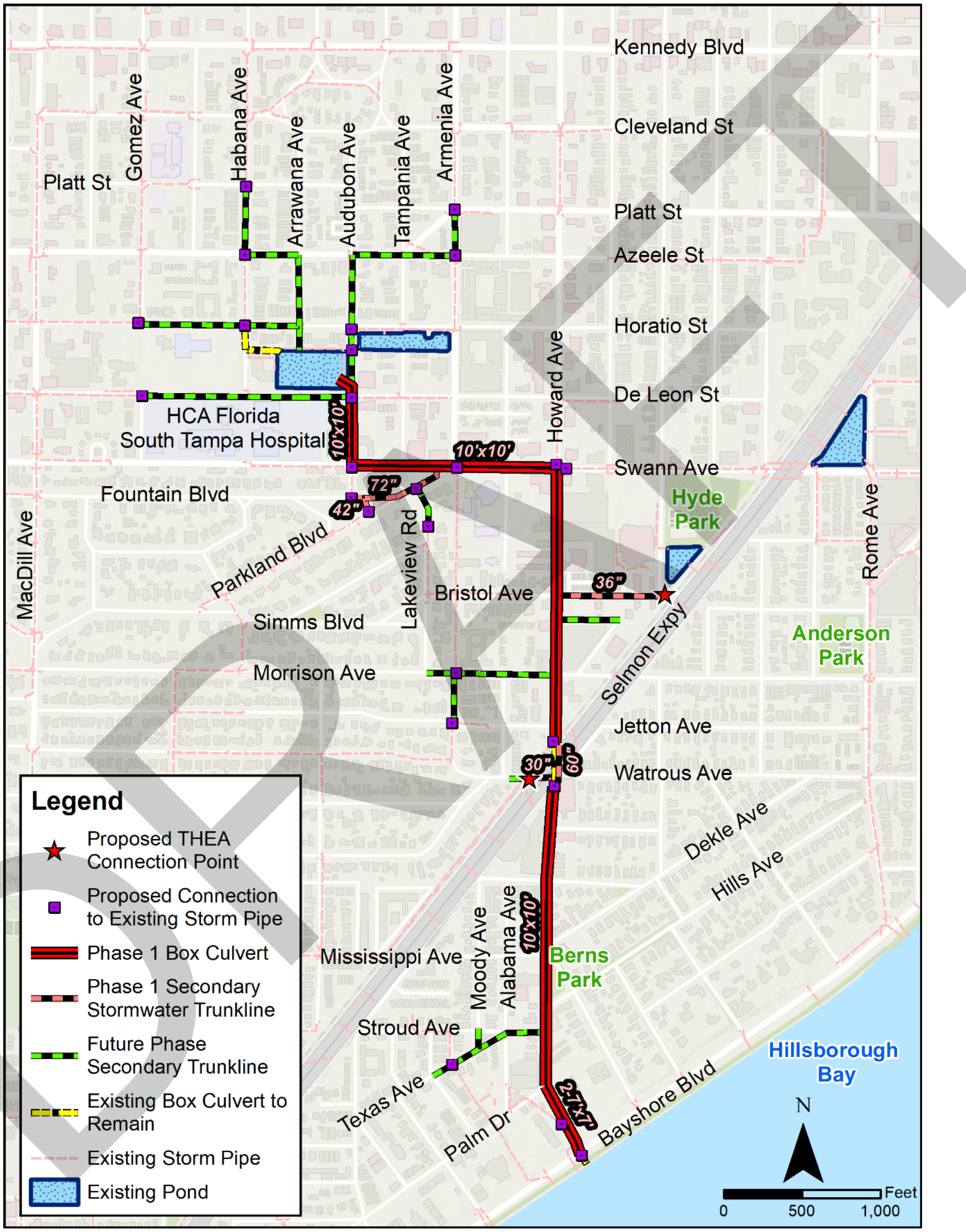

Figure 5 – Recommended Project Map

Figure 6 shows the reduction in flood extents for the 5-year/8-hour design storm **for only the Phase I project**. The purple shading represents existing flooding extents predicted by the model that would be eliminated during the same storm event once the project is complete. **What is not visible in the figure is the significant reduction in structure flooding and the reduced duration of roadway flooding after the completion of Phase I.**

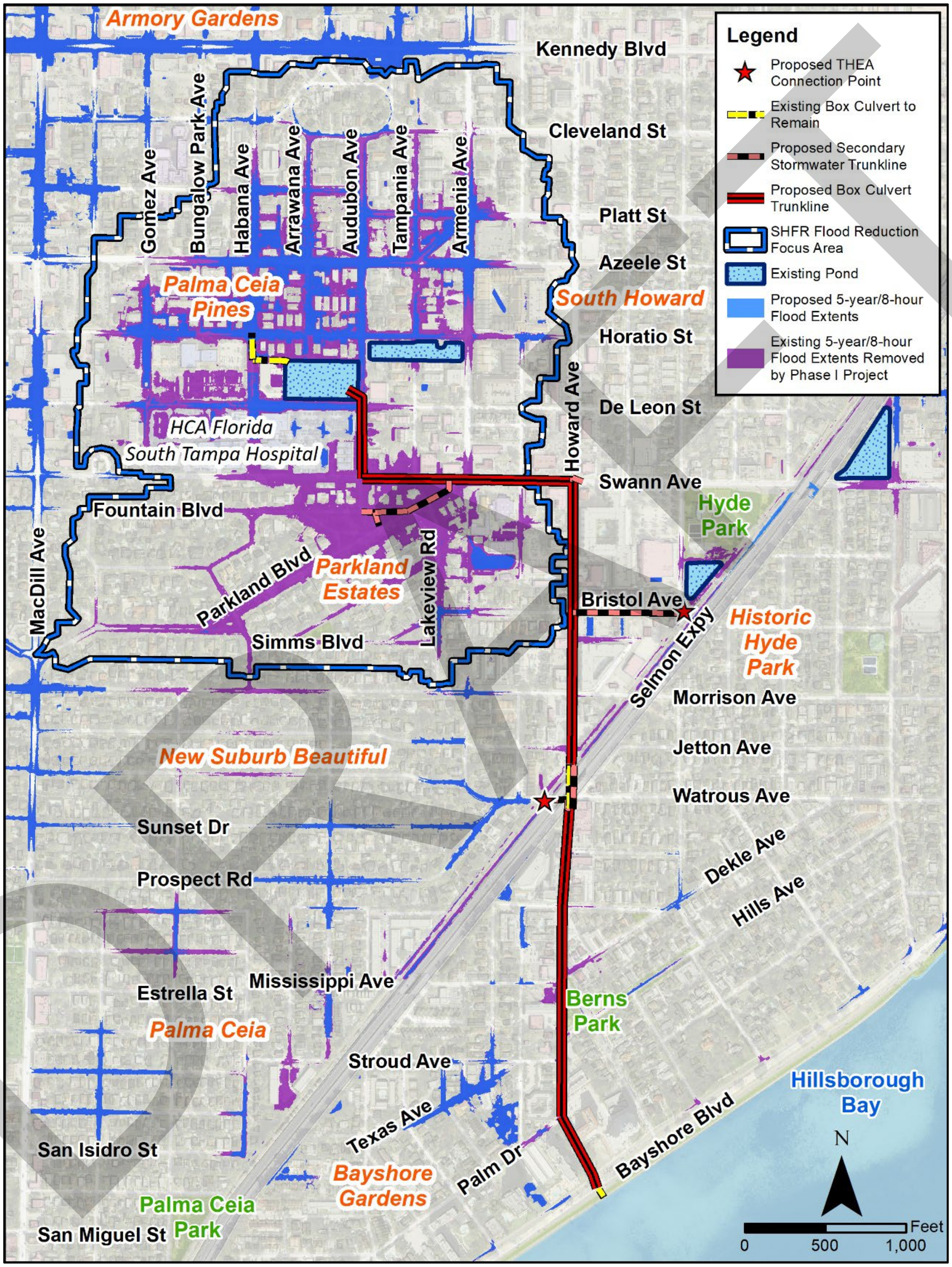

Figure 6 – Phase I - 5-year/8-hour Proposed Flood Extents Reduction

Table 3 below provides a summary of benefits anticipated after the construction of **only Phase I.** When compared to the overall solution's benefits in **Table 2**, it is apparent that **Phase I alone provides most of the structure flooding reduction. It will also significantly reduce the duration of roadway flooding both inside and outside of the SHFR Flood Reduction Focus Area.** Phase I provides the major artery needed for stormwater conveyance that future phases will connect into. These smaller future phase projects will provide a significant reduction in volume of roadway flooding that allows specific roadways and intersections to meet the FPLOS goal.

Table 3 – Summary of Proposed Phase I Flood Reduction Benefits

Flood Reduction Benefit	2.33-year/ 24-hour Design Storm (4.5 inches)	5-year/ 8-hour Design Storm (5.3 inches)	10-year/ 24-hour Design Storm (7.0 inches)	25-year/ 24-hour Design Storm (8.0 inches)	50-year/ 24-hour Design Storm (10.0 inches)	100-year/ 24-hour Design Storm (11.0 inches)	Hurricane Milton (13-14.5 inches*)
Proposed Reduction of Roadway Inundation (miles)	3.1	4.6	3.9	4.0	3.4	2.9	3.9
Proposed Reduction of Inundated Homes/Businesses**	N/A	96	113	172	183	153	225
% Reduction of Inundated Homes/Businesses**	N/A	100%	92%	85%	72%	56%	68%

*Hurricane Milton rainfall totals vary across the model's geographic limits, and were estimated by radar (source: NEXRAD)
**Includes predicted total number of ground floor dwellings, including single family homes, businesses, and individual apartment or townhome units, within the 206 specific buildings surveyed in 2025 by the design-build team.
Note: Benefits reflect all proposed Phase I improvements as depicted in red in **Figure 6.** Additional future projects that reduce runoff to this area will further increase these benefits.
Note: All values in the table are predicted using H&H model results and have not been field verified after observed rainfall events.

Table 4, Table 5, and **Table 6** below provide a summary of the incremental benefit-cost analysis (BCA) for Phase I and the future phases, using the Southwest Florida Water Management District's (SWFWMD) Stormwater Improvement Flood Protection (SIFP) Benefit Cost Analysis Tool. **Estimated project costs shown in each table include construction costs as well as engineering and permitting fees.**

A detailed estimate of the Phase I construction cost can be found in **Appendix L** and is based on the 30% design. A formal cost estimate of future phase projects has not been developed for this report, and the estimated range of their combined project costs was provided by the City.

It is important to note that the estimated costs are preliminary, based on present-day economic conditions when this document was written, and are subject to change. It is also important to remember that the future phases include Palma Ceia Pines, as well as other secondary stormwater collection systems that extend beyond the Phase I project corridor (see **Figure 5**), which are subject to change. Details regarding the BCA are discussed in **Section 6.6** of this report.

Table 4 – Benefit-Cost Analysis – Phase I only

Expected Annual Damage Without Project	$21,040,904
Expected Annual Damage with Project	$12,496,761
Expected Annual Damage Benefit	$8,544,143
Discount Rate	7.0%
Project Useful Life (# years)	50
Present Value of Future Benefits	$117,915,552
Estimated Project Cost	$99.8M
Benefit/Cost Ratio	**1.2**

Table 5 – Benefit-Cost Analysis – Future phases only, with Phase I already complete

Expected Annual Damage Without Project	$12,496,761
Expected Annual Damage with Project	$7,276,528
Expected Annual Damage Benefit	$5,220,233
Discount Rate	7.0%
Project Useful Life (# years)	50
Present Value of Future Benefits	$72,043,108
Estimated Project Cost	$32M to $50M*
Benefit/Cost Ratio	**1.4 to 2.2**

*Future phase project cost estimate range was provided by the City, and is based on present day dollars

Table 6 – Benefit-Cost Analysis – Total Project (Phase I and Future Phases)

Expected Annual Damage Without Project	$21,040,904
Expected Annual Damage with Project	$7,276,528
Expected Annual Damage Benefit	$13,764,376
Discount Rate	7.0%
Project Useful Life (# years)	50
Present Value of Future Benefits	$189,958,660
Estimated Project Cost	$132M to $150M*
Benefit/Cost Ratio	**1.3 to 1.4**

*Future phase project cost estimate range was provided by the City, and is based on present day dollars

1. Project Overview and Background

The South Howard Flood Relief (SHFR) project is a progressive design-build project awarded to the design-build team of Kimmins (builder) and AtkinsRéalis (designer), intended to provide significant and widespread flood relief to the Parkland Estates and Palma Ceia Pines neighborhoods, among others. The recurring roadway and structural flooding that plagues these neighborhoods has been documented for decades. Although this area's stormwater challenges have been studied by engineers for decades, no feasible solutions that provide meaningful flood relief for both Parkland Estates and Palma Ceia Pines have been implemented to date. This project aims to provide a long-overdue solution to the damaging rainfall-induced flooding endured by this community.

1.1 Project Location

The Parkland Estates and Palma Ceia Pines neighborhoods lie within the northeastern portion of the South Tampa peninsula. Specifically, the geography west of the Selmon Expressway, east of Henderson Blvd, south of W Kennedy Blvd, and north of W Morrison Ave. The 225-acre SHFR Flood Reduction Focus Area, shown in blue in **Figure 1-1** below, represents the primary area that experiences the most significant flooding and can expect to see enough flood reduction from the project to comply with the City's level of service requirements. In other words, the proposed system was sized primarily to achieve the project's flood reduction goal within this area. The project's flood reduction benefits are not limited to this area. Other locations adjacent to the project limits, particularly to the south and east of the SHFR Flood Reduction Focus Area, will also benefit from significant flood reduction that achieves the City's flood reduction goals.

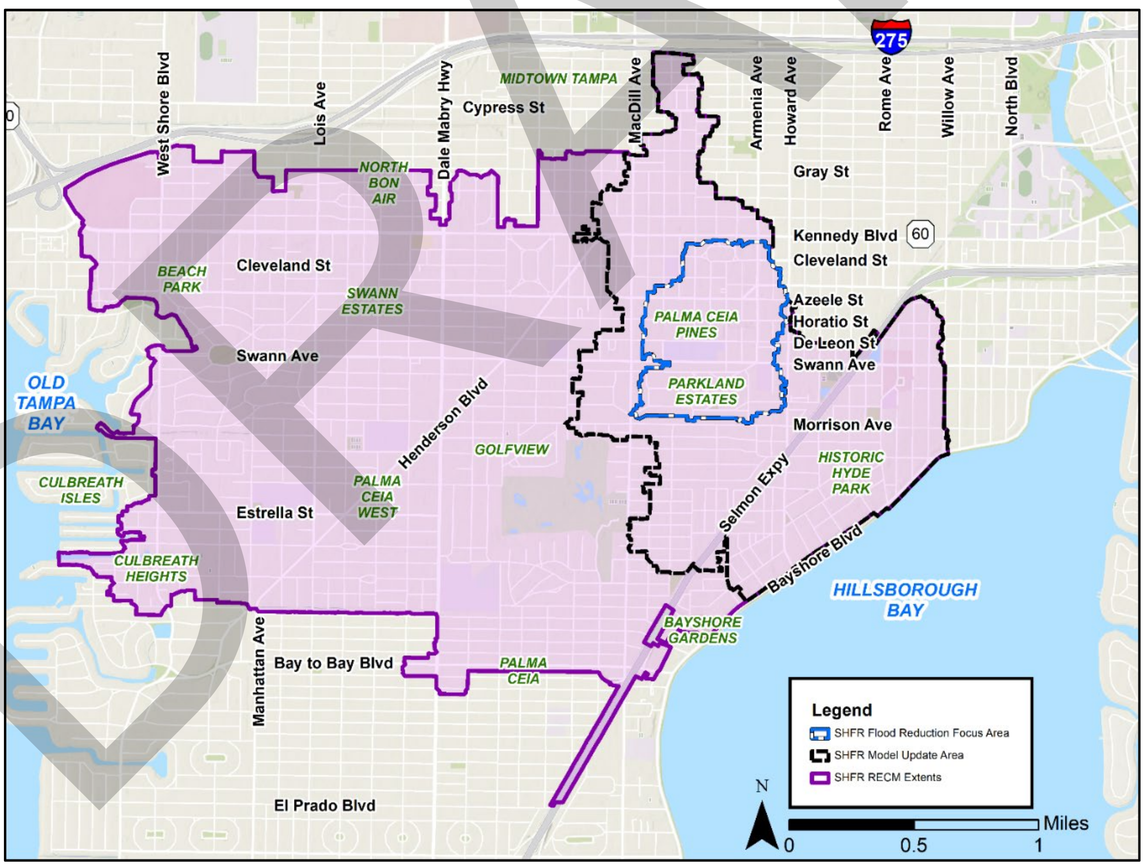

Figure 1-1 – Project Location Map

1.2 Why is this Project Needed?

The topography (ground surface elevations) of the Parkland Estates and Palma Ceia Pines neighborhoods form the shape of a bowl that encompasses over 200 acres. This area is bounded by S MacDill Ave (west), W Kennedy Blvd (north), S Howard Ave (east), and W Morrison Ave (south). Given the urban and dense nature of the drainage area contributing stormwater flow to this area, the stormwater infrastructure becomes easily overwhelmed during heavy rainfall events. This causes the low-lying area to flood, in essence "filling the bowl". **This flooding results in significant property damage and renders roadways impassable, jeopardizing the health, safety, and welfare of the public during heavy rainfall events.** The Palma Ceia Pines neighborhood includes Hospital Corporation of America (HCA) Florida South Tampa Hospital and medical offices, which are severely impacted by flooding conditions that temporarily eliminate access to these services, jeopardizing the lives of patients.

The City completed several studies in and around the Parkland Estates and Palma Ceia Pines area that identified flooding concerns dating back to the late 1960s. Since then, flooding complaints from businesses and residents, including structure flooding and road closures, have been documented by the City. **Figure 1-2** through **Figure 1-4** show over 250 flood complaints and flooding photos associated with rainfall events dating back to 2015 within the SHFR Model Update Area.

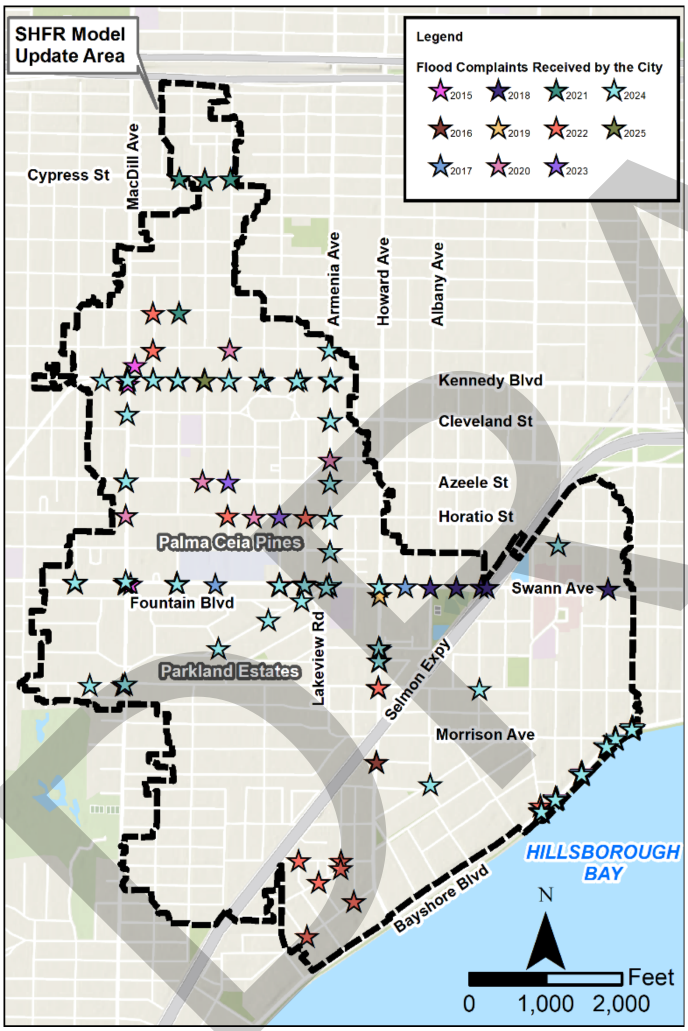

Figure 1-2 – Flood Complaints Received by the City

Figure 1-3 – Flooding along Swann Ave near S Audubon Ave on July 12, 2024

Figure 1-4 – Flooding along Parkland Blvd on August 1, 2015

1.3 Project Scope

The Kimmins | AtkinsRéalis design-build team was tasked to design and construct a project to meet the City's primary objective of alleviating flooding within Parkland Estates and Palma Ceia Pines. The flood reduction goal for this project is to provide safe passage along the roadways by allowing no more than 4 inches of flood depth over the lowest edge of pavement for the 5-year/8-hour storm event. This is defined as the flood protection level of service (FPLOS). The project consists of a large gravity conveyance system that travels from the area of the HCA Florida South Tampa Hospital out to Hillsborough Bay via Howard Ave to take advantage of the existing infrastructure under the CSX railroad and the Selmon Expressway (5' x10' box culvert) along with additional infrastructure at the entry point into Hillsborough Bay (triple 4' x 6' box culverts).

With the expected size of the conveyance required, the City understands that the utilities will need to be relocated and the roadway will be reconstructed along the project route. Additional improvements will be incorporated into the design to make this a safer environment for all modes of travel, where possible, and incorporate design of sustainable/green infrastructure to provide water quality benefits.

Through this project the Kimmins | AtkinsRéalis design-build team will be working collaboratively with the City to develop a project that is cost-effective, hydraulically efficient, minimizes disruption to stakeholders, and is environmentally friendly while meeting the goal of the project to reduce the flooding within Parkland Estates and Palma Ceia Pines. The design of this project is broken into two separate phases, Preliminary Engineering and Final Design.

The scope for the Preliminary Engineering Phase includes:

- Conversion of the XPSWMM hydrologic and hydraulic (H&H) model to ICPRv4 software, and a detailed update to the model that reflects current conditions and the interaction of stormwater flows between drainage basins.
- Route Study – this includes updating the existing model and developing a detailed H&H model to size the new primary trunkline to meet the overall flood reduction goals for the entire SHFR Flood Reduction Focus Area and to analyze and compare alternative routes and solutions to the flooding issues.
- Data Collection – this includes survey, subsurface utility exploration (SUE), geotechnical exploration, Right-of-Way verification, tree survey and ecological field survey.
- Preliminary Engineering Report to document all the findings and conclusions of the analysis and route/alternatives study.
- Streetscape alternatives for S Howard Avenue
- Preliminary cost estimates

The scope for the Final Engineering Phase includes:

- Design of the final selected project route and box culvert size
- Design of the utility relocations required to construct the project
- Streetscape and landscape design along the selected route
- Design of practical green infrastructure solutions to provide additional stormwater treatment
- A complete set of construction plans
- Permitting
- A Guaranteed Maximum Price (GMP)

As discussed previously in **the Executive Summary** of this report, this project will be broken into separate phases of work. The Final Engineering Phase of this scope of work is **only for Phase 1**. The Phase 1 project limits are shown in **Figure 1-5.**

Figure 1-5 – Phase I Project Map

2. Data Collection & Review

This section highlights the data collection and review efforts performed as part of the effort to complete the H&H modeling and development of this report. The design-build team has collected and reviewed available data including previous watershed and project feasibility studies, readily available geographic information systems (GIS) data, information pertaining to existing stormwater infrastructure (i.e., as-builts/record drawings), utility records and inventory, permitting documents, and available survey within the project's model update area. New data collected as part of this study includes traffic count data for S Howard Ave and W Swann Ave, tree survey and inventory along the three primary alternative routes, and survey of finished floor elevations (FFE) for over 200 structures within Parkland Estates and Palma Ceia Pines. A FFE is the elevation of the top of the lowest finished floor in a building. The team also performed several field investigations to gain a better understanding of the study area's existing drainage patterns, stormwater infrastructure, and potential design constraints like existing utilities and infrastructure associated with the CSX railroad and Selmon Expressway.

All analyses associated with this project use the following horizontal coordinate system and vertical datum, consistent with the County's 2017 DEM:

- Horizontal Coordinate System: *NAD83 (2011) / Florida West (ft-US)*
- Vertical Datum: *North American Vertical Datum of 1988 (NAVD88)*

All elevations obtained from documents based on the National Geodetic Vertical Datum of 1929 (NGVD29) were converted to the NAVD88 datum using a conversion factor of **(-)0.86 feet**, derived specifically for the project area using NOAA's online version of the National Geodetic Survey (NGS) Coordinate Conversion and Transformation Tool (NCAT) software.

2.1 Prior Engineering Studies

The drainage basins that make up the SHFR Flood Reduction Focus Area have been studied for decades, and conceptual solutions to flooding issues have been developed as part of these studies, which are discussed in this section. However, what the previous studies lack is a complete understanding of the interaction of stormwater between drainage basins, which creates a larger and more complicated flooding issue than previously thought. The SHFR project's preliminary engineering study documented in this report has identified this complex problem and has developed a comprehensive solution.

2.1.1 Cleveland Street Basin Drainage Study (PBS&J, September 1983)

As part of this study, engineering firm Post, Buckley, Schuh & Jernigan (PBS&J) analyzed the hydrologic and hydraulic conditions at the time within the Cleveland Street drainage basin and developed twelve alternative solutions to alleviate flooding within the basin. One important note from the report is that the Cleveland Street outfall was originally designed by the Florida Department of Transportation in 1956 through a joint agreement with the City of Tampa. The Cleveland Street basin includes the AMI detention pond and the Horatio Street system within Palma Ceia Pines, as discussed in the subsequent sections of this report. The PBS&J study identified significant flooding prior to 1983 and flooding complaints as early as 1969. It identified the low-lying roadways of Palma Ceia Pines between Cleveland St, Horatio St, MacDill Ave, and Armenia Ave as a "flood prone area".

The study provided the following conclusions that explain why the Cleveland Street system was severely undersized, even in the 1980s:

- *"Runoff coefficients used for design in the basin, which was relatively sparsely developed in 1956, ranged from 0.21 to 0.30 and averaged about 0.25. As a result of the development which has occurred in the area since that time, the average runoff coefficient for the basin has increased to approximately double that figure. In June, 1980 the Tampa Department of Public Works estimated the actual runoff coefficient to be 0.51.* ***This factor alone would double the quantity of stormwater runoff flowing to the Cleveland Street system."***
- *"The design storm used to design the system in 1956 was three-year frequency event. Current Tampa criteria is to design drainage facilities adequate to accommodate a five-year event."*
- *"The storm intensities reflected in rainfall curves have increased since the date of the original design. This increase is attributable to a combination of a greater amount of statistical data on which to base the curves, the development since that time of curves based on specific data for the Tampa region and, perhaps, some climatic change in the period since 1956."*

PBS&J recommended a preferred alternative based on feasibility, performance, and environmental impacts. The design storm event selected for the alternatives analysis was the 5-year/1.5-hour storm, which accumulates a total of 3.3 inches of rainfall in 90 minutes. The recommended alternative included construction of stormwater detention facilities and associated minor pipe improvements, an epoxy liner in the existing box culvert between S Himes Ave and the system's outfall to Old Tampa Bay, and construction of an additional outfall for the Westshore area. The recommended alternative had an estimated cost of $10.3M at the time of the study in 1983. The City was unable to implement this preferred solution due to economic constraints.

2.1.2 Cleveland Street Basin Drainage Study (PBS&J, 1988)

In 1988, the City's Stormwater Management Division initiated a series of comprehensive stormwater management studies throughout the City, which included a re-evaluation of the Cleveland Street Basin that expanded and updated the original 1983 study. The objectives of this study were to inventory the existing Cleveland Street Basin drainage facilities, analyze the performance and adequacy of the system through H&H modeling, identify the causes of recurrent flooding during relatively minor rainfall events, and recommend, after evaluation of a variety of possible alternatives, a preferred course of remedial action based on economic, environmental, feasibility and performance considerations.

Alternatives for conveyance improvements (gravity and pumps) and storage facilities were evaluated. It is important to note that this study focused solely on the Cleveland Street Basin, of which Palma Ceia Pines is only a small portion, and Parkland Estates lies outside of it. Therefore, the alternatives identified and analyzed were only within this basin area. The preferred solution is presented on the following page on **Figure 2-1** and **Figure 2-2.**

What the 1988 study lacks, however, is the interaction of runoff between the Cleveland Street basin with adjacent basins through overland flow. Isolating basins that exchange runoff underrepresents the amount of runoff contributing to a proposed system, which can lead to undersized outfalls. To develop a successful solution to a flooding problem, it is imperative that all runoff contributing to the problem is accounted for, like the SHFR analysis discussed in this report has done.

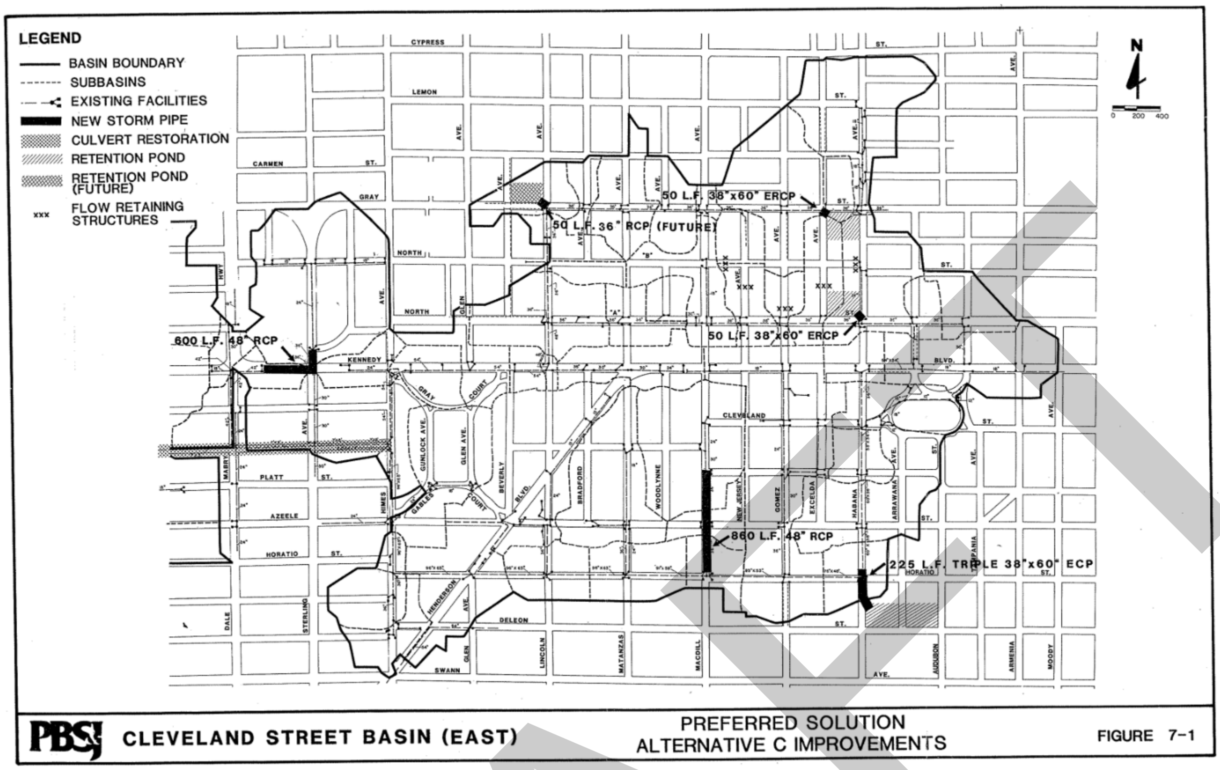

Figure 2-1 – Cleveland Street Drainage Basin Study (1988) Preferred Solution (East)

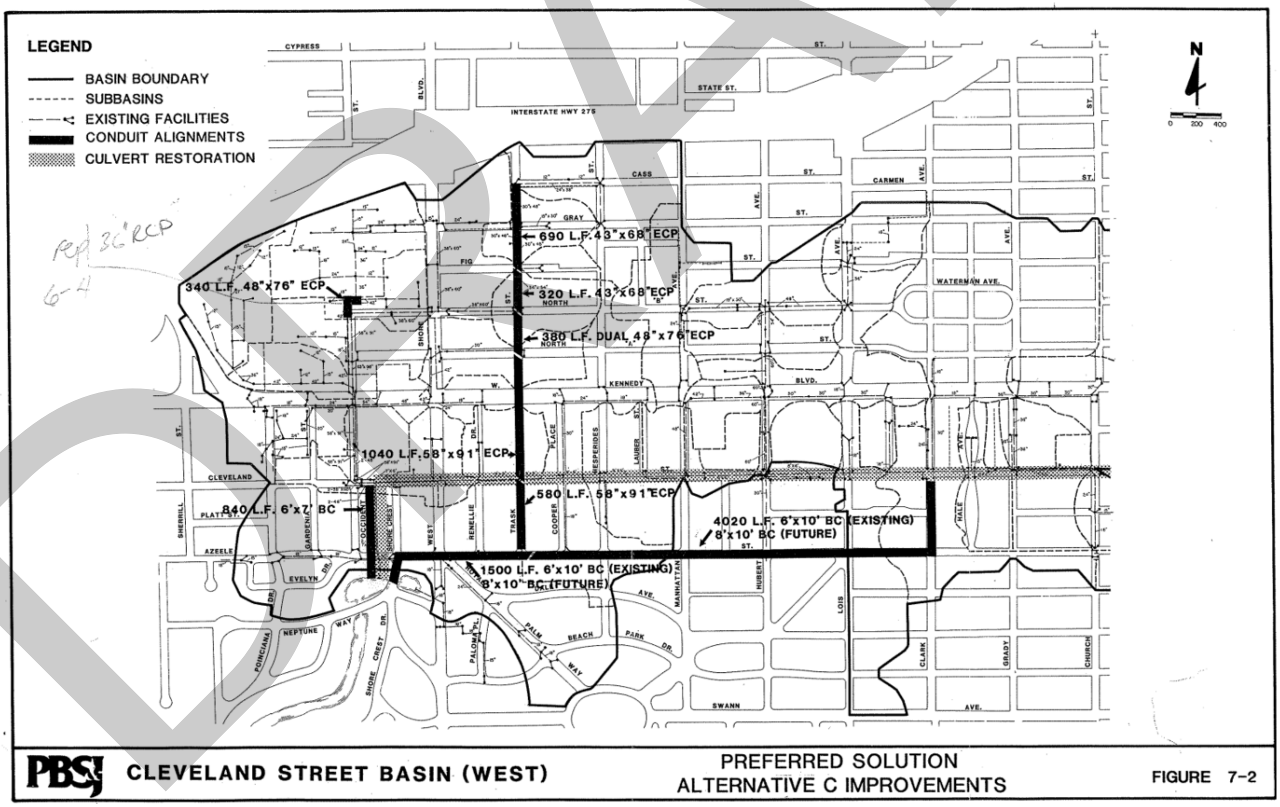

Figure 2-2 – Cleveland Street Drainage Basin Study (1988) Preferred Solution (West)

2.1.3 Cleveland Street Basin Masterplan Update (PBS&J, 2009)

This study was an effort to update the Cleveland Street Basin's masterplan developed in the 1980s, which included an update to the City's existing XPSWMM model, evaluation of existing flooding conditions and FPLOS deficiencies, and recommended improvements to improve those deficiencies. This study identified recurring flooding around the W Horatio St and S Habana Ave intersection, including structure flooding during the 5-year design storm, and made the following observations:

- *"During large storm events, water flows along the road from west to east and accumulates near the intersection of Habana Avenue and Horatio Street at which point it spills into the homes and yards of adjacent properties."*
- *"Level-of-service violations during the 5-year/24-hour event are predicted along both Habana Avenue and Horatio Street…The worst flooding conditions occur at the intersection of Habana Avenue and Horatio Street where flooding depths are predicted to reach up to 2.0 feet…It is also predicted that an estimated 35 homes will experience structural flooding throughout this area."*
- *"During the 100-year storm event…A road flooding depth of 3.2-feet is predicted at the intersection of Horatio Street and Habana Avenue… structural flooding is expected throughout the Horatio Street/Habana Avenue road corridor, with 93 homes estimated to flood during this large storm event"*

One of the recommended improvements, in conjunction with upgrades to the Cleveland Street system west of Palma Ceia Pines, was a new 54-inch diameter stormwater trunkline between the S Habana Ave & W Azeele St intersection and a new outfall to Hillsborough Bay at S Willow Ave & Bayshore Blvd. A map of this alternative is shown in **Figure 2-3.** The intent of the trunkline was to reduce flooding for the 5-year design storm, like the goal of the SHFR project. Similar to the 1988 study, the 2009 study lacks the interaction of runoff between the Cleveland Street basin with adjacent basins through overland flow. Isolating basins that exchange runoff underrepresents the amount of runoff contributing to a proposed system, which can lead to undersized outfalls. To develop a successful solution to a flooding problem, it is imperative that all runoff contributing to the problem is accounted for, like the SHFR analysis discussed in this report has done.

Figure 2-3 – PBS&J Cleveland Street Basin Masterplan Update (2009) Recommended Alternative

2.1.4 2017 Parkland Estates Drainage Improvements Preliminary Engineering Report (JMT, September 2017)

This study updated the City's Upper Peninsula H&H model using project-specific field survey data and evaluated eight alternatives to achieve a goal of no roadway flooding during the 5-year/24-hour design storm at W Swann Ave & S Audubon and on W Fountain Blvd near S Audubon Ave. The alternatives included:

- A stormwater detention facility in Parkland Estates
- Three gravity systems, each analyzed with and without detention (six total)
- A stormwater pump station option

Each alternative was assessed for benefits, cost, environmental impact, safety, constructability, property needs, long-range planning, and public input. A gravity system was selected as the preferred option.

The recommended solution involved a new stormwater pipe along W Swann Ave between S Habana Ave and S Audubon Ave, which has since been constructed. However, construction of a new outfall to Hillsborough Bay was never completed because of significant obstacles like the CSX railroad, the Selmon Expressway, and an existing 48" sanitary sewer force main—each of which has significant cost and schedule challenges. Without increased conveyance to the bay, any improvements made within Parkland Estates or on W Swann Ave provide very limited flood reduction.

2.1.5 Parkland Estates Feasibility Study (Dewberry, December 2018)

This study further refined the existing conditions H&H model to include the recently constructed stormwater pipe along W Swann Ave between S Habana Ave and S Audubon Ave as well as additional inlets within Parkland Estates. The three gravity solutions developed in JMT's 2017 study were reevaluated, and a fourth gravity alternative was evaluated. While the recommended gravity system from JMT's 2017 study remained the preferred solution, significant impacts to residents along the preferred route led to continued exploration of alternatives.

2.1.6 Internal Analyses (City of Tampa, January 2019 to August 2020)

The City evaluated multiple options to reduce flooding in Parkland Estates. Upstream modifications, including modification of the ZOM Pond weir and redirecting runoff to the Cleveland Street basin were dismissed due to minimal benefits and risk of adverse flooding impacts to others. Baslee Engineering Services prepared conceptual plans for a new gravity system, but identified the same challenges mentioned in the prior JMT and Dewberry studies along with constructability concerns due to narrow right-of-way along the proposed corridor.

Other options, such as increasing conveyance along the existing pipe system downstream of Parkland Estates, and weir adjustments near the Rubideaux St outfall, were dismissed due to limited flood reduction and adverse downstream flood impacts. Evaluated pump station alternatives were also dismissed due to potential adverse flooding impacts.

2.1.7 City Alternatives Revisited (JMT, August 2020)

In 2020, JMT was re-engaged to explore additional options, starting with the City's alternative to upsize the existing trunkline between the Selmon Expressway and the intersection of W Morrison Ave & S Marti St. Variations included flap gates to prevent backflow along W Parkland Boulevard, alternate termination points, and other system modifications along the route. Despite these efforts, model results led to conclusions similar to those of previous studies: minimal relief for Parkland Estates, high costs, ROW limitations, and constructability concerns. Attempts to address localized flooding adjacent to the route further increased costs while reducing the flood reduction benefits in Parkland Estates.

2.1.8 Stormwater Pumping Station and Force Main (JMT, March 2021)

JMT evaluated an alternative that included a new stormwater pump station within the green space between W Fountain Blvd and Parkland Blvd and a new force main outfall to Hillsborough Bay. Despite the higher operation and maintenance costs, the opportunity to use smaller conduits and a variety of construction methods were thought to make implementation more feasible, given the obstacles between Parkland Estates and Hillsborough Bay. Two pump station alternatives were developed to achieve the 5-year design storm FPLOS goal for Parkland Blvd and W Fountain Blvd:

- 10,000 sq. ft. wet well, two 70 cfs pumps, 42-inch force main
- 5,000 sq. ft. wet well, two 90 cfs pumps, 42-inch force main

Noise, visual impacts, and neighborhood disruption were key concerns. Additionally, these alternatives would provide benefits limited to the Parkland Estates neighborhood, limiting opportunities for cooperative funding initiatives.

During the planning phase, the City discovered archived as-builts that revealed existing box culverts beneath S Howard Ave at its crossing with the railroad and Selmon Expressway and at its intersection with Bayshore Blvd, eliminating the largest hurdles for a gravity solution. As a result, JMT was tasked with developing a preferred gravity alternative that incorporates these existing culverts.

2.1.9 Upper Peninsula Stormwater Improvements – East Region Preliminary Engineering Report (Feasibility study by JMT, April 2022)

In 2022, JMT published a feasibility study titled Upper Peninsula Stormwater Improvements – East Region, whose recommendations guided the initial direction of the South Howard Flood Relief project. Prior to this study, discovery of as-built plans for the existing box culverts beneath the CSX railroad, Selmon Expressway, and Bayshore Blvd finally led the way for planning of a feasible, constructable solution to alleviate the chronic flooding within Parkland Estates. This report also documented the previous studies mentioned in **Sections 2.1.4 through 2.1.8** above, along with their studied alternatives, which were deemed to be ineffective or infeasible.

Inadequate conveyance capacity within existing stormwater pipes was identified as the primary cause of flooding. The alternative solutions evaluated ways to increase conveyance of stormwater runoff between Parkland Estates and Hillsborough Bay. Calibration of the study's existing conditions model used a short duration, high intensity event observed on April 20, 2020. The model simulation of this event resulted in lower peak flood stages and shorter duration of flooding than what was observed during the event. The report noted that inlet capacity, which was not accounted for in the model, was likely restricting inflows to the system, which could explain the low peak stages and duration of flooding in the initial simulation. The model was adjusted to represent hydraulic restrictions due to limited inlet capacity.

In retrospect, the limited scope and budget of that feasibility study did not allow the team to capture the magnitude of stormwater runoff reaching Parkland Estates and Palma Ceia Pines from adjacent areas, including north of Kennedy and as far north as I-275 and the Lemon Street Canal basin. This is evident by the comparison of peak model stages between studies, and by the calibration and verification of the SHFR project's model, as discussed in **Sections 4.6 and 4.7** of this report.

JMT's recommended alternative, which established the first feasible and effective solution for Parkland Estates, included a 5'x10' box culvert between Parkland Estates and the railroad, and then a 4'x15' box culvert along S Howard Ave to the existing triple 4'x6' box culverts under Bayshore Blvd (see **Figure 2-4** below). Model results show that this alternative significantly reduces peak stages and duration of flooding within Parkland Estates and on W Swann Ave and nearly achieved the FPLOS goal of no water on the roadway for the 5-year/8-hour design storm. Conceptual plans were developed and an engineer's cost estimate totaled just over $45 million. It is important to remember that inflation and other factors have significantly increased construction costs for similar projects since this report was published in 2022.

The same recommended alternative would likely cost far more to implement than the estimated cost given in this study. The JMT report can be found in **Appendix A** of this report as part of the project's Design Criteria Package.

Figure 2-4 – JMT Feasibility Study (2022) Recommended Alternative

2.2 Documentation of Observed Flooding

The significant flooding that occurs in Parkland Estates and Palma Ceia Pines has been well documented. The City has provided photos showing the extent of flooding that has occurred during heavy rainfall events. Rainfall data was collected to provide context for the observed flooding, and for purposes of calibrating and verifying the project's detailed H&H model that is reflective of existing conditions, which is referred to as the Revised Existing Conditions Model (RECM). This data is sourced from nearby rain gauges and from SWFWMD's NEXRAD (Next-Generation Radar) dataset NEXRAD is a network of Doppler weather radars jointly operated by the National Weather Service (NWS), Federal Aviation Administration (FAA), and United States Air Force. It provides high-resolution data for several weather variables including precipitation and is widely used for hydrologic modeling.

2.2.1 August 1, 2015

On August 1, 2015, tropical atmospheric moisture over the eastern Gulf of Mexico was responsible for a storm that produced over 5 inches of rainfall in a matter of hours, leading to severe flooding that rendered roadways impassable, and inundated vehicles, homes, and businesses. NEXRAD rainfall data reveals that this event was incredibly similar in total rainfall depth and duration to FDOT's 5-year/8-hour design storm, which is the City's standard design criteria, and was used to size the SHFR project's infrastructure. A comparison of rainfall distribution between the two is shown in **Figure 2-5** below.

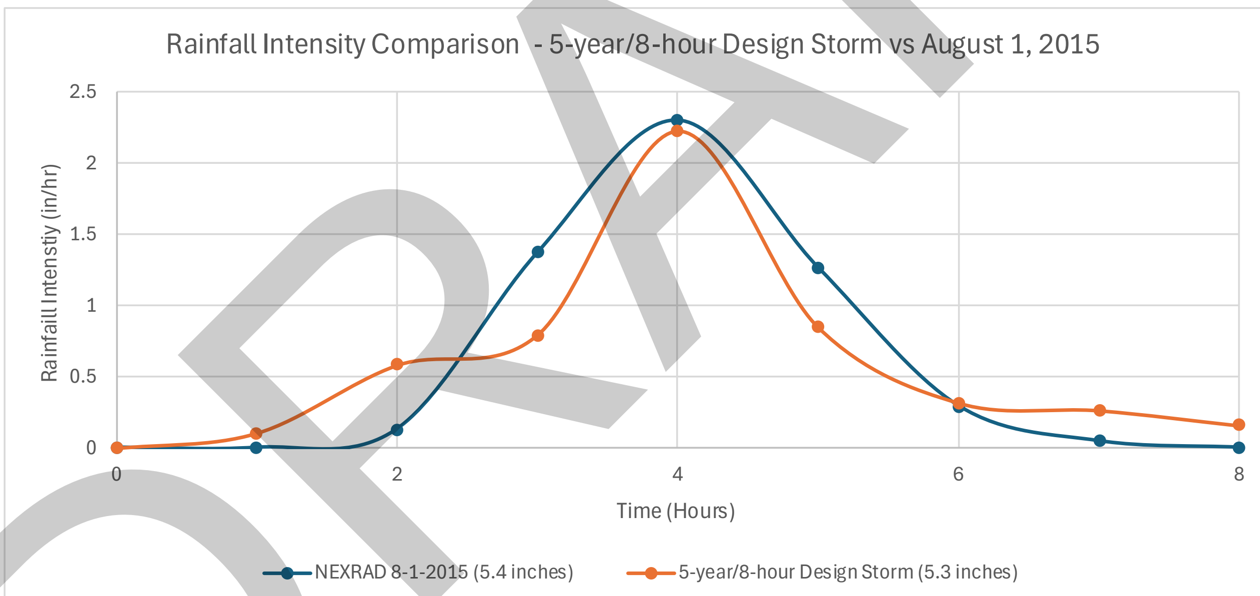

Figure 2-5 – Rainfall Intensity Comparison - 5-year/8-hour Design Storm vs August 1, 2015

Figure 2-6 shows an estimated flood depth of 3 to 4 feet over the lowest portions of W Fountain Blvd and W Parkland Blvd (top photos), flood stages (water surface elevations) approaching a home in Parkland Estates (bottom left), and an impassable roadway due to flooding on W Swann Ave near S Rome Ave (bottom right photo) during the rainfall event observed on August 1, 2015. The cumulative rainfall depth for this event was estimated in this area by NEXRAD data to be 5.4 inches over 5.5 hours. In addition to the damage to vehicles captured by the photos, structures were inundated in both Parkland Estates and Palma Ceia Pines according to residents who lived there at the time.

Figure 2-6 – Observed Flooding on August 1, 2015

The SHFR Revised Existing Conditions Model (RECM) predicts flooding during the 5-year/8-hour design storm event that aligns with the photos in **Figure 2-6**. The model predicts that peak flood depths reach 3 to 4 feet over these same roadways in Parkland Estates (top photos), and that flood depths over W Swann Ave just west of S Rome Ave (bottom right photo) range between 3 and 12 inches.

2.2.2 June 7, 2017

Figure 2-7 below shows flooding from a typical summer storm that produced about 1.4 inches of rainfall in one hour, according to NEXRAD data. The photo on the left shows W Fountain Blvd just east of S Audubon Ave (looking south) and the photo on the right shows W Swann Ave at S Audubon Ave (looking northwest from the south side of W Swann Ave).

Figure 2-7 – Observed Flooding on June 7, 2017

2.2.3 June 14, 2024

Figure 2-8 shows a flooded W Parkland Blvd after another summer storm event that produced about 1.8 inches of rainfall in 1 hour, according to NEXRAD data.

Figure 2-8 – Observed Flooding on June 14, 2024

2.2.4 June 29, 2024

Figure 2-9 shows vehicles struggling to navigate flooding on W Fountain Blvd at W Parkland Blvd (left) and at the intersection of W Swann Ave and S Audubon Ave (right) on June 29, 2024, from another summer afternoon storm that produced 2.4 inches of rainfall within 2 hours, according to nearby rain gauge data.

Figure 2-9 – Observed Flooding on June 29, 2024

2.2.5 July 12, 2024

Figure 2-10 shows flooding photos from a summer storm event that accumulated 2.0 inches of water over 3 hours, according to the City of Tampa's provided rain gauge data. The photo on the left was taken on W Swann Ave at the HCA Florida South Tampa Hospital main entrance and the photo on the right was taken further to the east at the intersection with S Audubon Ave.

Figure 2-10 – Observed Flooding on July 12, 2024

2.2.6 Hurricane Milton (October 9, 2024)

Hurricane Milton devastated Parkland Estates and Palma Ceia Pines in 2024, producing between 13.5 and 14.5 inches of rainfall (depending on the location) over the SHFR Flood Reduction Focus Area in less than 24 hours, according to NEXRAD data. The design-build team surveyed finished floor elevations of over 200 buildings (containing over 400 total first floor homes and businesses) within the SHFR Flood Reduction Focus Area. Comparing this data to the calibrated RECM's model results for a Hurricane Milton simulation, the team predicts that over 300 homes and businesses in Parkland Estates and Palma Ceia Pines sustained interior flood damage during the storm.

Photos of actual flooding are limited because the peak stages occurred overnight, and because residents that did not evacuate were likely inside to shelter from hurricane-force winds. However, peak flood stages are well documented with photos of stain lines and high-water marks left behind throughout the area. **Figure 2-11** and **Figure 2-12** below show damage sustained and evidence of peak stages seen during Hurricane Milton, respectively.

Figure 2-11 – Observed damage due to water intrusion on October 15, 2024

Figure 2-11 shows water-damaged property removed from homes on W Horatio St between S Gomez Ave and S Habana Ave (left) and on W Parkland Blvd just south of W Fountain Blvd (right) days after Hurricane Milton inundated the area.

Figure 2-12 below shows stain lines left behind the following day, after flood stages receded.

Figure 2-12 – High-water marks left by Hurricane Milton documented on October 15, 2024

2.3 Record Drawings & Prior Survey

The as-builts/record drawings and survey listed in **Table 2-1** were provided by the City and are geographically relevant to the SHFR Model Update Area and recommended project route. These documents can be found in **Appendix Q.**

Table 2-1 – Relevant As-builts/Record Drawings

Document	Year
Map of Drainage Facilities, in Place, for Interbay Area, City of Tampa, Florida	1954
As-built – Relief Storm Sewer – Swann Ave. and Parkland Boulevard	1954
As-built – City of Tampa Sewer Improvements	1956
Record Drawing – City of Tampa Water Department Improvements (S Audubon Ave)	1957
As-built – Drainage for City Park at Fountain & Parkland Blvds	1966
As-built – THEA South Crosstown Expressway (from Gandy Blvd to Euclid Ave)	1975
As-built – THEA South Crosstown Expressway – Howard Ave & Watrous Ave (includes existing 5'x10' box culvert beneath CSX railroad)	1976
As-built – Interbay Force Main (City of Tampa Sewage Disposal System)	1982
Record Drawing – City of Tampa Water Department – Cleaning & Lining (Bayshore Blvd, Howard Ave)	1982
As-built – City of Tampa Sewer Improvements (Howard-Swann Area)	1983
As-built – Swann Avenue – Armenia Ave to Packwood Ave – Utility Adjustment Plans (potable water)	1988
As-built – Bayshore Blvd. Storm Sewer Replacement at Howard & Albany Aves.	1989
As-built – Roadway and Drainage Improvements – Swann Avenue – Armenia Ave to Packwood Ave (used for Swann Avenue Pipe Rehabilitation - SW2010-03 plans)	1992
As-built – Swann Avenue – Armenia Ave to Packwood Ave – Sanitary Sewer Construction Plans	1992
As-built – Bayshore Interceptor Rehabilitation Project (City of Tampa Dept. of Sanitary Sewers)	1993
As-built – Lakeview Road Drainage – Parkland Blvd to Bristol Ave	1993
As-built – Renewal & Replacement, Sewage Disposal System – Howard Ave: Hills Ave to Palm Dr	1997
City of Tampa Water Department – Galvanized Main Replacement – Jetton Ave	1997
Record Drawing – 6" Water Main Extension – Bristol Avenue from Armenia Ave to Howard Ave	1997
Record Drawing – 6" Water Main Extension – Stroud Avenue from Moody Ave to Howard Ave	1997
As-built – Howard Ave & Bayshore Blvd Intersection Improvements (PW95-73)	1998
As-built – Palma Ceia Drainage Improvements (Parkland Blvd)	2001
As-built – Swann Avenue, Parkland Blvd and Armenia Ave Intersection Improvements	2002
As-built – South Tampa Area Reclaimed Project Contract D4 – Hyde Park/Palma Ceia	2004
As-built – Epicurean Utilities Plan	2013
Record Drawing – SOHO Square Apartments	2014

Document	Year
Topographic Survey – S Howard Ave., W Swann Ave. to W. Morrison Ave.	2015
Record Drawing – Howard Avenue Mixed Use – Sanitary Sewer and Water Distribution Plan	2016
As-built – Howard Avenue Flooding Relief (SW2017-01) (Marjory Ave Pump Station)	2017
As-built – Swann Avenue Drainage Improvements (SW2018-05)	2017
Topographic Survey – Howard and Bayshore	2019
As-built – Parkland Estates Flooding Relief (SW2021-01)	2020
Record Drawing – Reclaimed Water – Howard Avenue – from Bayshore Blvd to Palm Drive	unclear

2.4 Geographic Information System (GIS) Data

GIS data for the project area was collected from multiple sources including the City, the Florida Department of Transportation (FDOT), the Southwest Florida Water Management District's (SWFWMD) Open Data Portal, the National Oceanic and Atmospheric Administration's (NOAA) Open Data Access Viewer, the Florida Department of Environmental Protection's (FDEP) Land Boundary Information System (LABINS), the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), and Hillsborough County's Property Appraiser data site. A list of relevant data that was evaluated during the preliminary design phase is provided below within **Table 2-2.**

Table 2-2 – Collected GIS Data

Data	Source	Year
Digital Elevation Model (DEM)	Hillsborough County	2017
Lemon Street Canal (Cypress Memorial Area) Model GWIS Geodatabase	City of Tampa/AtkinsRéalis	2018
Upper Peninsula Model GWIS Geodatabase	City of Tampa/AtkinsRéalis	2018
Aerial Imagery	FDOT	2023
Land Use Coverage	SWFWMD	2023
Stormwater Infrastructure Inventory	City of Tampa	2023
Aerial Imagery (post-Hurricane Milton)	NOAA	2024
Building Footprints	Hillsborough County	2024
Tide Stage Data	NOAA	2024
Environmental Resource Permits (ERP)	SWFWMD	2025
Parcel Lines	Hillsborough County	2025
Potable Water Infrastructure Inventory	City of Tampa	2025
Reclaimed Water Infrastructure Inventory	City of Tampa	2025
Reported Street Flooding	City of Tampa	2025
Soils Coverage	USDA NRCS	2025
Wastewater Infrastructure Inventory	City of Tampa	2025

2.4.1 Digital Elevation Model

Hillsborough County's 2017 LiDAR-based digital elevation model (DEM), developed by Dewberry, Inc. for SWFWMD and Hillsborough County, is the most current regional elevation dataset available and was used to develop the project's RECM. This DEM is critical to the development of overland flow connections and stage/storage relationships within the model. It is also used to map predicted flood extents and to estimate low roadway elevations at a planning level to assist with FPLOS analysis.

Although the data is nearly 10 years old, it is the latest available DEM and is considered valid for the purposes of this study because this area has since experienced limited new development and change in ground surface elevations that would significantly affect overland stormwater flows.

The DEM represents topographic features using a raster graphic that is based on a gridded system of squares. Each square grid has a cell size of 2.5 square feet and represents a single elevation, which is reflective of the average of all LiDAR points collected within the respective cells. The elevation information is derived from LiDAR collected via aerial mapping between January and March of 2017**. Figure 2-13** below shows the DEM raster within the SHFR RECM extents.

More information about this dataset and its accuracy can be found at [2017 SWFWMD Lidar DEM: Hillsborough County, FL | InPort].

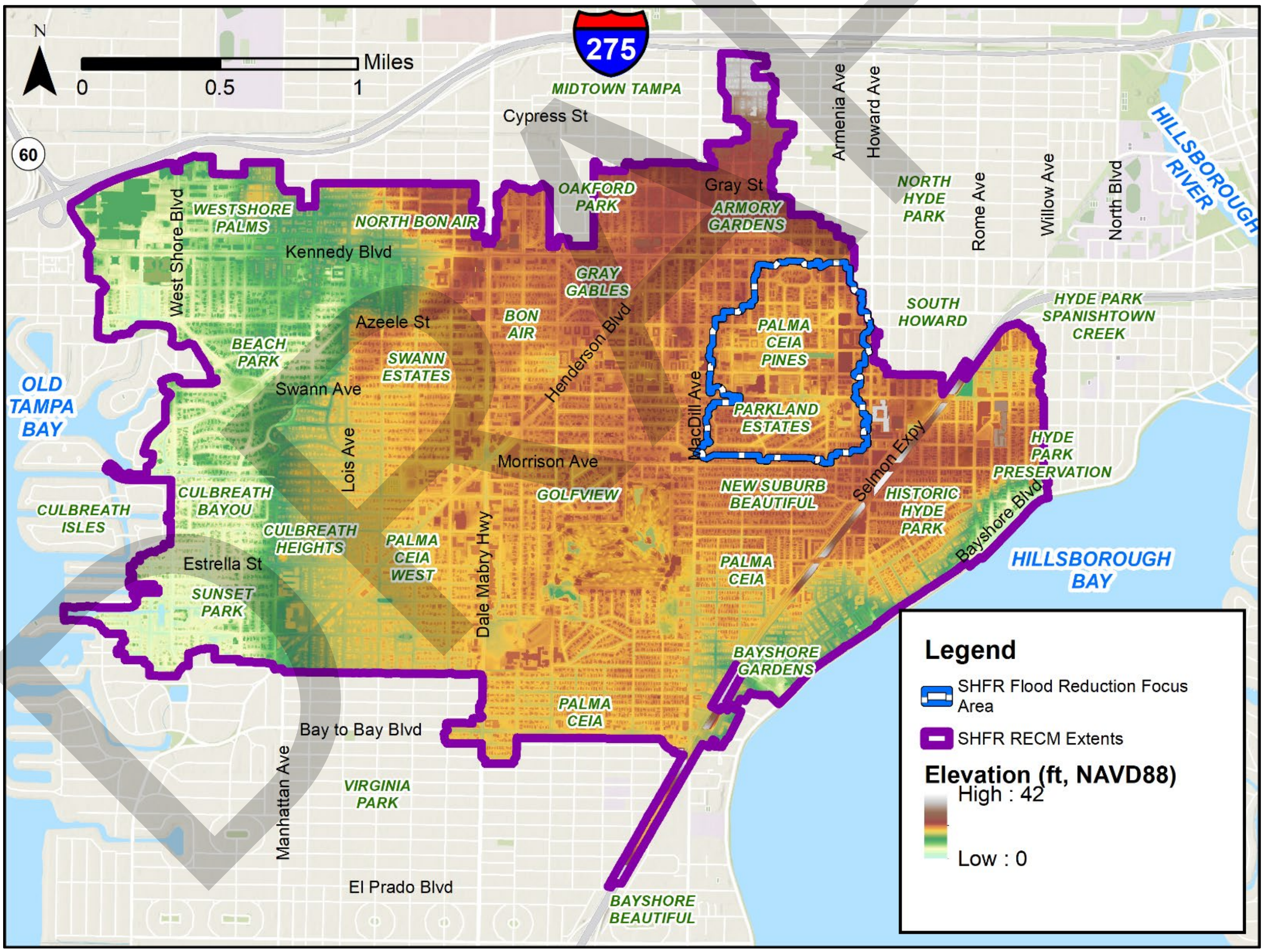

Figure 2-13 – SHFR Digital Elevation Model (Hillsborough County, 2017)

2.5 Environmental Resource Permit Documents

The design team collected and reviewed relevant permitting documents from SWFWMD including drainage reports, construction plans, and as-builts/record drawings for 106 Environmental Resource Permits (ERPs) (including permit exemptions). Relevant permits whose documentation was evaluated are shown below in **Figure 2-14.** This permit documentation is public information and can be found at www31.swfwmd.state.fl.us/maps/pages/viewer_erp.html. The data obtained from these permit documents aid in understanding any recent changes to the watershed and were included in the model analysis.

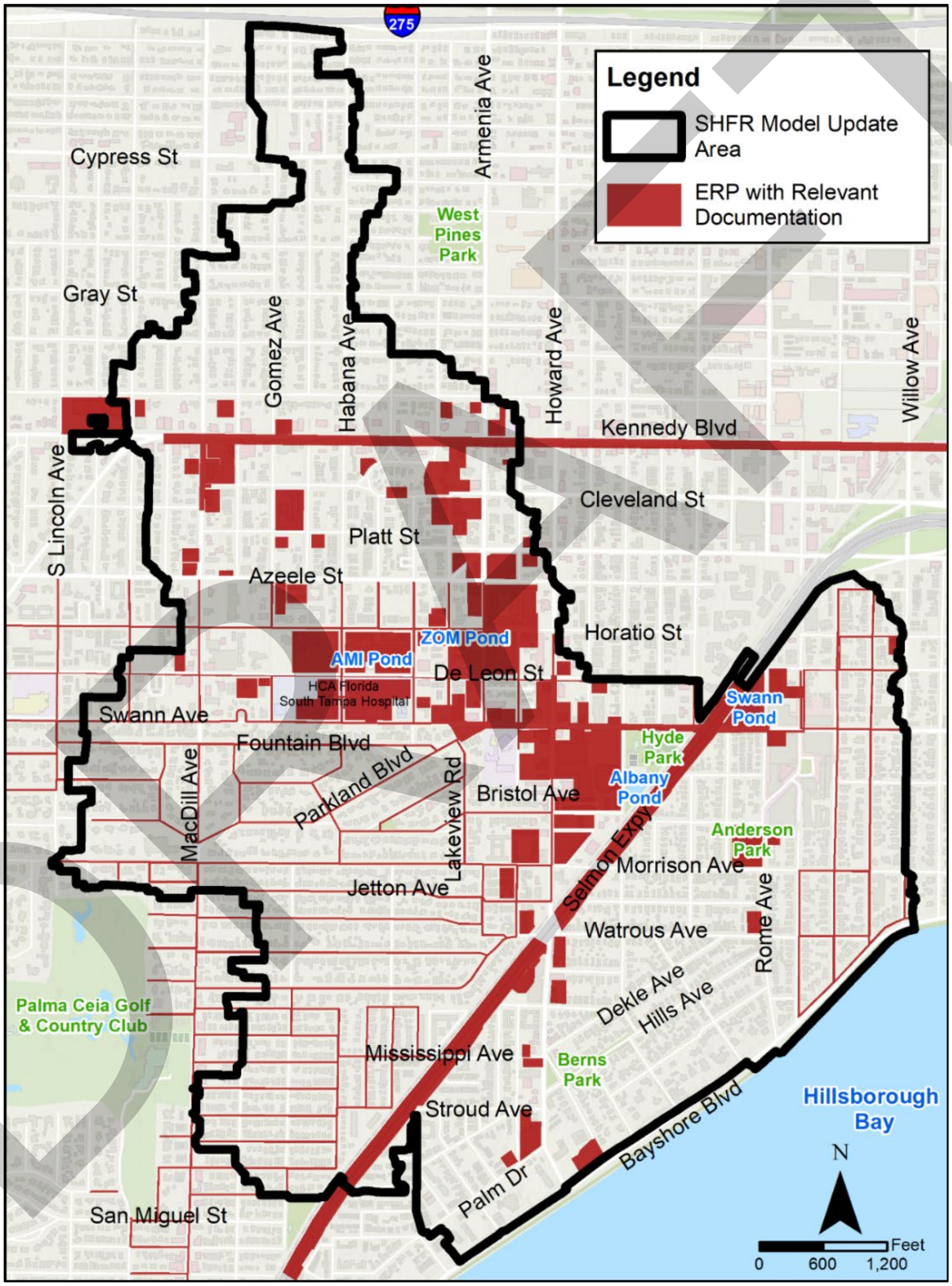

Figure 2-14 – Relevant ERPs for RECM Development

2.6 New Data Collection

2.6.1 Field Investigations

Several field investigations were conducted throughout the year 2025 as part of the preliminary design effort to investigate critical stormwater conveyance systems, stormwater infrastructure that had conflicting information among available data sources, and stormwater infrastructure that lacked credible available information. Pipes and culverts were located, and sizes were measured when accessible. Findings were used to verify or update model subbasins and hydraulic connections between model nodes. Photographs were taken at the locations depicted in **Figure 2-15**, some of which can be found with corresponding descriptions in **Appendix B.**

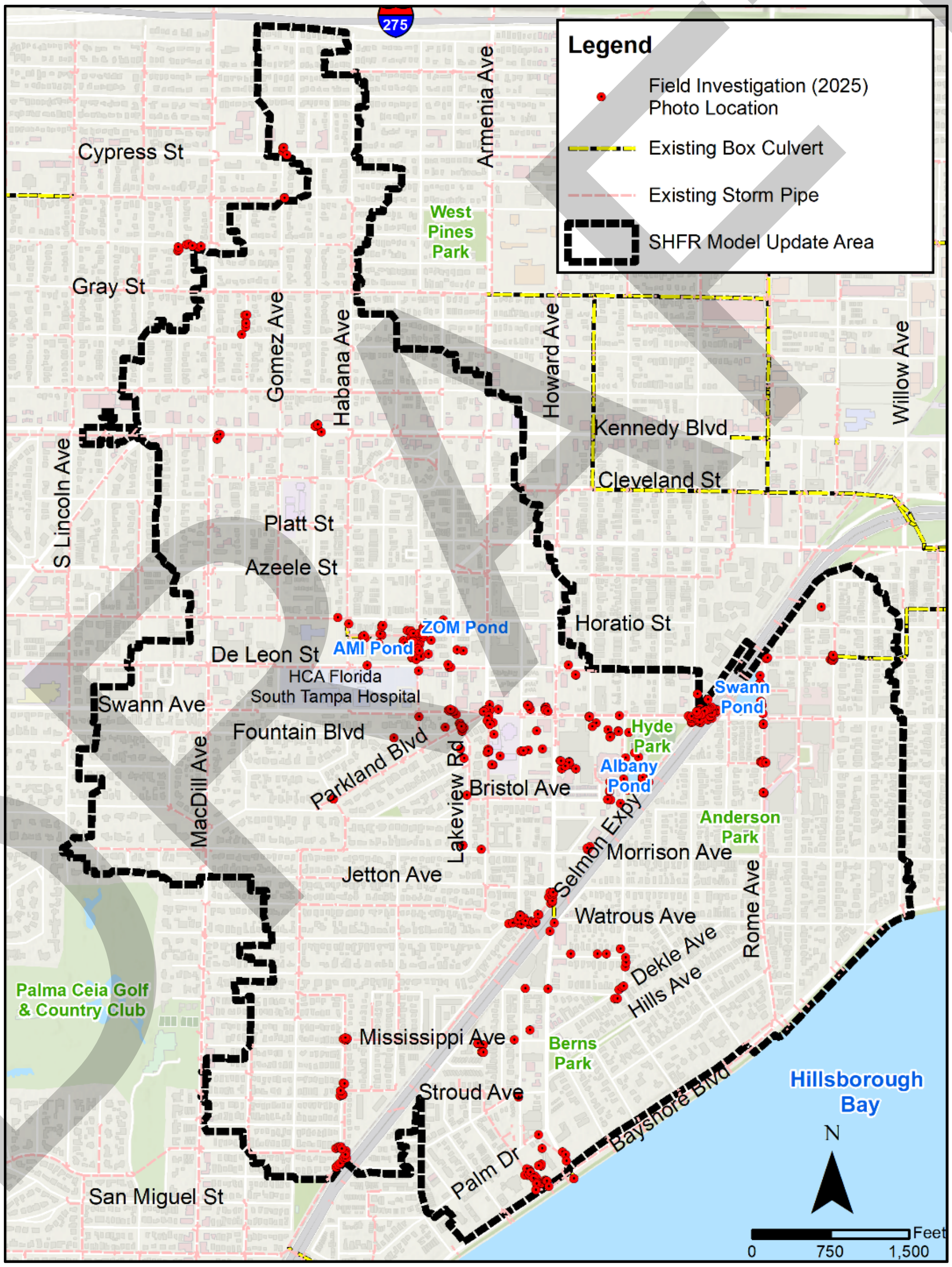

Figure 2-15 – Field Investigation Map

2.6.2 Geotechnical Exploration

A geotechnical investigation was performed in April of 2025 by AREHNA Engineering, Inc (AREHNA) to search for concrete remnants underneath the central green space in Parkland Estates located between W Fountain Blvd and W Parkland Blvd. This investigation was performed in response to community speculation that the concrete remnants may exist and negatively impact soil percolation within the area. Hand auger borings to depths between 6 and 7 feet below ground surface found no evidence of concrete debris below the surface.

A second geotechnical investigation was carried out by AREHNA on May 5th, 2025 to locate the existing 5'x10' box culvert beneath the CSX railroad and Selmon Expressway on S Howard Ave. Nine soundings were completed by jetting water to penetrate up to 14 feet below existing grade within S Howard Ave. The culvert was confirmed to exist to the north of the CSX railroad crossing and to the south of the Selmon Expressway overpass.

Findings from both investigations can be found in **Appendix N**.

2.6.3 Topographic and Right of Way Surveys

Topographic and right of way surveys along the recommended project route are ongoing at the time of this report, and once complete, will be used to progress the design to the 60 percent phase. The preliminary survey does provide surface elevations of specific features, which have been used to establish benchmarks for calibration and verification of the RECM. Once the survey is finalized, the RECM will be further refined to include the data where it is applicable and will be included as part of the ERP application submitted to SWFWMD.

2.6.4 Ground Penetrating Radar (GPR) Exploration

In December of 2025, ECHO UES, Inc. (ECHO) conducted a GPR investigation of the existing 5'x10' box culvert beneath the Selmon Expressway and CSX railroad. This level of exploration is limited, especially at the depth of the existing culvert, and will need to be supplemented by borings to confirm the exact limits of the box culvert walls. The GPR analysis was able to locate the approximate ends of the existing box culvert, which are shown below in **Figure 2-16** and **Figure 2-17.**

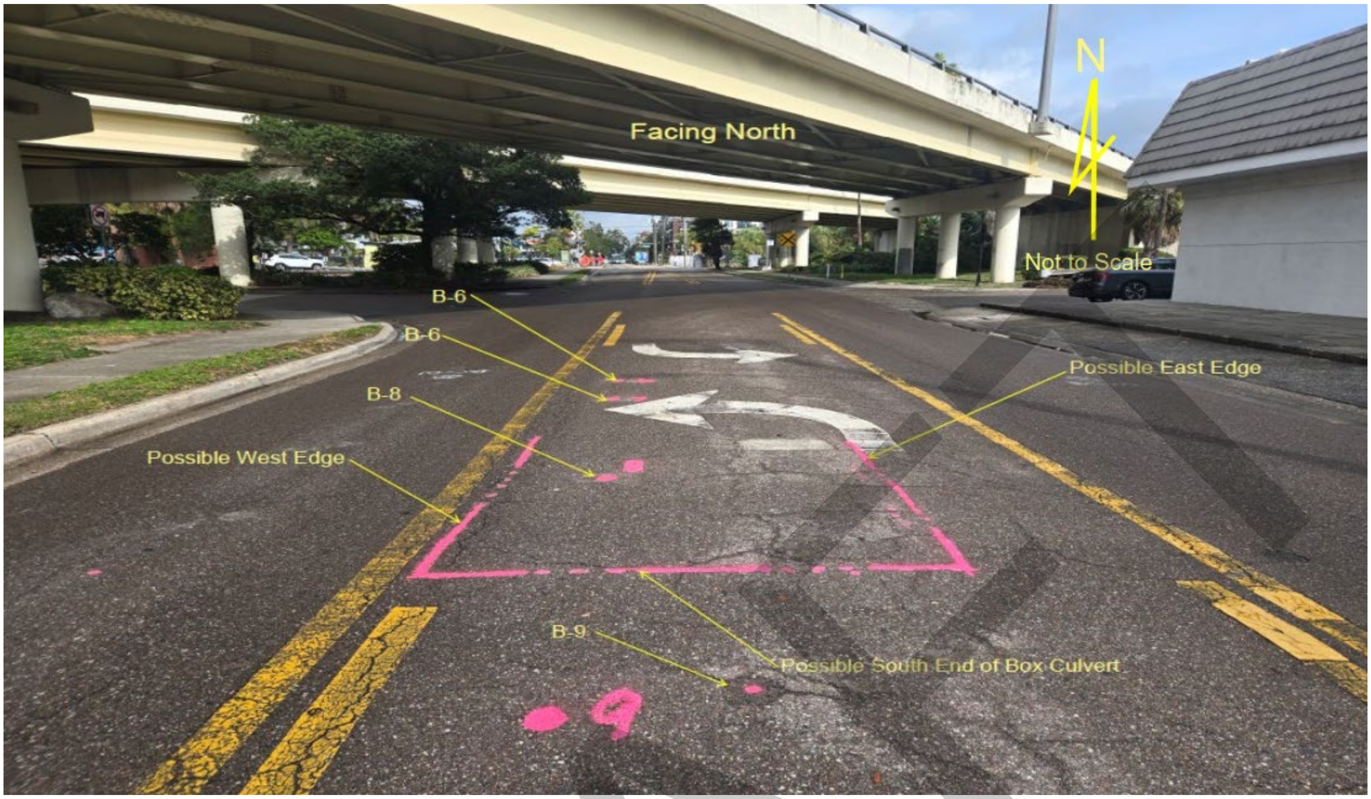

Figure 2-16 – GPR location of existing box culvert (south end, looking north)

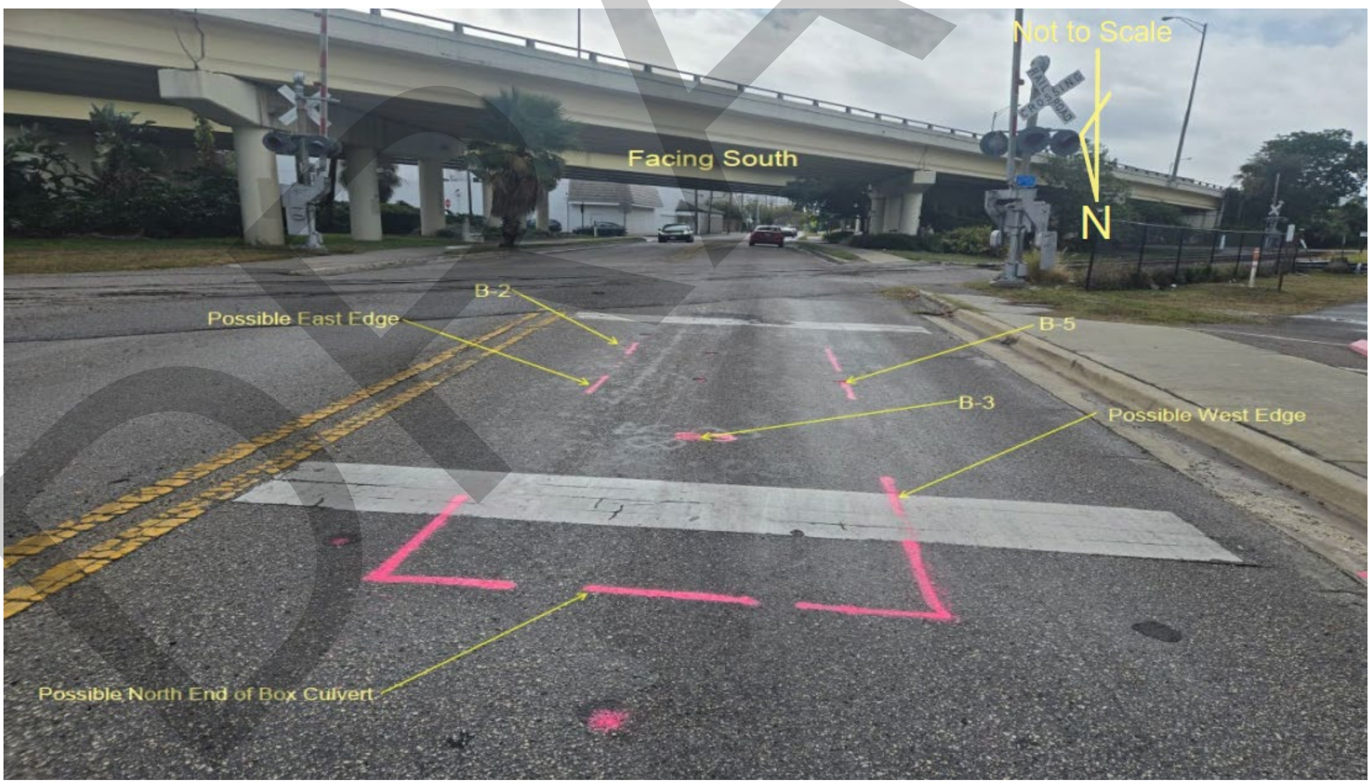

Figure 2-17 – GPR location of existing box culvert (north end, looking south)

2.6.5 Finished Floor Elevations (FFEs)

To predict structure flooding during various rainfall events and quantify the anticipated reduction of structure flooding because of the project, FFEs were surveyed for 206 individual buildings within Parkland Estates and Palma Ceia Pines. As mentioned previously, a FFE is the elevation of the top of the lowest finished floor in a building. The buildings were selected as candidates to be surveyed based on proximity to the RECM's predicted Hurricane Milton flood extents, which were mapped in ArcGIS using the model's peak stage and the 2017 DEM. Structures within the SHFR Flood Reduction Focus Area whose building footprint had significant contact with the Hurricane Milton simulation's flood extents were identified and included in the survey request. A map of the FFEs can be found in **Appendix D**.

2.6.6 Tree Survey and Assessment

AtkinsRéalis environmental scientists walked each primary alternative's route between March and May of 2025 to measure and assess the condition of all accessible trees within each corridor, under supervision of a certified arborist. Additional site visits were made in July and August of 2025 to survey additional trees within anticipated project limits. The tree inventory was developed using Survey123 software. Geospatial data was collected with a sub-meter Global Navigation Satellite System (GNSS), at times integrated with a Spike laser rangefinder for offset shots where the tree base occurs outside of the right of way, but the crown or roots extend into the right of way.

A total of 647 trees were mapped, identified, measured and photographed. A total of 46 species were identified, however each of the 17 grand trees identified were Live Oaks. Trees with a diameter at breast height (DBH) of 32" or larger and a condition rating of "fair" or better are considered grand trees, consistent with the City of Tampa's tree ordinance definition. A summary table of the tree inventory along with corresponding maps showing each tree's location can be found in **Appendix C.**

Table 2-3 below provides a list of unique tree species identified, total tree count by species, and count of Grand Tree specimens by species for all trees identified as part of this study.

Table 2-3 – SHFR Tree Inventory by Species

Tree Type	Count of Species	Count of Grand Tree
American elm	9	-
Birch	5	-
Bottlebrush	3	-
Camphor	6	-
Crepe Myrtle	51	-
Dahoon	2	-
Elm Chinese	11	-
Exotic	15	-
Kusamaki	2	-
Loblolly bay	16	-
Magnolia	12	-
Manila palm	4	-
Maple Red	2	-

Tree Type	Count of Species	Count of Grand Tree
Oak Laurel	32	-
Oak Live	263	17
Olive	2	-
Palm Cabbage	105	-
Palm Date	16	-
Palm Exotic	25	-
Palm Robellini	18	-
Palm Wash	3	-
Pignut hickory	2	-
Pine sp.	4	-
Pine Slash	4	-
Queen palm	4	-
Royal palm	2	-
Schefflera	2	-
Surinam cherry	3	-
Sweetgum	3	-
Triangle palm	3	-
Tuckeroo	2	-
Water oak	2	-
Unique species*	14	-
Grand Total	**647**	**17**

2.6.7 Traffic Data Collection

The design team collected traffic counts along W Swann Ave and S Howard Ave during April of 2025 to gain a better understanding of total daily traffic volumes. For portions of the analyzed routes outside of W Swann Ave and S Howard Ave, average annual daily traffic (AADT) values were obtained from FDOT's Florida Traffic Online website: Florida Traffic Online. If a route segment did not have FDOT data associated with it (most small, local roadways), an AADT of 1000 was assumed for analyses associated with this report. Traffic data collected as part of the SHFR project can be found in **Appendix E**.

3. Existing Site Conditions

The previous section highlighted the data collection and review that were completed as part of the H&H modeling effort and the development of this report. This section will build upon the data that was collected to document the drainage patterns, the hydrologic conditions, and the utilities within the SHFR Model Update Area, with emphasis on the areas in and surrounding Parkland Estates and Palma Ceia Pines neighborhoods.

3.1 Topography and Surface Drainage

The understanding of the topography, or ground surface elevations, within the project area is paramount to developing a H&H model that reflects the flow of the water during a rainfall event. For this project's H&H analysis, the topography of this area is represented by a DEM which was developed from LiDAR data as discussed in **Section 2.4.1** of this report. The DEM indicates how water flows over the ground surface due to gravity and changes in elevation. It also indicates how much storage volume exists within depressions in the ground surface. **Figure 3-1** shows the DEM's representation of ground surface elevations from Kennedy Blvd to Bayshore Blvd between MacDill Ave and Howard Ave, which includes most of Parkland Estates and Palma Ceia Pines**.**

Figure 3-1 represents the existing ground surface, which can be understood by interpreting the different colors represented in the figure. This is explained below from the highest elevations to the lowest elevations.

- **Highest elevations** shown are in **white/grey** (example is the raised portion of Selmon Expressway)
- **Second highest** elevations are shown by a **brown/red color**
- **Third highest** elevations are shown in **yellow/orange color**
- **Second lowest** elevations are shown in **green**
- The **lowest elevations** are shown in **blue** (example is Hillsborough Bay / Bayshore Blvd)

Using this explanation above, the large green, yellow, and orange areas that surround the HCA Florida South Tampa Hospital are low-lying areas. Also, this area is surrounded by brown/red color along W Kennedy Blvd to the north, S MacDill Ave to the west, W Morrison Ave to the south, and S Howard Ave to the east, therefore forming a bowl.

While this bowl is low-lying in comparison to adjacent terrain, it is important to remember that even the lowest ground elevations in Parkland Estates are still 15 feet above sea level, protecting this area from flooding due to storm surge.

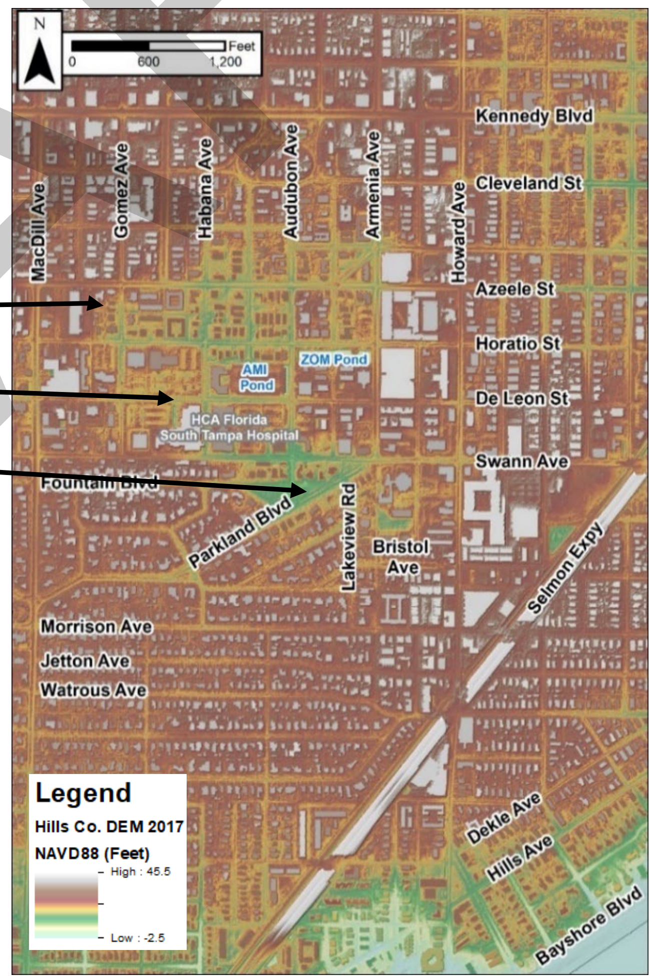

Figure 3-1 – Ground / Surface Topography

To further highlight the low-lying area in Parkland Estates and Palma Ceia Pines the following Figures show a plan view that is zoomed into the bowl area and the location of a cross section representing the elevations along the black dashed line on **Figure 3-2, Figure 3-4**, and **Figure 3-6** to help understand the elevation changes.

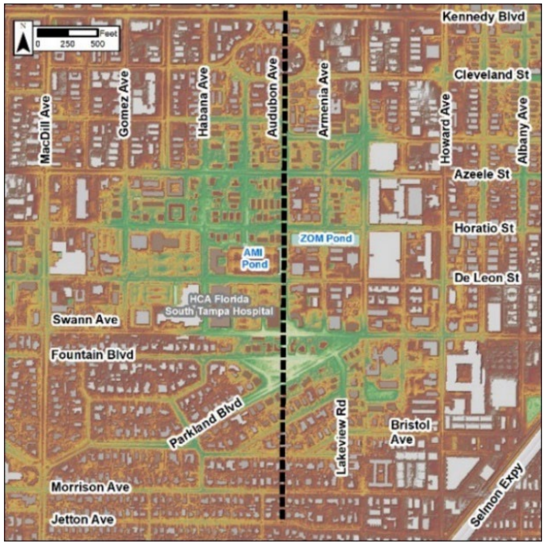

Figure 3-2 – Ground/Surface Topography

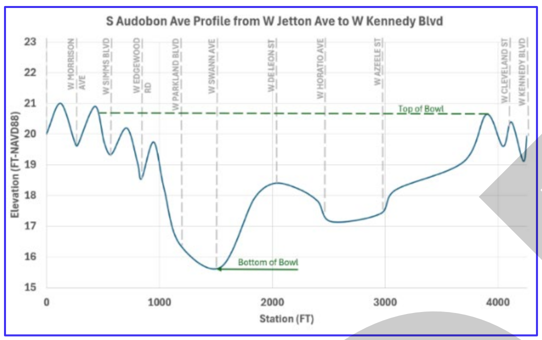

Figure 3-3 – Cross Section along Audubon Ave from Jetton Ave to Kennedy Blvd

Figure 3-4 – Ground/Surface Topography

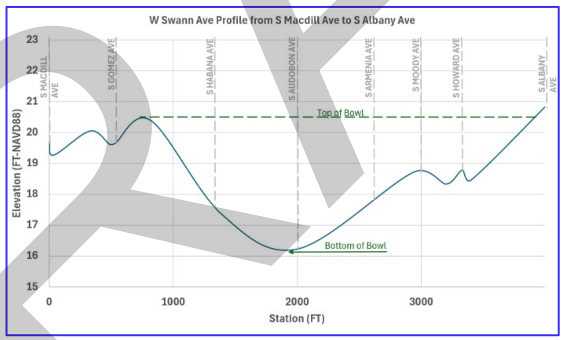

Figure 3-5 – Cross Section along Swann Ave from MacDill Ave to Albany Ave

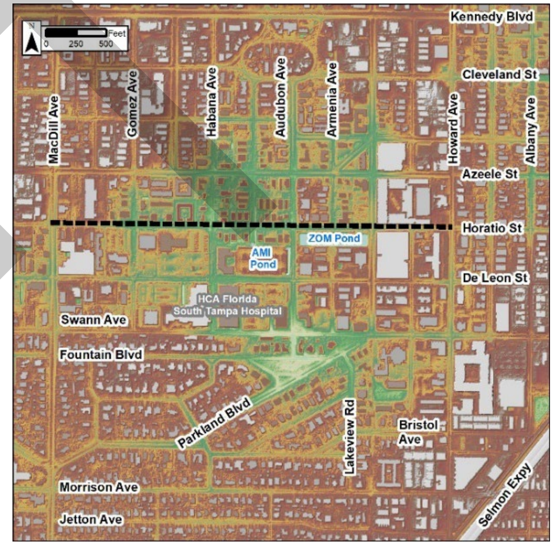

Figure 3-6 – Ground/Surface Topography

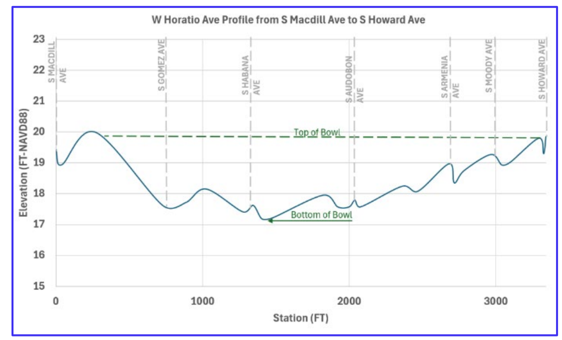

Figure 3-7 – Cross Section along Horatio St from MacDill Ave to Howard Ave

The figures above demonstrate that the area bounded by W Kennedy Blvd on the north, S MacDill Ave on the west, W Morrison Ave on the south, and S Howard Ave on the east forms a depression. As such, it must rely on the stormwater infrastructure (underground pipes) to drain stormwater produced by rainfall events. **Figure 3-3, Figure 3-5, and Figure 3-7 demonstrate that when pipes are overwhelmed**, **water must reach an elevation around 20 feet before overtopping the bowl. This results in flooding that is 3 to 5 feet deep within the lowest parts of Parkland Estates and Palma Ceia Pines.**

3.2 Existing Outfall Systems and Drainage Patterns

A full understanding of this area's existing drainage patterns requires not only an understanding of the topography described in the previous section, but also an understanding of the existing stormwater infrastructure, which primarily consists of underground conveyance systems (inlets and underground pipes). A combination of low-lying topography and severely undersized and antiquated stormwater infrastructure is responsible for the severe flooding that occurs in Parkland Estates and Palma Ceia Pines.

The three current outfall systems that drain the SHFR Flood Reduction Focus Area are the Cleveland Street Outfall system, the Upper Peninsula West Outfall system, and the Upper Peninsula East Outfall system. An overview of these systems is presented in **Figure 3-8,** along with their respective drainage areas. These three systems provide the only way for water to drain from the low-lying areas in the SHFR Flood Reduction Focus Area, until the bowl fills and overtops the high ground elevations that form its boundary, resulting in flooding depths of 3 to 5 feet as mentioned previously. All three of these systems were constructed prior to 1960 and are severely undersized, resulting in flooding during heavy rainfall events.

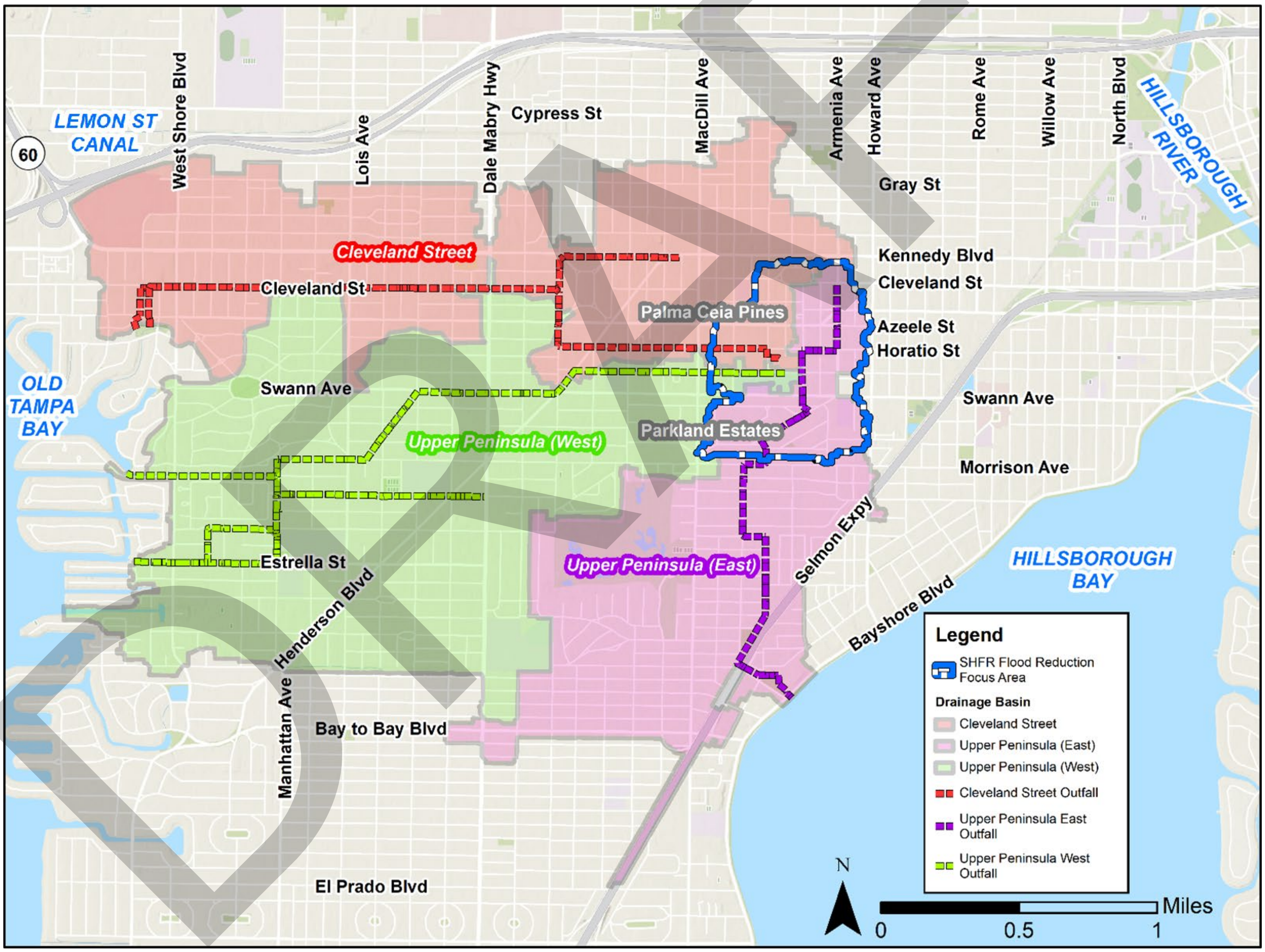

Figure 3-8 – Overview of Existing Man-Made Drainage Basins

3.2.1 Cleveland Street Outfall System (W Horatio St Trunkline)

The Cleveland Street Basin includes a portion of Palma Ceia Pines, which is designed to drain west through a large elliptical pipe beneath W Horatio St beginning at S Habana Ave. The now-severely undersized pipe system and outfall west to Old Tampa Bay was designed by FDOT and was constructed in the late 1950s as a joint venture between FDOT and the City. It was designed using what are now antiquated rainfall intensities, design standards, and development densities. More information about the history of this system can be found in the City's 1983 drainage study.

Roughly 60 acres between W Kennedy Blvd and W Horatio St drain directly to the AMI detention pond through a 4'x8' box culvert (**Figure 3-9**), which also serves as the pond's primary outfall when it reaches its capacity and reverses flow, discharging into the Cleveland Street Outfall system (**Figure 3-10**). The AMI Pond, which is approximately 2.5 acres in size and lies beneath a parking deck owned by HCA Florida South Tampa Hospital, is maintained by the City and was constructed as a joint use facility in the early 1990s to provide stormwater treatment and flood relief to W Kennedy Blvd, Palma Ceia Pines, and the Cleveland Street Outfall system. It provides approximately 16.7 ac-ft of available storage for stormwater runoff. An internal weir beneath the S Habana Ave & W Horatio St intersection directs low flows into the pond for stormwater treatment during less intense and manageable rainfall events. The pond recovers the final 2 feet of its available treatment depth using a combination of underdrain system and submersible pump, which forces the remaining water into the Cleveland Street Outfall system.

The system receives excess rainfall as runoff not only from the Cleveland Street Basin area, but also from overland flows that come from a surcharged Lemon Street Canal system to the north. When the Cleveland Street Outfall system becomes overwhelmed, stormwater backs up into the SHFR Flood Reduction Focus Area (**Figure 3-11**), flowing to AMI detention pond, and the adjacent low-lying roadways and properties. Some of this water makes its way south over land to W Swann Ave and Parkland Estates during severe rainfall events, like the 5-year/8-hour design storm.

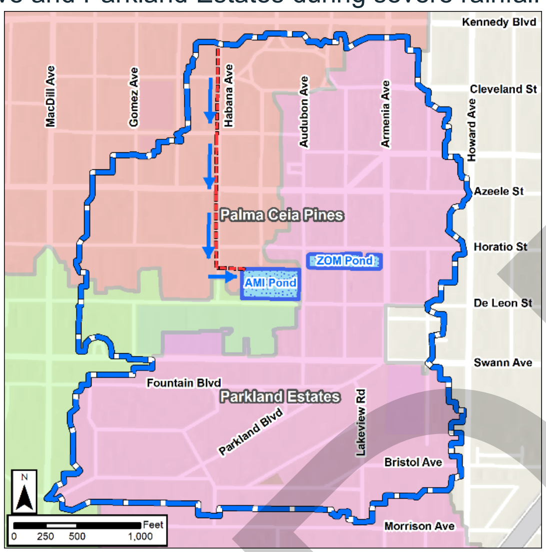

Figure 3-9 – Horatio Street Trunkline – Low-Flow Conditions (Positive Flow)

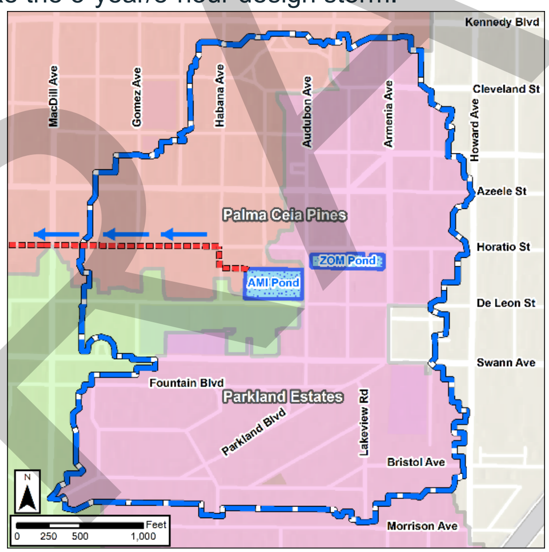

Figure 3-10 – Cleveland Street Outfall System – Designed High Flow Conditions (Positive Flow)

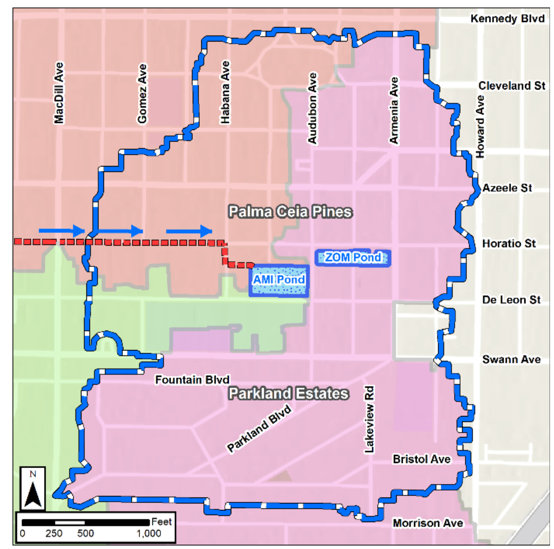

Figure 3-11 – Cleveland Street Outfall System – Actual High Flow Conditions (Negative Flow)

Legend Cleveland Street Outfall | Existing Pond | SHFR Flood Reduction Focus Area | Cleveland Street | Upper Peninsula (West) | Upper Peninsula (East)

3.2.2 Upper Peninsula West Outfall System (W De Leon St Trunkline)

The Upper Peninsula West Basin includes a large portion of the Upper Peninsula watershed, and outfalls to Old Tampa Bay by way of multiple box culverts and canals, including the recently completed Dale Mabry/Henderson Trunkline. Palma Ceia Pines is at the eastern boundary and most upstream portion of this basin, which includes W De Leon St to the west of S Audubon Ave and a portion of HCA Florida South Tampa Hospital. This system was originally constructed prior to 1950 based on the South West Tampa Drainage District Primary Drainage Facilities map in **Appendix R.**

The underground pipe system designed to convey stormwater west across the peninsula (**Figure 3-12**) is prone to becoming overwhelmed during periods of heavy rainfall, like the Cleveland Street Outfall system. When this happens, stormwater can reverse flow and come out of the storm inlets along W De Leon St (**Figure 3-13**), contributing to the flooding around the hospital. **Figure 3-14** below shows a graph generated by this project's H&H model that predicts flow through this system during the 5-year/8-hour design storm. Negative flows reflect stormwater coming into the SHFR Flood Reduction Focus Area (**Figure 3-13**) for a period of time while the downstream system is overwhelmed, before reversing flow again and discharging west, as it was intended to do (positive flows in **Figure 3-14**).

Figure 3-12 – Upper Peninsula West Outfall System – Low Flow Conditions (Positive Flow)

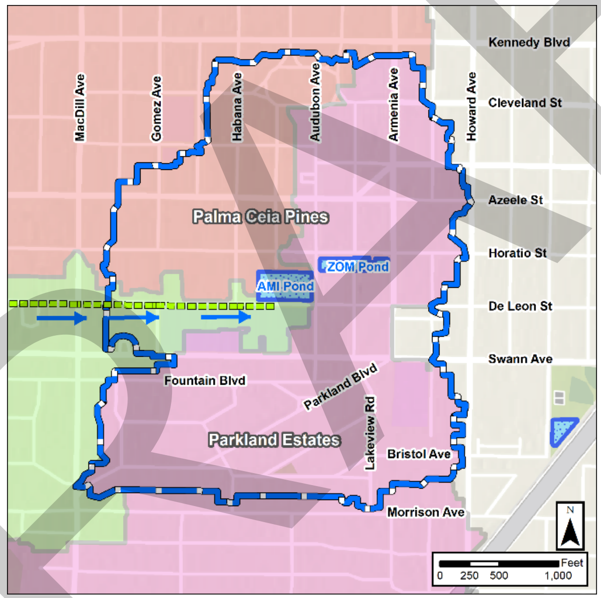

Figure 3-13 – Upper Peninsula West Outfall System – High Flow Conditions (Negative Flow)

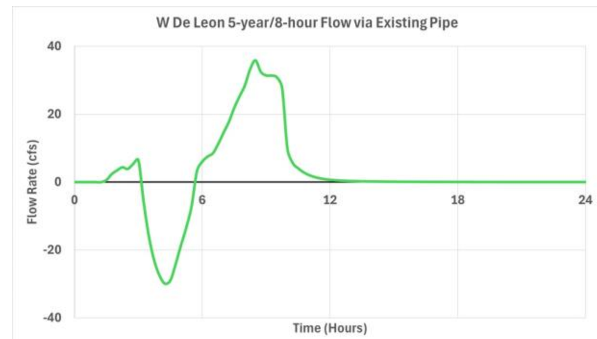

Figure 3-14 – Upper Peninsula West Outfall System – Flow Conditions in a 5-year/8-hour Storm Event

Legend Upper Peninsula West Outfall | Existing Pond | SHFR Flood Reduction Focus Area | Cleveland Street | Upper Peninsula (West) | Upper Peninsula (East)

3.2.3 Upper Peninsula East Outfall System (S Audubon Ave Trunkline)

The Upper Peninsula East Basin makes up a portion of the Upper Peninsula watershed, primarily to the east of S Dale Mabry Hwy and to the south of the Cleveland Street Basin. It drains to Hillsborough Bay beneath Bayshore Blvd through large pipes or box culverts at two primary locations: Rubideaux St and a drainage easement between W Bay to Bay Blvd and W Barcelona St. Palma Ceia Pines is at the northern boundary and most upstream portion of this basin, which includes S Audubon Ave and S Armenia Ave to the north of W Swann Ave. This basin also includes much of Parkland Estates and New Suburb Beautiful.

Approximately 40 acres contribute stormwater runoff to the ZOM Pond – a 1.3-acre stormwater detention pond located along the south side of W Horatio St between S Audubon Ave and S Armenia Ave. The pond was constructed by the City in 2001 to provide compensatory stormwater treatment for multiple offsite projects, and for additional flood relief. The pond has limited available storage (less than 4 acre-feet) for stormwater, which is then discharged directly to S Audubon Ave where a 36-inch diameter pipe carries the stormwater into Parkland Estates.

The severely undersized existing pipe system in Parkland Estates designed to convey stormwater south toward Hillsborough Bay (**Figure 3-15**) was originally constructed prior to 1950 based on the South West Tampa Drainage District Primary Drainage Facilities map in **Appendix R**. While upgrades have since been made to a portion of the system within Parkland Estates, much of the trunkline downstream of these upgrades remains unchanged and is prone to back up into the low-lying roadways of Parkland Estates when it becomes overwhelmed by heavy rainfall (**Figure 3-16**), just like the two systems discussed previously. **Figure 3-17** shows the flow leaving Parkland Estates with the values that are positive being flows discharging as designed and the negative flows representing flow back into Parkland Estates.

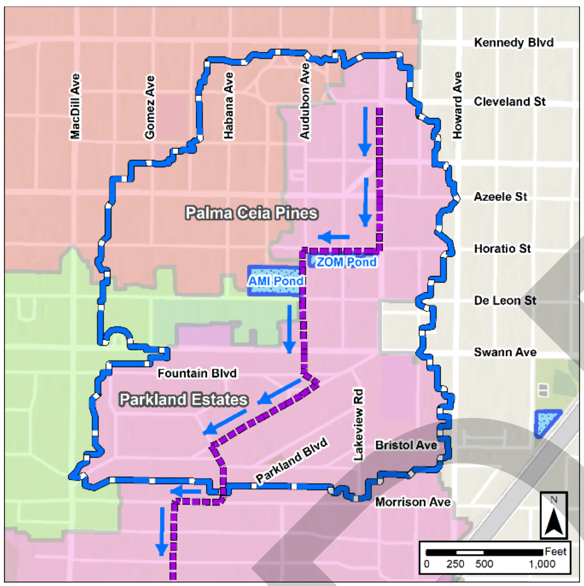

Figure 3-15 – Upper Peninsula East Outfall System – Low Flow Conditions (Positive Flow)

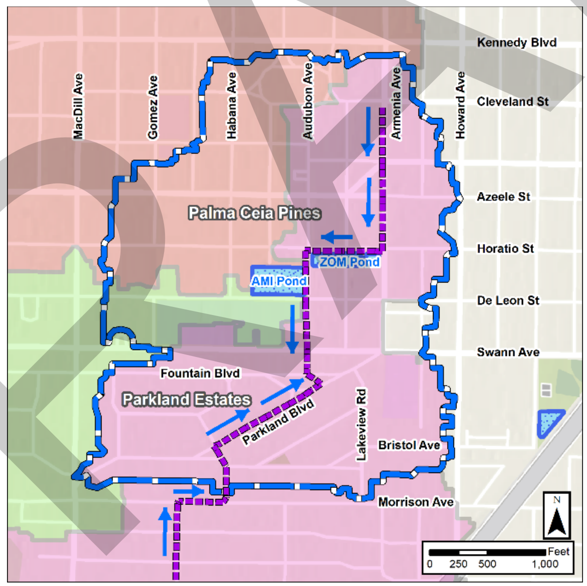

Figure 3-16 – Upper Peninsula East Outfall System – High Flow Conditions (Negative Flow)

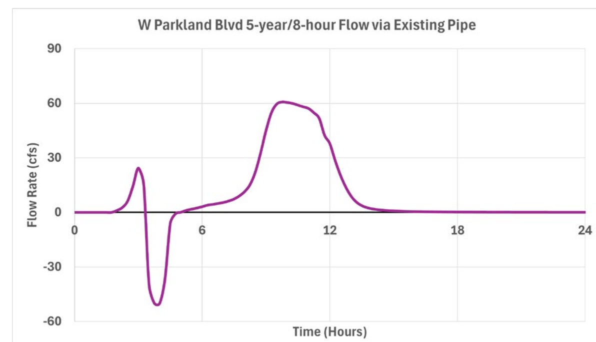

Figure 3-17 – Upper Peninsula East Outfall System – Flow Conditions in a 5yr-8hr Storm Event

Legend Upper Peninsula East Outfall | Existing Pond | SHFR Flood Reduction Focus Area | Cleveland Street | Upper Peninsula (West) | Upper Peninsula (East)

3.2.4 Swann Pond, Albany Pond, and S Rome Ave Outfall

Stormwater runoff from approximately 100 acres is routed directly into the 1.7-acre detention pond between W Swann Ave, the Selmon Expressway, and S Rome Ave, known as Swann Pond. In the early 1990s, the pond's drainage area was expanded west to include W Swann Ave between S Armenia Ave and S Westland Ave (including a portion of S Howard Ave), helping to alleviate flooding along the corridor, which drained through the undersized Upper Peninsula East Outfall through Parkland Estates at the time. The project also used the pond to provide stormwater treatment to compensate for the addition of turn lanes on W Swann Ave. Swann Pond discharges through a control structure at its southeast corner, and then along S Rome Ave through approximately 3,100 linear feet of 48-inch diameter pipe directly into Hillsborough Bay. The S Rome Ave outfall picks up stormwater from approximately 60 additional acres to the south of the Swann Pond basin on its way to Hillsborough Bay.

The stormwater pond located between S Albany Ave, the Selmon Expressway, and W Swann Ave receives stormwater runoff from approximately 16 acres, which includes a portion of the Selmon Expressway, a portion of S Albany Ave, and the ALDI at W Swann Ave and S Albany Ave. The pond currently has no functioning outfall because the pump station on its southeast side that once controlled water levels in the pond is inoperable. Water fluctuation in the pond is driven by groundwater conditions and percolation until it elevates enough to overtop its bank, at which point it discharges north and east within a small ditch along the CSX railroad, ultimately reaching W Swann Ave and Swann Pond.

This overall drainage pattern is illustrated below in **Figure 3-18**.

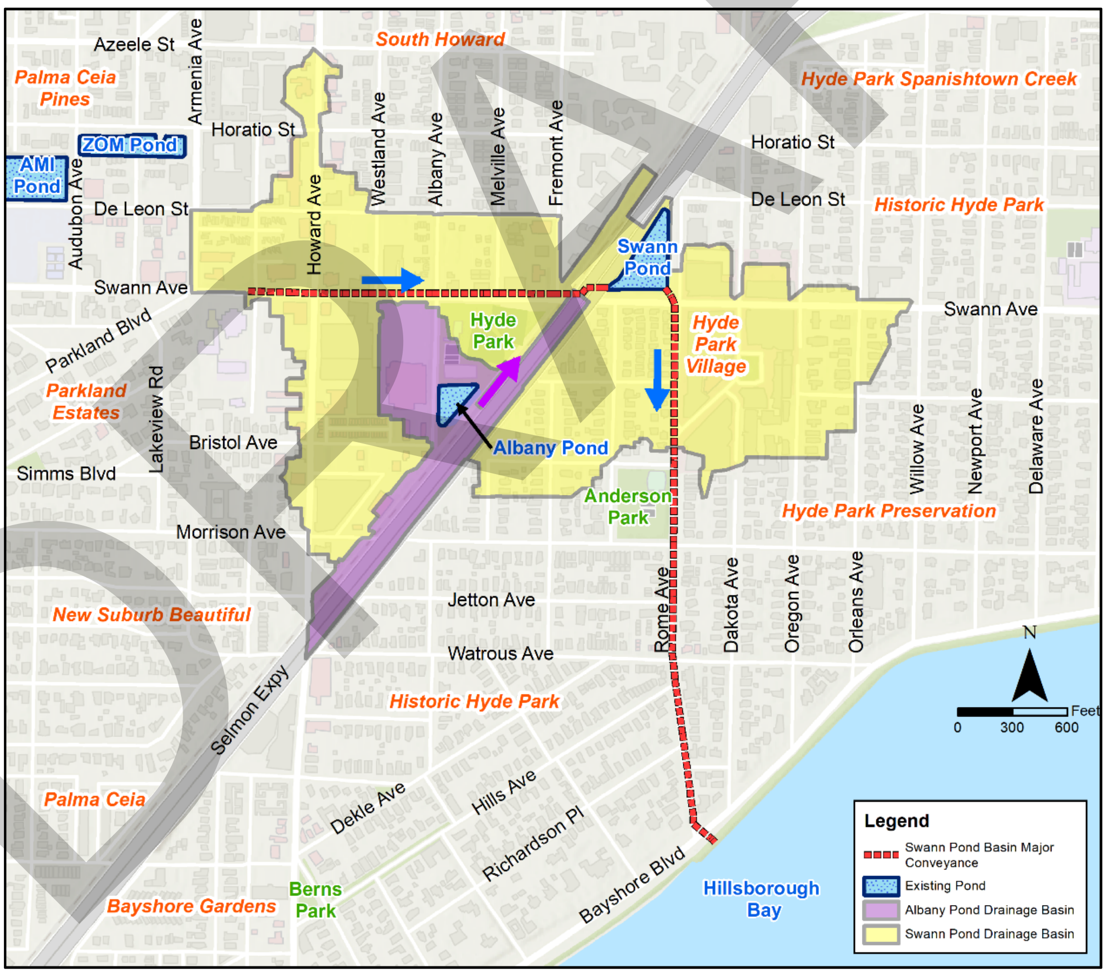

Figure 3-18 – Swann Pond, Albany Pond and S Rome Ave Outfall Existing Drainage Map

3.3 Utilities

Given that the alternatives evaluated in this report include large underground stormwater conveyance systems that will inevitably conflict with existing utilities, it is anticipated that relocation of many existing utilities will be required to complete the project. A spatial overview of the City's existing wastewater, potable water, and reclaimed water systems near the anticipated project limits is illustrated in **Figure 3-19** below. This utility information was provided by the City.

Below summarizes the utility infrastructure within the potential project area:

- Sanitary sewer gravity system includes pipes ranging in diameter from 6 inches to 42 inches with the largest pipe – a 42-inch diameter (a 48-inch diameter pipe that has been lined to create an inside diameter of 42 inches) carries wastewater north and east along Bayshore Blvd between W Barcelona St and the Selmon Expressway.
- 48-inch diameter sanitary sewer force main exists along Bayshore Blvd between W Barcelona St and S Rome Ave, where it follows S Rome Ave north until it turns east on W De Leon St. This force main deflects beneath the existing triple box culverts beneath Bayshore Blvd at S Howard Ave.
- Potable Water System includes pipes ranging in diameter from 2 inches to 12 inches with the largest sizes located on along S Howard Ave, W Mississippi Ave, and Bayshore Blvd.
- Reclaimed Water System includes pipes ranging in diameter from 2 inches to 30 inches with the largest pipe – a 30-inch diameter ductile iron pipe – located along W De Leon St to the west of S Fremont Ave, and along W Swann Ave to the east of S Fremont Ave.

The most challenging utilities that this project will need to avoid are the large sanitary sewer force and gravity mains mentioned above. Crossing the existing large gravity main is unavoidable and will require a large conflict structure within the Bayshore Blvd corridor, where the new culvert connects to the existing triple box culverts beneath Bayshore Blvd.

Crossing the 48-inch diameter force main, which handles almost a third of the City's wastewater, is also unavoidable if the new trunkline is to reach Hillsborough Bay to the south of W Horatio St. One of the appeals of using S Howard Ave for the new trunkline is that this force main was designed in 1973 at a lower elevation across the Bayshore Blvd & S Howard Ave intersection in anticipation of a future box culvert outfall crossing it at this location. Subsequently, the existing triple box culverts were constructed above the force main in the late 1980s. This avoids the need for temporary shutdown and vertical relocation of the large force main, reducing both cost and duration of construction.

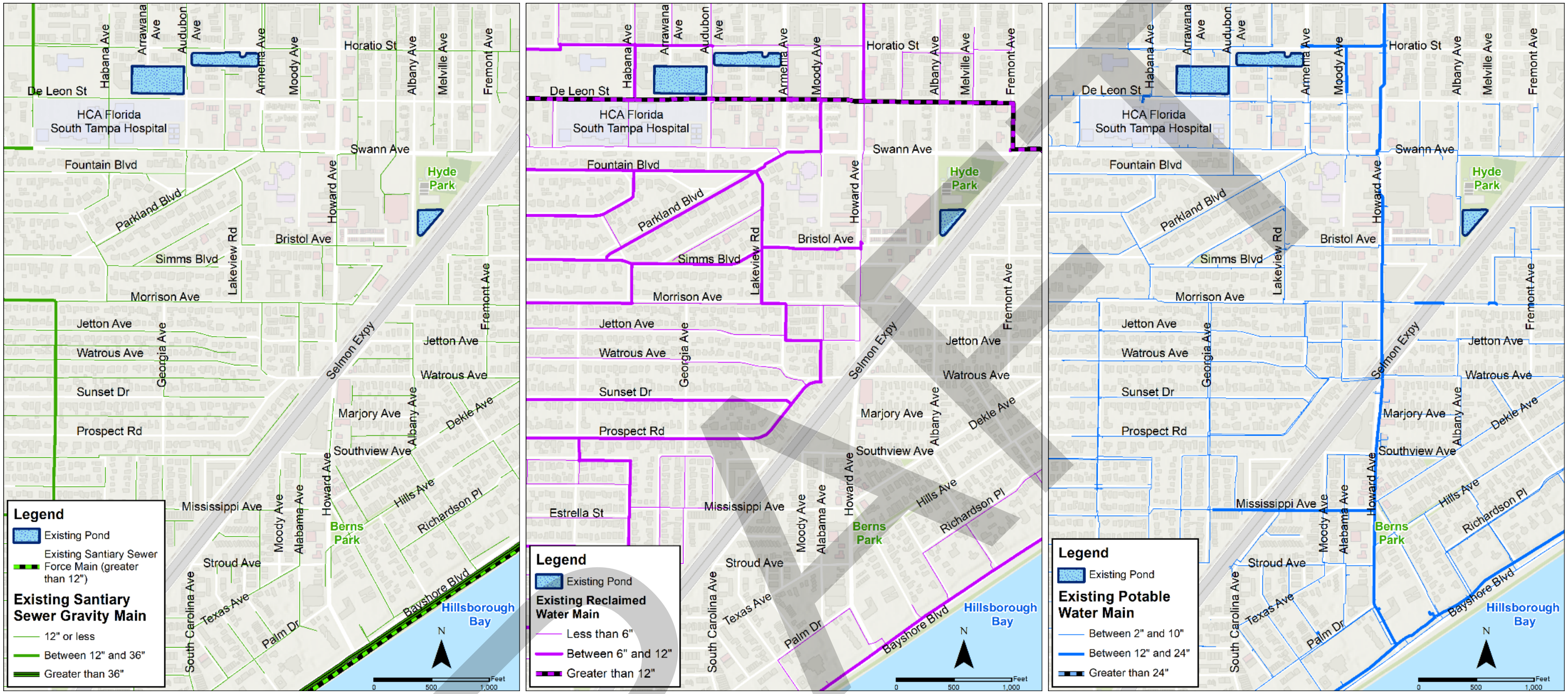

Figure 3-19 – Overview of Existing Water and Wastewater Utilities

3.4 Soils Information

Soils information for the RECM extents was sourced from the USDA NRCS Web Soil Survey (WSS) and was classified by hydrologic characteristics. The hydrologic soil groups (HSG) designation for soils is used to estimate runoff from precipitation. Their characteristics are described below:

- **HSG A**: Soils with high infiltration rates when the groundwater elevation exceeds 3 feet of depth. Soil types comprising this group generally include deep well drained to excessively drained sands that produce significant rainfall losses as infiltration.
- **HSG B**: Soils with a moderate infiltration rate when saturated. This group is chiefly comprised of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture.
- **HSG C**: Soils with a slow infiltration rate when saturated. This group consists chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture.
- **HSG D**: Soils with a very slow infiltration rate and high runoff potential. These consist primarily of soils that have a permanent high-water table; soils that have a claypan, clay layer, or other relatively impermeable material at or near the surface; or mucky wetland soils.
- **HSG W:** Designation is used for bodies of water such as the sea, lakes, ponds, and rivers.

Soils are also assigned dual hydrologic classifications (e.g. A/D or B/D) if they exhibit substantially different hydrologic characteristics during the wet and dry seasons. During the wet season, these soils become saturated throughout much of the soil column due to elevated water table conditions. Infiltration is thus impeded, and the soils exhibit Group D infiltration characteristics. During the dry season when the water levels recede, infiltration rates increase to those corresponding to Group A or Group B levels.

As shown in **Table 3-1**and **Figure 3-20** below, the HSG A makes up 55% of the project area.

Table 3-1 –Summary of Hydrologic Soil Group within SHFR Model Update Area

Hydrologic Soil Group	Area (AC)	Percentage of Total Area
A	579.6	55.2%
A/D	380.1	36.2%
C/D	23.8	2.3%
D	64.4	6.1%
W	1.5	0.1%

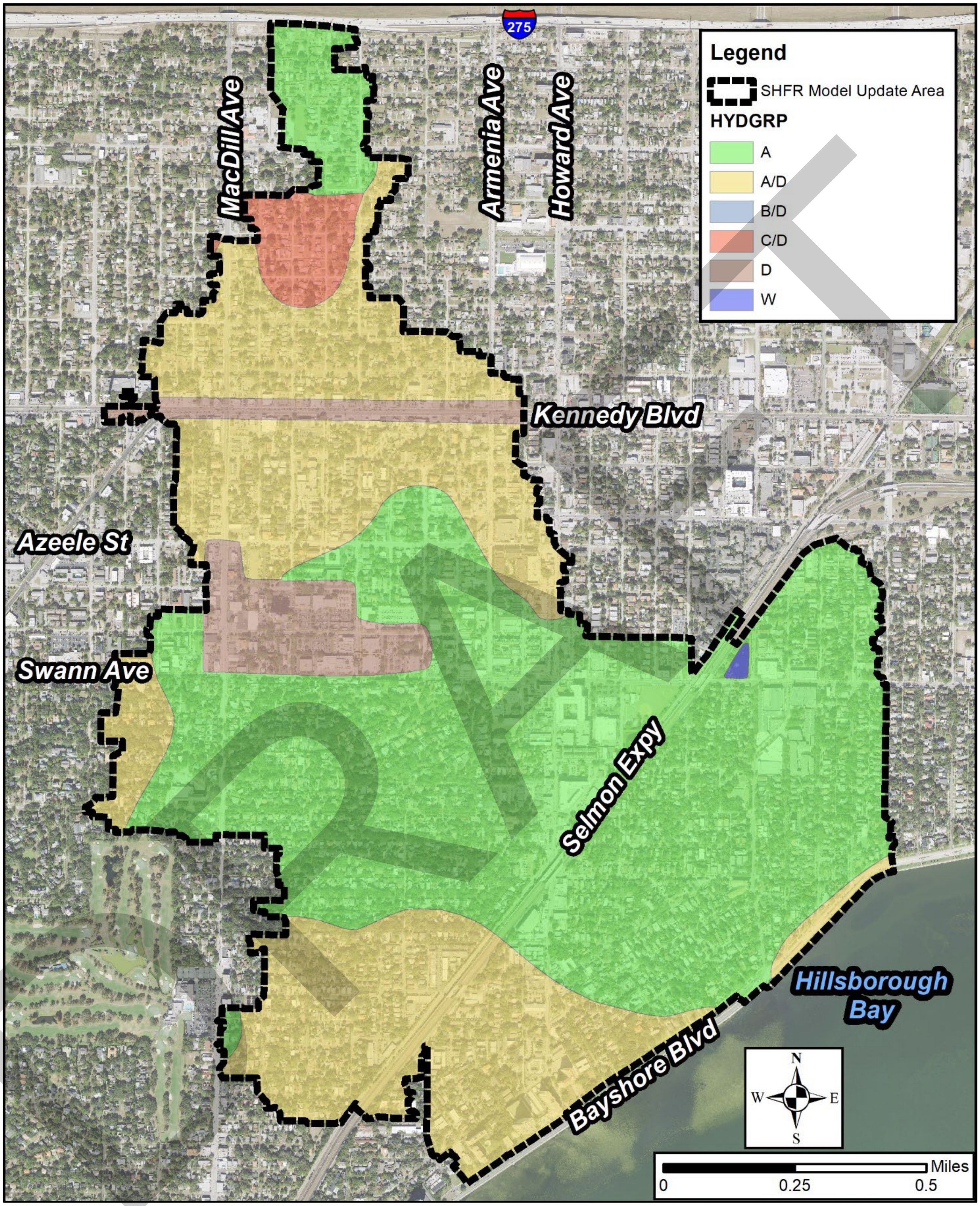

Figure 3-20 – Soil Coverage within SHFR Model Update Area

3.5 Land Use Information

The 2023 land use coverage data was downloaded from SWFWMD and updated where appropriate based on the most recent available aerial imagery. As shown in **Table 3-2** and **Figure 3-21**, the main land use coverage within the project's model update area is residential high density (77%), followed by commercial and services (18%). The other land use coverages within this area make up less than 5% of the total area.

Table 3-2 –Summary of Land Use Coverage within SHFR Model Update Area

Land Use	Area (AC)	Percentage of Total Area
Commercial and Services	184.3	17.6%
Emergent Aquatic Vegetation	0.6	0.1%
Institutional	13.3	1.3%
Recreational	6.2	0.6%
Reservoirs	2.5	0.2%
Residential High Density	810.7	77.3%
Transportation	31.0	3.0%
Utilities	0.7	0.1%

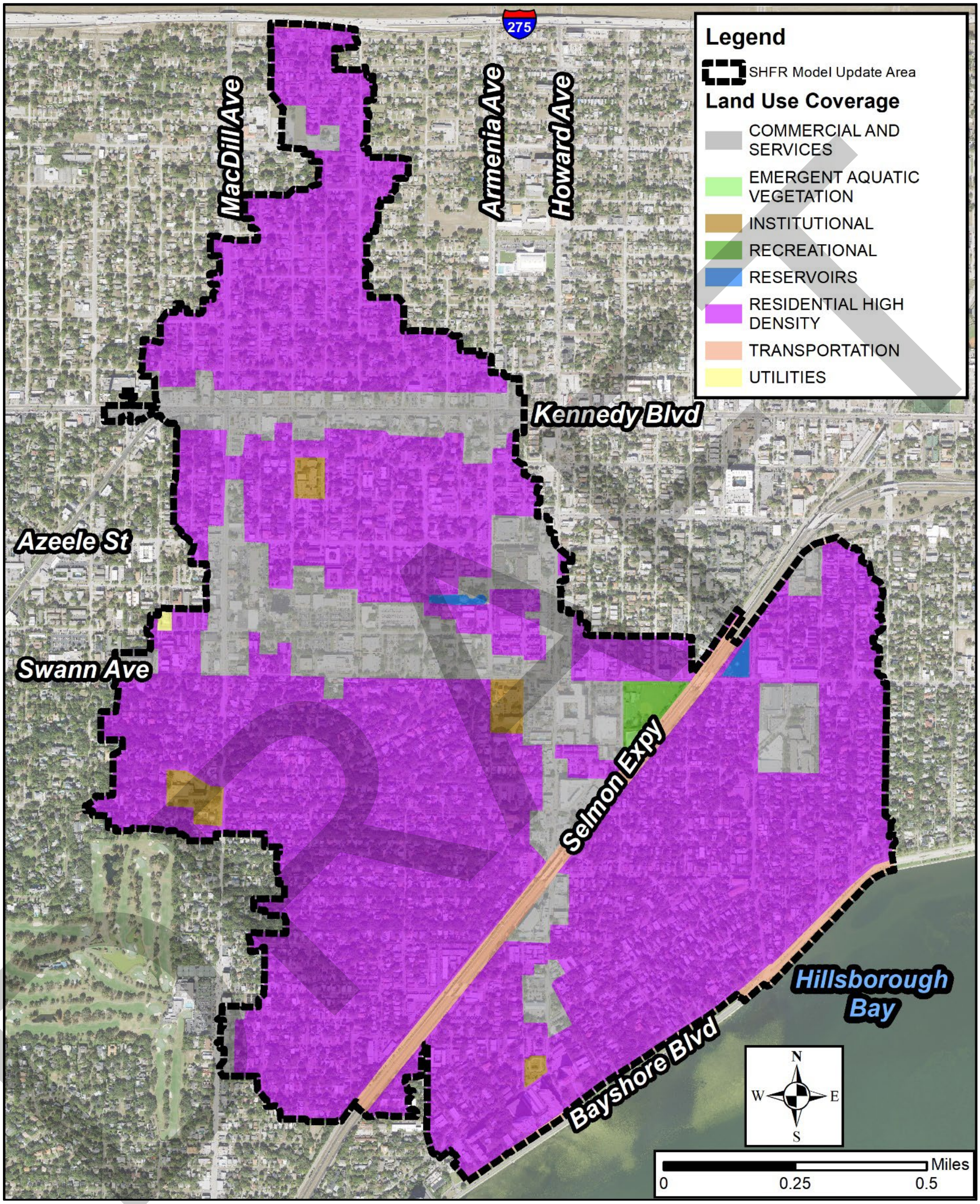

Figure 3-21 – Land Use Coverage within SHFR Model Update Area

4. Existing Conditions H&H Model

4.1 Overview of Model Development

The development of a detailed and defensible model that accurately reflects flood conditions during simulations of known rainfall events is critical to the design of a successful flood relief project. The design team used a range of available data to update the City's latest Upper Peninsula Watershed H&H model (UPWM), which includes most of the SHFR Flood Reduction Focus Area and its three existing primary outfalls. This model's last complete update occurred in 2012, but it was further refined in 2018 as part of the Dale Mabry/Henderson Trunkline project. The proposed conditions model for that project, which has since been constructed, was used as a starting point for the development of the SHFR existing conditions model (RECM). The H&H model that was developed by JMT as part of their 2022 feasibility study was also reviewed and used in part to develop the RECM, which is reflective of today's H&H conditions.

The RECM is used to predict the severity of existing flooding for a range of synthetic design storm events, and to identify FPLOS deficiencies within the model update area. A copy of the RECM can easily be modified to create proposed conditions models for any alternative, whose results can then be compared back to the RECM results to quantify anticipated flood reduction benefits of potential solutions.

Here is a summary of the steps taken to develop the project's RECM (prior to calibration and verification):

- The modeling effort began in 2025 by converting the City's approved Upper Peninsula Watershed 1-dimensional XPSWMM model to ICPR 4 (now StormWise) modeling software.
- This baseline model was then expanded to include the geographic area deemed hydraulically relevant to Parkland Estates and Palma Ceia Pines neighborhoods, which we refer to as the SHFR Model Update Area in this report (see **Figure 4-1**).
- The latest available data collected (discussed in Section 2) was used to add or refine the model's subbasins, node configuration, and links (hydraulic connections between nodes) within the SHFR Model Update Area.
- The latest soils and land use coverages were used to update hydrologic parameters of subbasins, and the 2017 DEM was used to update above-ground storage available for runoff throughout the entire RECM limits.
- Time of concentration was evaluated and updated for subbasins within the SHFR Model Update Area, where appropriate.
- Hydrologic simulations were prepared for seven design storm events using SWFWMD guidance and documentation for the 24-hour events, and FDOT documentation for the 5-year/8-hour event.
- Model boundary nodes and boundary stage sets were added or updated to reflect a constant water surface elevation of 2.0 (ft, NAVD88) for the design-storm events at all locations within Old Tampa Bay and Hillsborough Bay.
- Other boundary nodes were added to the east of the model update area to receive excess flows leaving the model's geographic limits. Water surface elevations at these nodes were incorporated as time-stage relationships for each event simulated and reflect model results from the adjacent Cypress Street Outfall model for the same storm event, where applicable.
- Inflows and outflows across the model's northern shared boundary with the Lemon Street Canal Basin were applied as external hydrographs at the appropriate locations within the model, based on the City's most recent Lemon Street Canal Model (updated in 2018). This was done to ensure that stormwater making it to the Cleveland Street Outfall system from an overwhelmed Lemon Street Canal system is accounted for in the RECM.

Figure 4-1 below provides a comparison of the base model's limits (in green) to the SHFR Model Update Area (black) and RECM limits (purple), along with the locations of boundary nodes and external inflows/outflows.

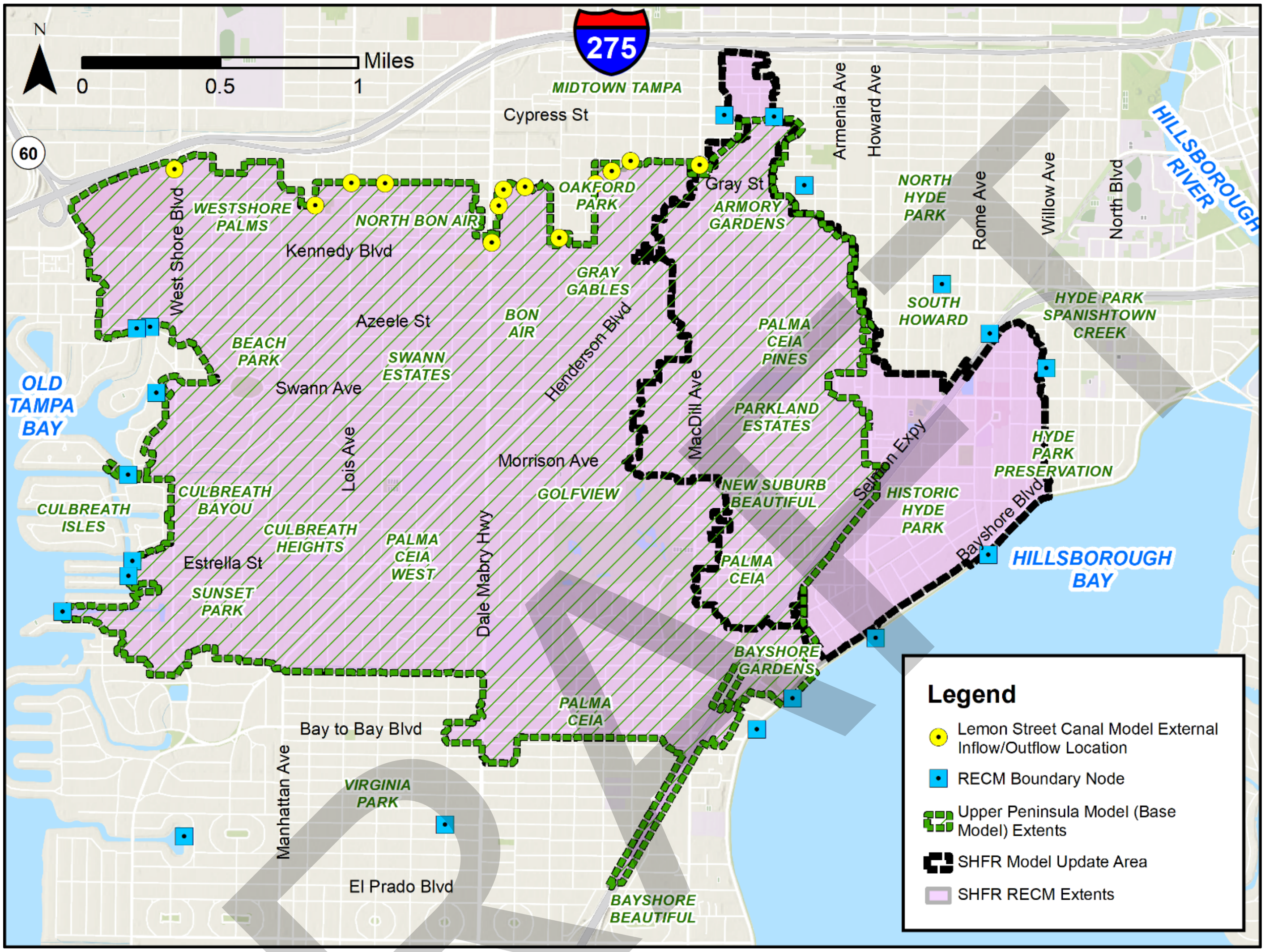

Figure 4-1 – Model Update Overview

4.2 XPSWMM Model Conversion

As mentioned in **Section 4.1**, the City of Tampa's UPWM (2018) – a 1-dimensional XPSWMM model – served as a base model to build the RECM in Interconnected Channel and Pond Routing Model (ICPR) version 4.07.08, referred to in this report as ICPRv4. The UPWM's features and data are organized within a Geographic Water Information System (GWIS) which is a geodatabase containing all the information needed to build the H&H model. The UPWM's GWIS was imported into a new ICPRv4 model to begin the conversion.

The new ICPR model was then evaluated in detail to ensure model features converted correctly. Some parameters exist in ICPR and not in XPSWMM, such as minimum node storage, so these were populated appropriately before the model's hydrologic simulations were prepared and executed. Results from the converted model were compared back to the UPWM to confirm that the difference in model results was not significant. The converted model was then updated as discussed in the following sections to develop the RECM.

4.3 Hydrology

The RECM uses the NRCS Runoff Curve Number (CN) method to calculate stormwater runoff for different rainfall simulations, consistent with the UPWM and the adjacent Lemon Street Canal model. A peaking factor value of 256 was used with a corresponding unit hydrograph, consistent with SWFWMD guidelines and representative of typical conditions in Florida. ICPR uses an initial abstraction coefficient of 0.2 for the NRCS CN method, which is multiplied by the soil storage depth to calculate lost rainfall volume prior to runoff, including water retained on structures and foliage, in surface depressions, and water removed through evapotranspiration. Soil storage depth is computed from the composite curve number value assigned to each subbasin. The model generates stormwater runoff hydrographs for each subbasin at 15-minute intervals based on CN values, which are then applied to corresponding nodes within the hydraulic model.

4.3.1 Rainfall

Specified rainfall depths and distributions (of rainfall intensity over total duration of the event), based on SWFWMD or FDOT documentation (depending on event duration), were used to develop rainfall simulations for the seven design storms within the model and are consistent with local regulatory standards. Actual rainfall data was collected using NEXRAD (discussed previously in **Section 2.2**) for the model calibration and verification event simulations – Hurricane Milton and the rainfall event observed on September 3rd, 2024, respectively. This rainfall varied throughout the RECM's geographic limits, which is discussed further in **Sections 4.6 and 4.7**. The source of rainfall data used for the design storm events is defined below:

The 24-hour design storm events use:

- Rainfall depths based on isohyetal maps, found in SWFWMD's ERP Applicant's Handbook Volume II (Project Design Aids)
- NRCS Type II Florida Modified rainfall distribution, consistent with SWFWMD's permitting requirements

The 5-year/8-hour design storm event uses:

- Rainfall depth of 5.3 inches based on the FDOT Zone 6 IDF curve (idfcurves.pdf)
- FDOT 8-hour rainfall distribution

Both design storm rainfall distributions used are already built into the ICPRv4 modeling software. The rainfall depths and distributions used for this project are consistent with the methodology used in other recently updated City of Tampa H&H models such as the UPWM, the Lemon Street Canal (Cypress Memorial Area) model, and the Lower Peninsula Watershed Model (LPWM).

Recurrence intervals for design storms are often misunderstood. They do not reflect a schedule, but instead a probability. For example, a 100-year storm does not mean that it can (or will) happen once every 100 years – it means that there is a 1 percent chance of that event happening in any given year, based on historical data. The calculation is:

% likelihood each year = 1 / XX-year storm event

Therefore, a 5-year storm has a 20% chance of occurring each year, a 25-year storm has a 4% chance of occurring, and so on. It is possible, as we witnessed in 2024 across the Tampa Bay area, to have multiple rainfall events with high recurrence intervals within a given year. Recurrence intervals are also dependent on rainfall intensity. This often leads to a short duration, 5, 10 or 25-year storm being mischaracterized as "just a normal summer thunderstorm" that caused flooding. When this happens, the most common reaction within the community is that something must be broken or obstructed.

For reference, 3.1 inches, 3.7 inches, and 4.5 inches of rain in one hour is considered a 10-year, 25-year, and 100-year storm, respectively according to FDOT's IDF curves that are specific to this area. Several rainfall events like these occurred in the Tampa Bay area in 2024.

The rainfall depths used for each rainfall event in the SHFR models are listed in **Table 4-1** below.

Table 4-1 – Simulated Storm Events

Design Storm Event	Rainfall Depth (inches)
2.33-year/24-hour (Mean-Annual)	4.5
5-year/24-hour	5.5
10-year/24-hour	7.0
25-year/24-hour	8.0
50-year/24-hour	10.0
100-year/24-hour	11.0
5-year/8-hour	5.3
Calibration Event (Hurricane Milton, 2024)	Varies (13.0 - 14.5)
Verification Event (9/03/2024)	Varies (1.1 - 2.5)

4.3.2 Subbasin Delineation Updates

As mentioned in **Section 4.1,** the UPWM's geographic limits were expanded to include any area deemed to be hydraulically relevant to Parkland Estates and Palma Ceia Pines, to ensure that all stormwater runoff that may influence flood stages in these neighborhoods is accounted for in the model. The SHFR Model Update Area was evaluated in detail to ensure that all hydrologic and hydraulic parameters within this boundary, including subbasin delineation, are consistent, accurate, and current.

Modification of subbasins along the western boundary of SHFR Model Update Area requires that some subbasin delineation updates to the west of this area are made, so that all subbasin boundaries align. While a few subbasins outside of the model update area were modified slightly, the hydraulic connectivity in these areas still reflects the UPWM. Hydraulic connectivity was only updated within and across the model update area boundary.

Subbasin delineation updates were made using engineering judgement based on a comprehensive review of available data such as the DEM, City stormwater inventory, permitted plans and record drawings, aerial imagery, and desktop tools such as Google Street View. In some cases where additional clarity was needed, field investigations were conducted to determine subbasin delineation.

Table 4-2 and **Figure 4-2** below provide a summary of the subbasin changes made as part of the RECM development.

Table 4-2 – RECM Subbasin Update Summary

Source	Number of Subbasins
Original UPWM (2018)	522
New Subbasins outside of UPWM	74
Updated UPWM Subbasins	174
RECM	**634**

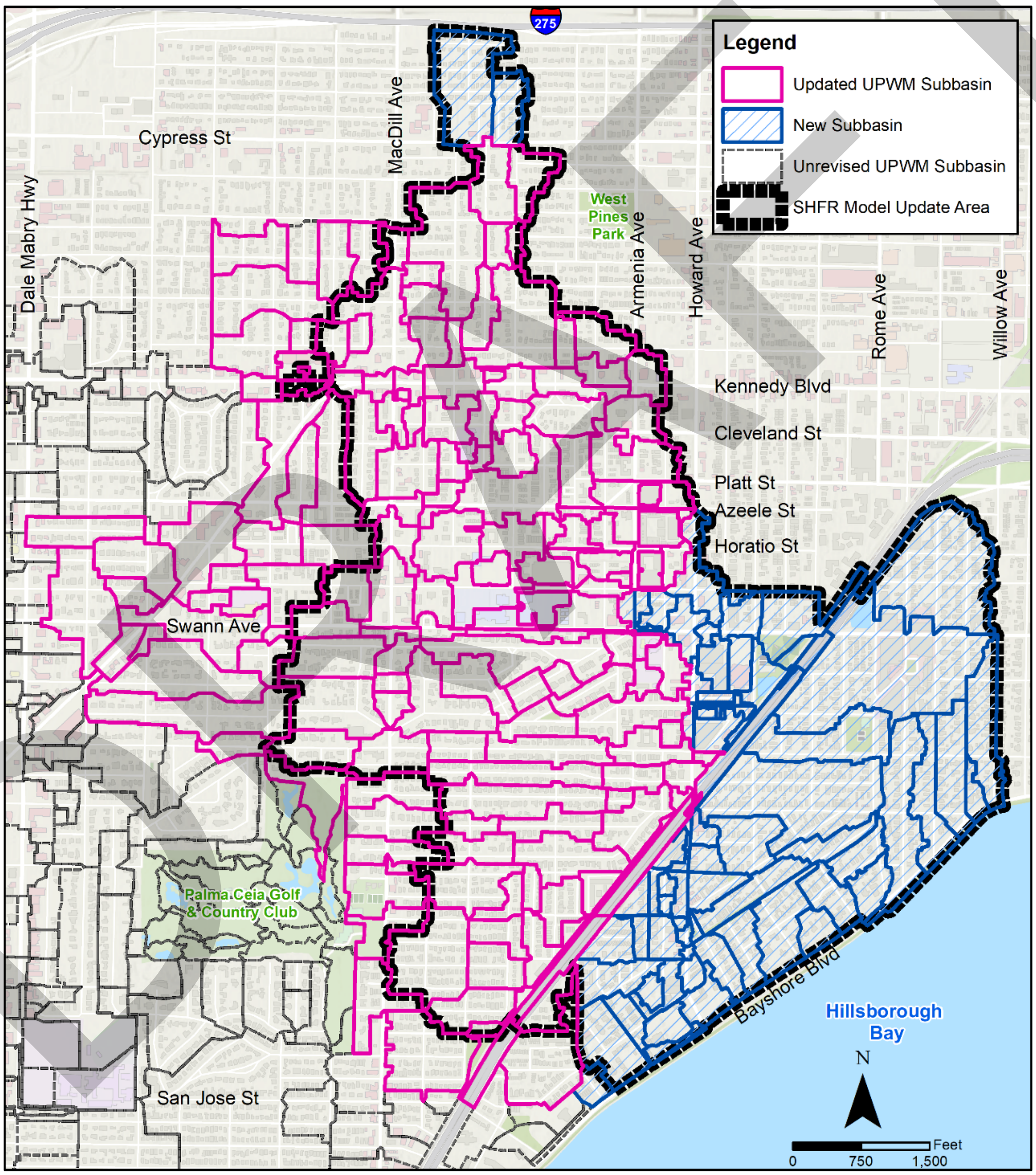

Figure 4-2 – Subbasin Additions and Updates

4.3.3 Time of Concentration (Tc)

Time of concentration is defined as the time needed for water to flow from the most remote point in a subbasin to the subbasin's outlet (or model node in this case). Tcs were reviewed and updated as necessary within the SHFR Model Update Area for sub-basins that were added/modified within the RECM limits using the following methodology:

- Due to the highly developed nature of the watershed, subbasins under 4 acres were assigned a minimum Tc of 10 minutes.
- For modified UPWM subbasins that did not change substantially, the previous Tc was used.
- Tc values were explicitly calculated for 40 RECM subbasins using TR-55 methodology and an evaluation of the DEM and aerial imagery.

Figure 4-3 below illustrates the 40 subbasins for which new Tcs were calculated.

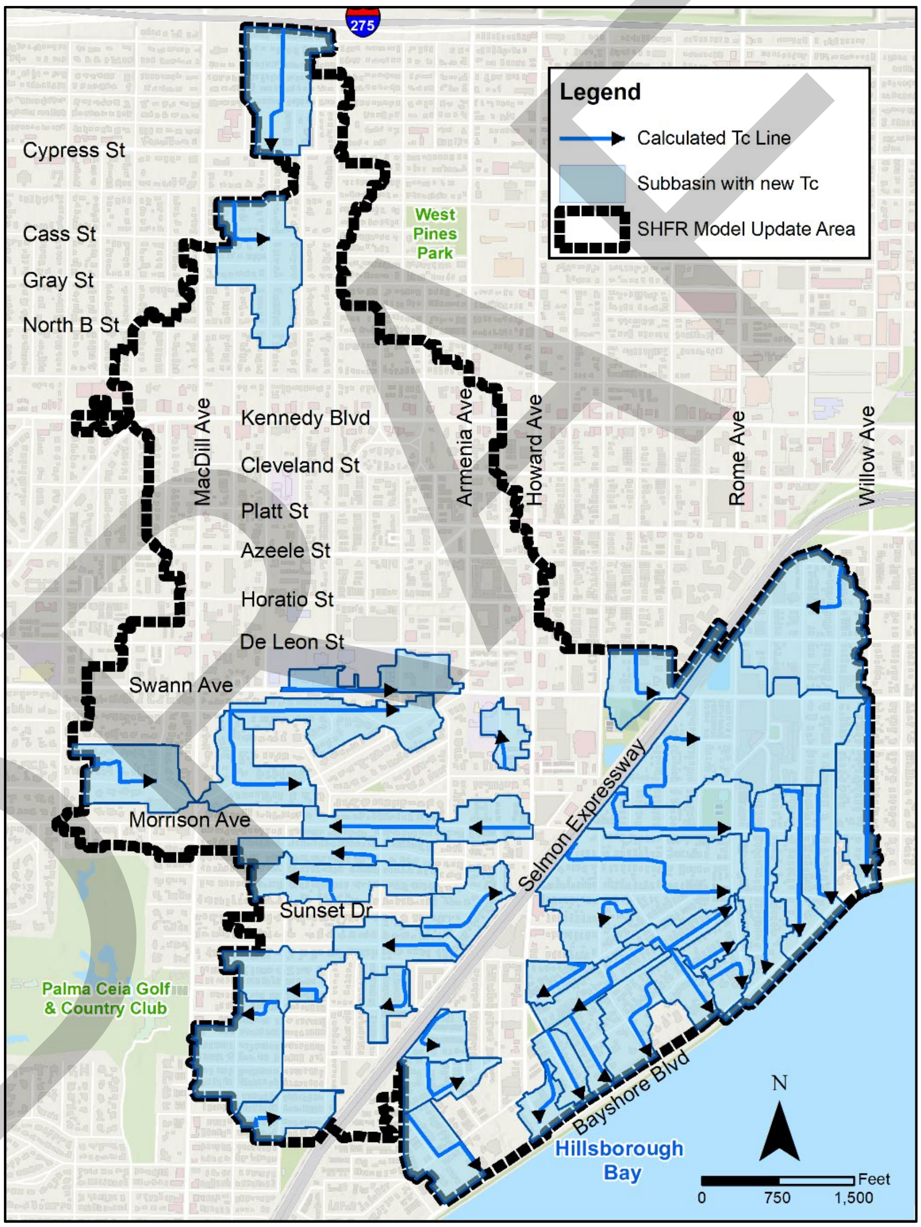

Figure 4-3 – Calculated Tcs

4.3.4 Runoff Curve Numbers

Composite runoff curve number values are computed for each subbasin within ICPR from the spatial intersection of subbasin, soils and land use coverages, all of which exist graphically within the model. A runoff curve number set lookup table within the model provides curve number values for each possible combination of soils and land use coverages based on TR-55 methodology and is used to compute each subbasin's weighted curve number value. Because the UPWM is an XPSWMM model and uses externally calculated curve numbers, the RECM's CNs were recalculated within ICPR **for the entire model,** for consistency.

Antecedent Moisture Conditions reflect the moisture level in the ground and are used to characterize overall "wetness" before a rainfall event. They are typically selected as one of three options for modeling purposes:

- AMC I – Dry – an ideal soil condition for infiltration, where soils have minimal moisture
- AMC II – Average Conditions
- AMC III – Wet – When heavy rainfall has occurred during the previous 5 days

Different antecedent moisture condition assumptions use different CN set lookup tables. For the design storm simulations, a TR-55 AMC-II condition was used, which represents average "wet season" hydrologic conditions prior to the simulated event. For both the calibration and verification events, a TR-55 AMC-III condition was used to reflect the saturated condition of the soils at the time of these two events, which both occurred in 2024 during one of the wettest seasons on record for this area. The equation developed by the USDA Soil Conservation Service (SCS) used to convert CNs from AMC-II to AMC-III is:

$$\textbf{Runoff } CN_{AMC\ III} = 23 * CN_{AMC\ II} / (10 + (0.13 * CN_{AMC\ II}))$$

The calibration and verification model simulations are discussed further in **Sections 4.6 and 4.7**. A comparison of the CN set lookup tables used in the RECM can be found in **Table 4-3** below.

Table 4-3 – CN Set Lookup Tables

Land Use	HSG	AMC-II CN	AMC-III CN
Residential Low Density	A/D	82	91
Residential High Density	A	77	89
Residential High Density	A/D	91	96
Residential High Density	B/D	91	96
Residential High Density	C/D	91	96
Residential High Density	W	100	100
Commercial and Services	A	89	95
Commercial and Services	A/D	95	98
Commercial and Services	B/D	95	98
Commercial and Services	C/D	95	98
Institutional	A	69	84
Institutional	A/D	89	95
Institutional	B/D	89	95
Institutional	C/D	89	95

Land Use	HSG	AMC-II CN	AMC-III CN
Recreational	A	49	69
Recreational	A/D	82	91
Golf Courses	A	49	69
Golf Courses	A/D	82	91
Golf Courses	C/D	82	91
Open Land	A	39	60
Open Land	A/D	77	89
Reservoirs	A	100	100
Reservoirs	A/D	100	100
Reservoirs	C/D	100	100
Bays and Estuaries	A	100	100
Bays and Estuaries	A/D	100	100
Bays and Estuaries	W	100	100
Transportation	A	81	91
Transportation	A/D	92	96
Transportation	B/D	92	96
Transportation	C/D	92	96
Transportation	W	100	100
Utilities	A	81	91
Utilities	A/D	92	96
Reservoirs	W	100	100
Emergent Aquatic Vegetation	A	98	99
Residential High Density	D	92	97
Commercial and Services	D	95	98
Transportation	D	93	98
Open Land	D	80	91
Institutional	D	90	96

4.4 Hydraulic Connectivity

As mentioned in **Section 4.3**, the model generates stormwater runoff hydrographs for each subbasin at 15-minute intervals based on CN values, which are then applied to corresponding nodes within the hydraulic model. Model nodes are connected by hydraulic links, in the form of pipes, overflow weirs, drop structures, overflow channels, and rating curves that represent stormwater pump stations. Flows are routed through the hydraulic system during and after the simulated rainfall event to compute water surface elevations at nodes and flow rates through links.

4.4.1 Storage of Runoff

4.4.1.1 Above Ground (Stage-Area Curves)

Storage volume provided by ponds and depressions in the ground surface is represented in the RECM by stage/area relationships assigned to model nodes. Stage/area tables, commonly displayed as curves, were developed at 0.1-ft intervals using Arc Hydro tools in ArcGIS, with the 2017 DEM raster to update storage curves **for the entire model** for consistency.

At locations within the SHFR Model Update Area where overland channel links are modeled, storage exclusion areas were generated to exclude the representative channel cross sections from the storage volume calculation, eliminating duplication of available storage volume within the model. Storage within overland channel cross sections is already included within the model framework based upon cross sectional area and channel length.

It should be noted that the latest UPWM used Hillsborough County's 2011 DEM, which for reasons unknown has widespread differences in comparison to the 2017 DEM elevations. The 2011 DEM raster values are consistently lower at the same locations than the 2017 DEM raster, by 4 to 8 inches typically.

Minimum area values of 0.01 acres were assigned to each stage in the tables when the calculated area did not meet that threshold. Nodes intended to represent junction structures with no significant storage were still given stage/area information but used the minimum 0.01 acres for each table entry, beginning at the lowest connecting link invert elevation, to ensure model stability.

4.4.1.2 Underground Vaults (Stage-Volume Curves)

Stage-volume tables (also represented as curves) were used to model existing underground stormwater vaults within the SHFR Model Update Area if the storage capacity was greater than 5,000 cubic feet (0.11 ac-ft). Anything smaller than that was considered hydraulically insignificant for the magnitude of rainfall events analyzed. Stage-volume curves were developed using the information found in ERP plans and documentation.

Underground storage vaults were modeled by separating the stage-volume node associated with the vault from adjacent terrain-based storage nodes for clarity and transparency. The stage-volume nodes were hydraulically connected to the appropriate stage-area node which receives runoff from the subbasin using a weir that represents the bottom of the vault.

This method makes it easy to identify these facilities within the model and separates the different sources of available storage. It also allows the model to accurately account for vault ceilings that limit available storage.

4.4.2 Initial Node Stages

The following assumptions were made to determine initial stages for storage nodes within the SHFR model update area:

- In most cases, the invert elevation of the lowest underground pipe leaving a node was used.
- When the downstream initial stage was higher than the lowest pipe invert (tidally influenced systems below the bay's surface, for example), that value was used to begin the simulation in a static condition.
- For nodes with no subsurface links, the lowest elevation in the stage-area table was used.
- For underground vaults, the elevation of the bottom of the vault was used, unless ERP documentation specifies otherwise.
- **Swann Pond** (node PondB) – 11.46 (ft, NAVD88) was used, which is the elevation of the lowest weir on the pond's outfall control structure per ERP documentation. While the ERP documentation mentions a normal water level (NWL) of 10.12 (ft, NAVD88), several field investigations and evaluation of available imagery consistently support an initial stage that is more consistent with the weir elevation.
- **Albany Pond** (node PondA) – 18.0 (ft, NAVD88) was used based on evaluation of aerial imagery, field observation, and evaluation of the surrounding ground elevations that physically control water levels in the pond during heavy rainfall events. As discussed in **Section 3.2.4**, the pump station that controlled water levels within the pond at one point is not operational and is not permitted through SWFWMD. No seasonal high groundwater table (SHGWT) estimate was available at the time of the RECM development. The RECM's initial stage is approximately 18 inches below the lowest edge of pavement elevation along S Albany Ave and is a conservative wet-season initial stage.
- **ZOM Pond** (node NRU0890) – 15.64 (ft, NAVD88) is used to reflect the permitted SHGWT, which is maintained by a bleed-down orifice constructed as part of the pond's outfall control structure.
- **AMI Pond** (node NCL3730) – 9.14 (ft, NAVD88) is used to reflect the permitted pond bottom elevation and initial stage, which is recovered after a rainfall event by the pond's underdrain and pump station. It should be noted that using an initial pond stage of 11.38 (ft, NAVD88) to match the downstream weir within the Cleveland Street Outfall system, which controls this pond's water levels by gravity, has a negligible impact on the RECM's 5-year/8-hour design storm's peak flood stages in this area. That is because 2 to 3 feet of depth in this pond does not provide nearly enough storage to mitigate the flooding anticipated during the 5-year/8-hour storm.

4.4.3 Pipe Connections

Outside of the SHFR Model Update Area, the pipes in the RECM match those of the UPWM because most of the stormwater infrastructure in this area is very old and little has changed in the way of pipe systems since 2018. As mentioned previously, the version of the UPWM that this effort began with is the proposed conditions model for the Dale Mabry/Henderson Trunkline Project, and so that relatively new culvert system is reflected in the RECM.

Within the SHFR Model Update Area, the UPWM pipes were reviewed against the latest available City stormwater inventory and the as-built plans, survey, and permit documentation discussed in **Section 2** to verify pipe location, size, geometry, and elevations where applicable. Field investigations were also conducted by the design team to verify pipe information, as discussed in **Section 2.6.1.**

New pipes were identified as part of data collection and were added to the model when necessary. If a new pipe was added based on a documented size, but no vertical information was available, assumptions were made using current engineering standards for minimum ground cover and pipe slope to estimate inverts.

All pipe links within the SHFR Model Update Area were given both an entrance and exit loss coefficient of 0.5 to represent minor losses within the structures at each end, unless the pipe terminates within a static water body like a pond or the bay. In those cases, the pipe was given an exit loss coefficient of 1.

4.4.4 Stormwater Pumps

Stormwater pumps whose purpose is to recover available storage and/or treatment volume after rainfall events but not to provide stormwater conveyance or reduce flooding during a rainfall event were not included in the model simulations. This applies in the RECM to any bleed-down mechanism (like an orifice or small notch in a pond's outfall control structure) that is intended to create an initial condition, not to provide conveyance during a rainfall event.

In the specific case of the AMI Pond's pump station, because the pump system was designed only to recover treatment volume *after* rainfall events and is too small to provide flood relief *during* rainfall events, the pump is not functional in the model simulations. The pond's primary outfall during a rainfall event is the existing 4'x8' box culvert which connects it to the Cleveland Street Outfall system. An internal weir within this culvert system uses gravity to control the water level in the pond at elevation 11.38 (ft, NAVD88) per ERP documentation. This means that the pump's only function is to slowly draw the pond's water surface down approximately 2 feet from elevation 11.38 to 9.14.

When pump systems are used for stormwater conveyance, they are modeled as rating curve links, which use an operating table in the model that establishes the rates and conditions for flow instead of the upstream and downstream hydraulic conditions throughout the simulation, as is the case for other links in the model. On and off switches are established for the rating curve link based on the pump station design.

The only stormwater pump modeled as part of the RECM represents the pump station constructed by the City at S Howard and W Marjory Ave in 2017 to provide localized flood relief to the intersection. This pump sends stormwater north through an 8-inch diameter force main into a curb inlet beneath the Selmon Expressway at S Howard Ave and W Watrous Ave.

4.4.5 Overland Flow

Overland flow connections are a significant part of a H&H model that represents a highly urbanized area. During the peak of heavy rainfall events, most of the stormwater is exchanged between nodes through overland flow links, which represent sheet flow along roadway corridors and across land when the underground pipe systems become overwhelmed. All RECM overland flow links within the SHFR Model Update Area were created as new features and do not reflect the UPWM. Overland flow links reflect the UPWM throughout the rest of the model and are typically modeled as channels. Overland flow connections are represented in the SHFR Model Update Area in one of two ways:

1. **Weir links** – These are generally used to represent the overtopping of a roadway crown, or another ridge in the ground surface. In most cases weir links were used to represent flow along a roadway corridor for short distances (less than 500 feet). The DEM was used to assign weir inverts and to generate cross sections for irregular weir links.
2. **Channel links** – Overland flows along roadway corridors were modeled as channels if they travel at least 500 feet to reach the downstream node's underground conveyance system. A total of 29 standardized cross sections were developed and include typical corridor sections based on roadway width, curb/gutter, and median presence, along with a few atypical roadway sections for unique cases. The cross sections typically reflect the entire corridor between the right of way lines. An example of one of the typical cross sections is illustrated in **Figure 4-4** below. Upstream and downstream invert elevations were assigned based on the DEM and were applied to the channel's cross section to complete the channel link in the model.

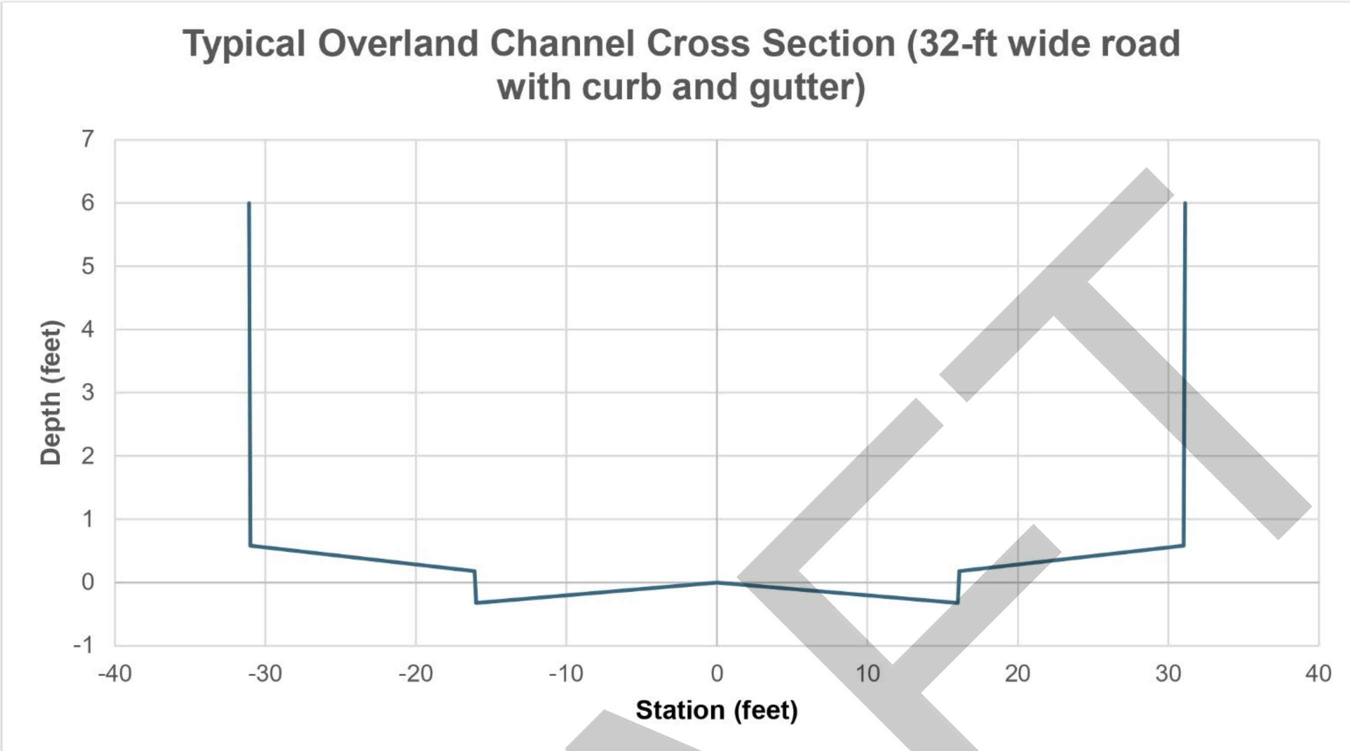

Figure 4-4 – Typical Overland Channel Cross Section (32-ft wide road with curb and gutter)

4.5 Boundary Conditions

The interaction of stormwater runoff between the RECM's geographic model extents and adjacent water bodies and watersheds is an important component of the model. Accounting for these variables and their influence on flood stages within the model helps to create an accurate and defensible model, which is critical to developing effective flood relief solutions.

Hydraulic boundary conditions are introduced in the model in one of two ways:

1. A boundary node outside of the model limits is given external time-stage data in a table, known as a boundary stage set. A boundary link is created as part of the model which connects the boundary node to one of the model nodes, allowing the exchange of stormwater between the two locations to be calculated as part the model simulation. This is commonly used to represent tidal conditions when the model is connected to a bay or ocean. It is also used simply to provide a receiving node for a link representing overflows leaving the model limits.
2. A table that specifies external inflows or outflows at set time intervals, which have already been calculated outside of the model, is injected directly into a model node to account for this predetermined flow into (or sometimes out of) the model. These are referred to in the model as external hydrographs.

In the RECM, boundary conditions have been introduced to account for hydraulic interaction with Hillsborough Bay, Old Tampa Bay, the Lemon Street Canal basin, the Spanishtown Creek basin, and the Cypress Street Outfall basin. **Figure 4-1** (in **Section 4.1**) provides locations of the boundary nodes and external hydrographs.

4.5.1 Tidal Boundary Conditions

For all design storm events in the RECM, the water surface elevation in Hillsborough Bay and Old Tampa is assumed to be a constant 2.0 (ft, NAVD88). This is considered the 1-year coastal stillwater elevation for this portion of Hillsborough Bay as discussed in **Section 3.3.3** of the City's Lower Peninsula Watershed Management Plan (2019).

The 1-year coastal stillwater elevation is considered the highest tidal elevation with a near 100-percent probability of occurring in a calendar year, and in this case is approximately 1 foot higher than the Mean Higher High Water (the average of the higher of the two high tides each day observed over the National Tidal Datum Epoch – a 19-year period).

For the model calibration and verification simulations where recorded rainfall data was used, water surface elevations recorded at nearby tide gauges were used over the same period to accurately reflect tidal conditions throughout the duration of those specific events.

4.5.2 Hydraulic Interaction with Adjacent Watersheds

The RECM limits share a boundary with several other City basins, whose models indicate the exchange of stormwater between the basins during severe rainfall events. The most significant exchange occurs with the Lemon Street Canal basin, which shares a boundary with the Cleveland Street basin, along the northern edge of the UPWM (and RECM) geographic limits. Interaction between the RECM and the Spanishtown Creek and Cypress Street Outfall basins exists to a lesser extent. This hydraulic interaction across basin lines has been accounted for by extracting hydrographs from the City's H&H models for the adjacent basins and applying them to RECM boundary nodes or as external hydrograph sets that can be applied to RECM storage nodes.

4.5.2.1 Lemon Street Canal Basin

The Lemon Street Canal 1-dimensional XPSWMM model was updated in 2018 as part of the Cypress/Memorial Area Drainage Study Update completed by Atkins. As part of the model update, nine nodes were taken from the adjacent UPWM (2018) and were established as boundary nodes for the Lemon Street Canal model. Boundary links were created in the Lemon Street Canal model to hydraulically connect to these nine nodes, and to simulate overland flows that enter the UPWM when the Lemon Street Canal System becomes overwhelmed and surcharged. The boundary nodes are shown in **Figure 4-5** below, which is an excerpt from the 2018 Atkins report.

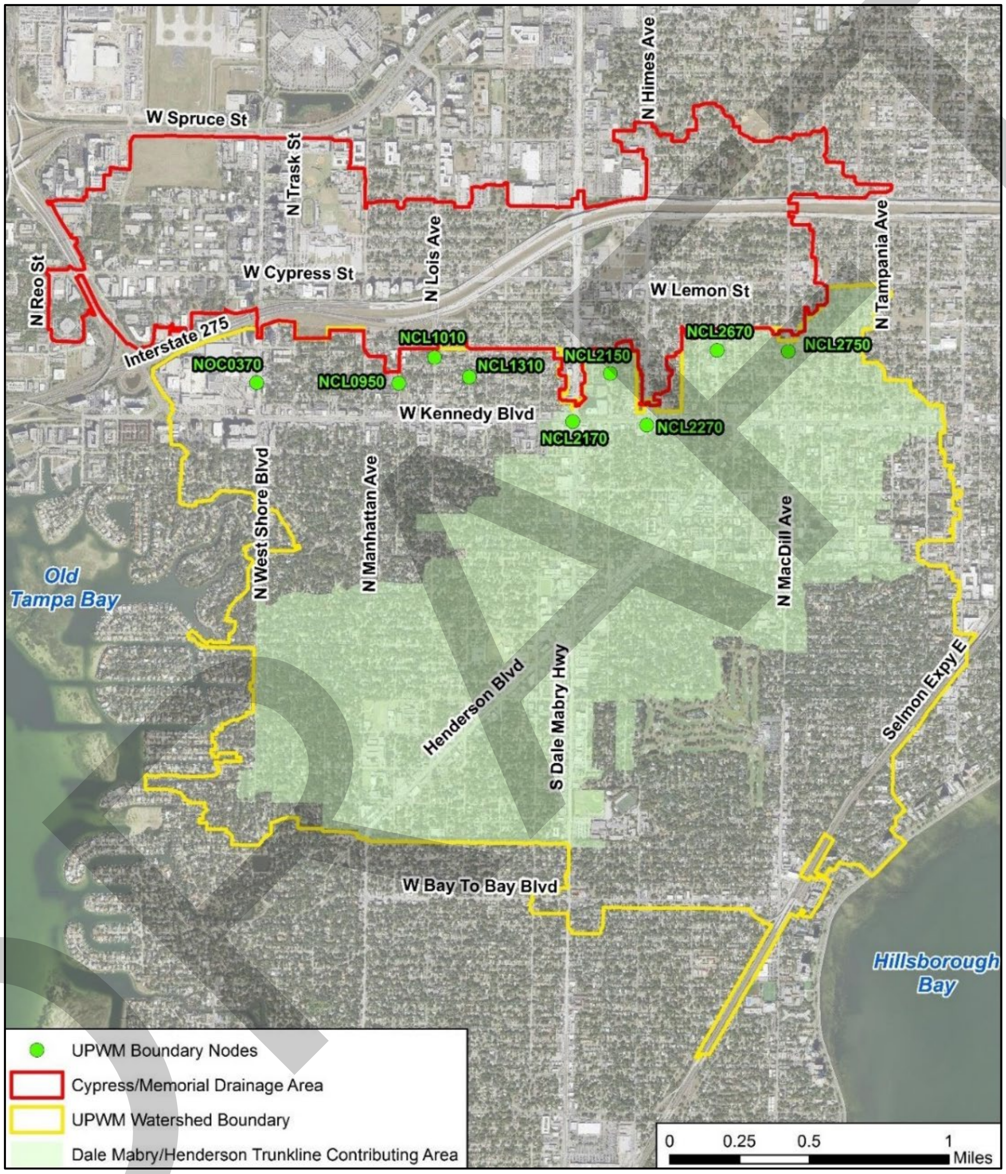

Figure 4-5 – Lemon Street Canal Model Boundary Nodes within the UPWM

As part of the RECM development, the Lemon Street Canal XPSWMM model was rerun with an updated tidal condition and rainfall data that is consistent with RECM. The model results from these new simulations were extracted as time series data for the boundary links that connect the Lemon Street Canal model to the nodes in **Figure 4-5**. The results that showed exchange of flows between the basins were then consolidated into eight external hydrographs for each event simulated, which are applied to these nodes in the RECM to reflect flows from and into the Lemon Street Canal system.

External hydrographs were used instead of time-stage boundary nodes in this case for two reasons:

1. The boundary links within the Lemon Street Canal model do not exist in the UPWM but were developed using the UPWM.
2. Both the UPWM and Lemon Street Canal model use the 2011 DEM, providing an “apples to apples” terrain comparison of this area. Because the RECM uses the 2017 DEM, relying on stages to calculate the flows between models is somewhat unreliable.

4.5.2.2 Spanishtown Creek Basin

A similar exercise was performed with the latest Spanishtown Creek/Cypress Street Outfall Model – a 2-dimensional XPSWMM model developed in 2020 for the Cypress Street Outfall project. The model was adjusted to use a tidal condition and rainfall that is consistent with the RECM, and the full set of simulations were executed. The updated model results for two nodes were extracted as time-stage data and were used to develop two boundary stage sets within the RECM, which serve as a dynamic tailwater condition along the eastern boundary of the RECM limits.

4.6 Model Calibration

The model calibration for this project was focused on the SHFR Model Update Area, with special attention given to the SHFR Flood Reduction Focus Area. The model’s calibration was completed by reviewing photos that document high-water marks left behind by receding flood water, estimating the elevations of those high-water marks (also referred to as stain lines), and comparing those estimated elevations to the peak flood stages predicted by the RECM’s simulation of the event.

The calibration event selected for this exercise was Hurricane Milton which occurred on October 9th, 2024, and devastated the Parkland Estates and Palma Ceia Pines neighborhoods with over 13 inches of rainfall in less than 24 hours, causing significant property damage and inundating hundreds of homes and businesses within the SHFR Flood Relief Focus Area. Given the severity of the event and widespread flood damage, the peak flood stages were well documented with photos.

The model was calibrated using NEXRAD rainfall data, which is discussed in **Section 2.2**. The NEXRAD pixels used for the model simulation are displayed in **Figure 4-6** below along with their respective total rainfall depths over the duration of the event**.** The total rainfall depths ranged between 13 and 14.5 inches across the SHFR RECM geographic limits**.** Total rainfall depths ranged between 13.6 and 14.5 inches over the SHFR Flood Reduction Focus Area.

To accurately adjust the model’s boundary conditions at Old Tampa Bay and Hillsborough Bay, NOAA tidal gauge data was collected from the Old Port Tampa (Station ID: 8726607) and East Bay (Station ID: 8726674) stations. **Figure 4-7** shows the East Bay tidal stage along with the cumulative rainfall depth over time, for the duration of the storm. Interestingly, because Milton made landfall to the south of Tampa Bay, the hurricane drove water out of the bay to an elevation that is approximately five feet below mean sea level during the late-night hours of October 9th, 2024, during and shortly after the peak rainfall intensity. Therefore, any flooding that occurred during Hurricane Milton within the SHFR Flood Reduction Focus Area was strictly due to rainfall.

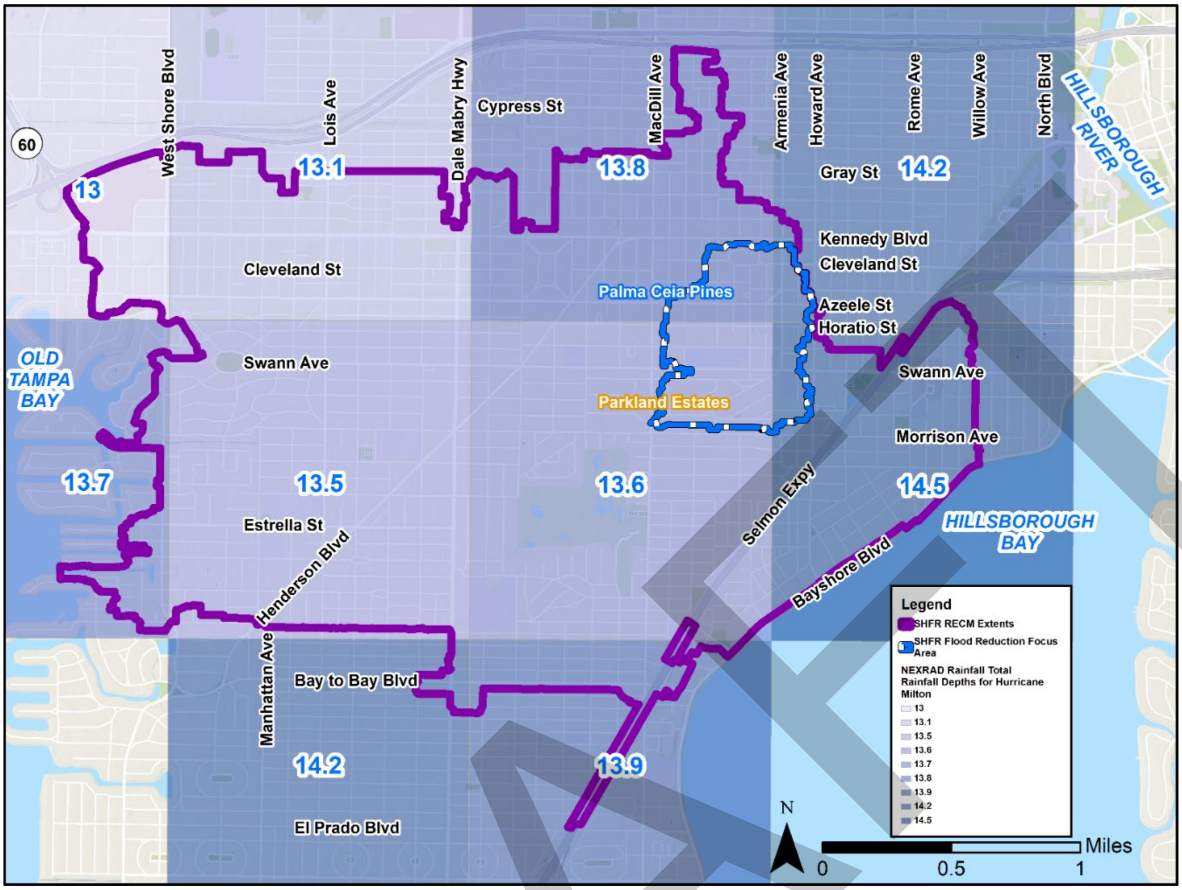

Figure 4-6 – NEXRAD Pixels used for Rainfall Depths (Calibration)

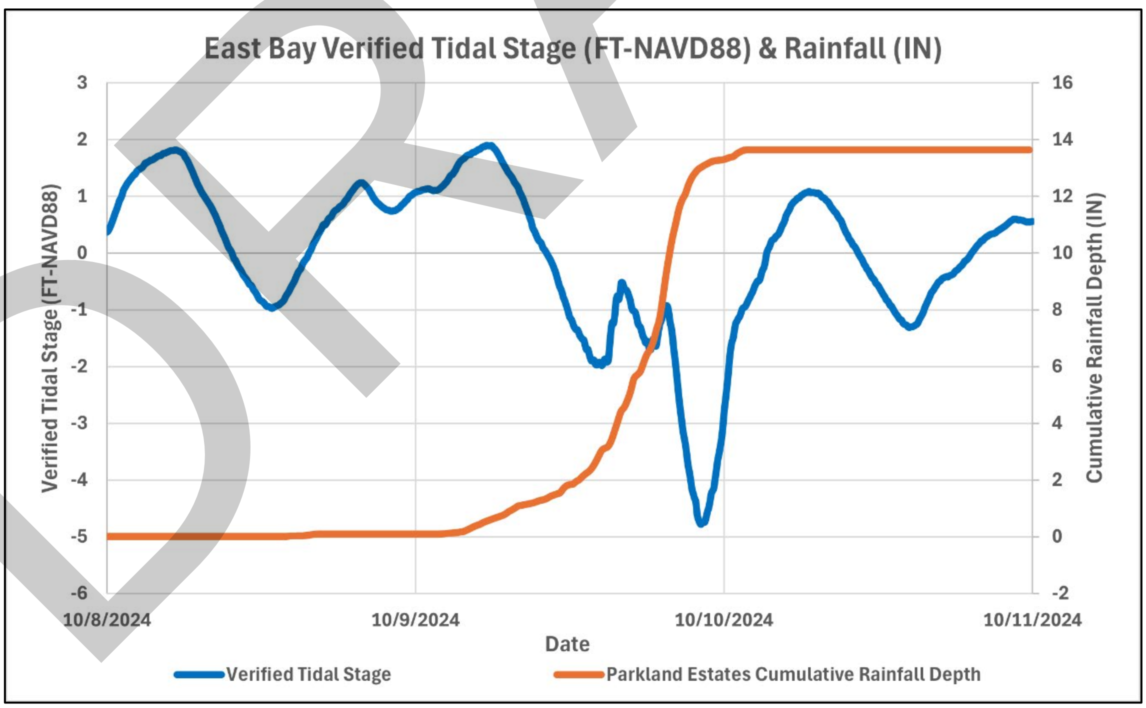

Figure 4-7 – East Bay Tidal Gauge Data

In 2024, Tampa experienced one of its wettest rainy seasons on record, with some areas receiving about 52 inches of rain from June to September, surpassing the previous record of 51.2 inches set in 1945. This total excludes the substantial rainfall brought by Hurricane Milton in early October. Due to the consistently high rainfall in the area throughout the 2024 rainy season prior to the RECM's calibration and verification events, the model's curve numbers were adjusted from AMC II to AMC III for both simulations.

The calibration exercise focused on stain lines documented at four locations – two within Parkland Estates and two within Palma Ceia Pines to estimate observed peak flood stages produced by Hurricane Milton's rainfall. These elevations were estimated using vertical measurements and benchmarks elevations established by City staff, estimates from the DEM, and by preliminary survey for the SHFR project design. These locations are shown on a map along with the flood depths estimated by the RECM calibration simulation in **Figure 4-8**. The stain lines at each of the locations can be seen in the photographs located in **Figure 4-9**.

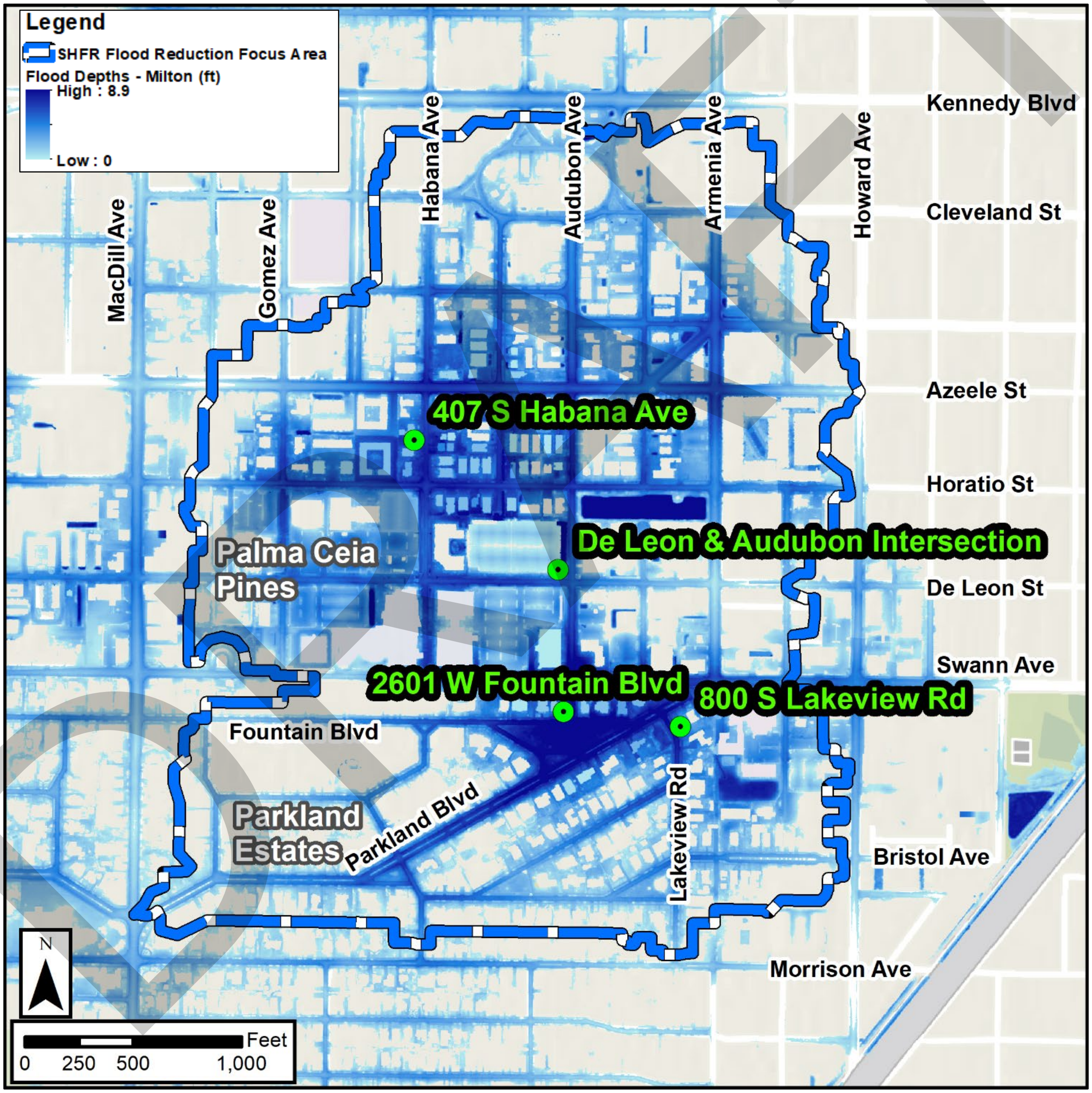

Figure 4-8 – Model Calibration Stage Observation Points

Figure 4-9 – Observed High Water Marks

The results compare closely to observed flood stages based on the estimated elevation of stain lines and high-water marks within Parkland Estates and Palma Ceia Pines, as can be seen below in **Table 4-4**.

Table 4-4 – Comparison of Modeled vs Observed Calibration Results

Location	**Flood Stage (NAVD88 Feet)** Observed	**Flood Stage (NAVD88 Feet)** RECM	**Stage Difference (Feet)** Observed – RECM
407 S Habana Ave	20.6	20.62	-0.0
800 S Lakeview	20.5	20.62	-0.1
De Leon & Audubon Intersection	20.7	20.61	0.1
2601 W Fountain Blvd	20.6	20.61	-0.0

4.7 Model Verification

A verification storm event was simulated in the RECM to represent a short but intense rainfall event that occurred on September 3rd, 2024. Like the calibration event, NEXRAD data was used to replicate the observed rainfall in the model. This event was reflective of a very intense afternoon summer thunderstorm, producing 2 inches of rainfall in just one hour (and 2.3 inches of total rainfall for the event) within the SHFR Flood Reduction Focus Area.

The NEXRAD pixels used for the model simulation are displayed in **Figure 4-10** along with their respective total rainfall depths over the duration of the event**.** The total rainfall depths ranged between 1.1 and 2.4 inches across the SHFR RECM geographic limits**.** Total rainfall depths ranged between 1.1 and 2.3 inches over the SHFR Flood Reduction Focus Area.

Photos were taken at multiple locations during the storm event which allowed for comparison to the peak stages predicted by the RECM simulation. The photos were taken at 7:15 PM which is nearly two hours after the peak rainfall occurred. The locations of the photos used for verification are shown below in **Figure 4-11** and the photos of the observed flooding are shown in **Figure 4-12, Figure 4-13, Figure 4-14**, and **Figure 4-15**.

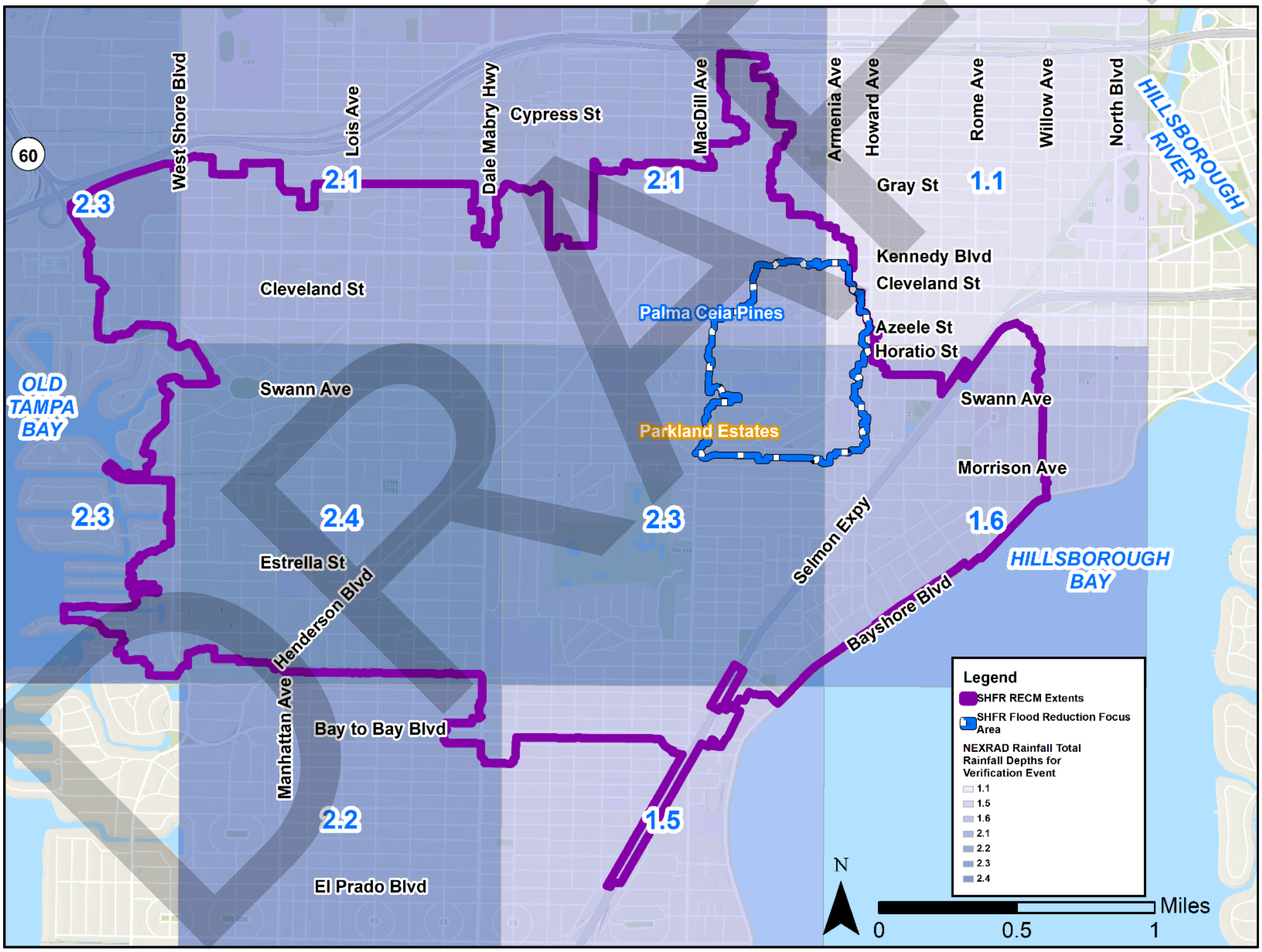

Figure 4-10 – NEXRAD Pixels used for Rainfall Depths (Verification)

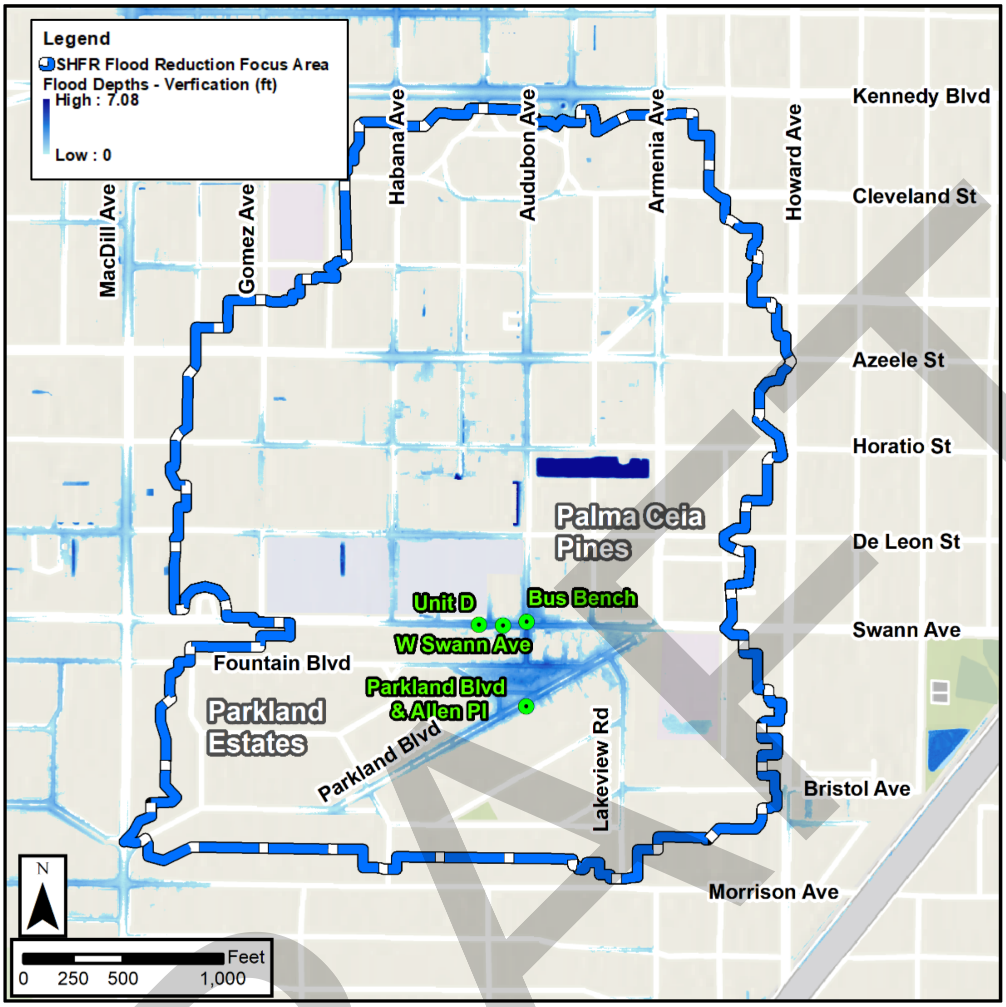

Figure 4-11 – Model Verification Stage Observation Points

The results compare closely to observed flood stages based on the estimated elevation of stain lines and high-water marks within Parkland Estates and along W Swann Ave, as can be seen below in **Table 4-5.**

Table 4-5 – Comparison of Modeled vs Observed Verification Results

Location	Flood Stage (NAVD88 Feet) Observed	Flood Stage (NAVD88 Feet) RECM	Stage Difference (Feet) Observed – RECM
Parkland Blvd & Allen Pl	18.0	17.96	0.0
W Swann Ave (Unit D)	17.9	17.96	-0.1
W Swann Ave (bus bench)	18.0	17.97	0.0
W Swann Ave	18.0	17.96	0.0

Peak stages in the model closely match flood stages observed by the community during the verification event. The following pages show the photographs at the four locations evaluated and provide a brief description of how the observed elevations were estimated.

Fountain Park is shown to be fully inundated in **Figure 4-12** – Parkland Blvd and Allen Pl (Verification Photo)**Figure 4-12**. On the left side of the house with the red roof is a raised mound near a retaining wall that sits just above the flood stage. This matches the shape of the flood extents shown in **Figure 4-11.** The DEM identifies ground elevations within the median ranging from 17.5 to 18.0, consistent with estimated minimal depth of inundation seen in **Figure 4-11**.

Figure 4-12 – Parkland Blvd and Allen Pl (Verification Photo)

W Swann Ave is fully inundated in **Figure 4-13** with the flood extents reaching the base of the shrub in the upper right-hand corner of both photos. The modeled flood stage at this location is 17.96 FT which aligns with the elevation estimated by the DEM at this location.

Figure 4-13 – W Swann Ave (Verification Photo)

Unit D on Swann Ave shows flooding above the second step leading up to the door in **Figure 4-14.** The photo on the left represents the flood extents, while the middle photograph provides perspective for the depth of flooding. The photograph on the right shows the height of the steps. The modeled flood stage at this location is 17.96 FT. The sidewalk outside of Unit D has an estimated elevation of 16.5 FT and the FFE of this building was surveyed at 18.94 FT. This information was used to estimate a peak flood stage of 17.9 FT.

Figure 4-14 – Unit D on W Swann Ave (Verification Photo)

The park bench shown **Figure 4-15** on W Swann Ave sits on a slab of concrete that has an estimated surface elevation of 16.5 FT. Based on the measurement, the peak flood stage observed is estimated to be 18.0 FT. The modeled flood stage is 17.96 FT.

Figure 4-15 – Park Bench on W Swann Ave (Verification Photo)

The results of the RECM's calibration and verification simulations demonstrate the model's accuracy, including peak flood stages that are generally accurate within a few inches. The validation of these reliable model results builds confidence in the SHFR project's solution, whose proposed conditions model was built upon the RECM.

4.8 RECM Results

4.8.1 Flood Protection Level-of-Service Analysis

An existing condition FPLOS analysis was performed using the RECM results and the 2017 DEM. The intent of the analysis was to both identify and quantify the existing FPLOS deficiencies within the SHFR Model Update Area. The criteria used to evaluate FPLOS conditions is shown in **Table 4-6**.

Table 4-6 – SHFR FPLOS Criteria

FPLOS Type	Storm Event	Criteria Description
Roadway(s)[1]	5-year/8-hour (20% Chance)	Peak flood stage less than 4 inches above low EOP

[1]Criteria is used for all roadway categories in the City, including neighborhood/local, collector, and arterial roads.

Low EOP elevations were estimated for model nodes within the SHFR Model Update Area using the 2017 DEM. The peak stages for these nodes were compared against their corresponding low EOP elevations to determine predicted flood depths and roadway FPLOS deficiencies. These comparisons are shown in **Table 4-7** and **Figure 4-16** for the 5-year/8-hour design storm event. Flooding depths over the FPLOS target of 4 inches above the low EOP are highlighted in red, signaling a FPLOS deficiency. Flooding depths between zero and 4 inches above the low EOP are shown in red text but are not highlighted. **It is important to remember that the flood extents shown below assume that the existing stormwater infrastructure is fully maintained and unobstructed.**

Table 4-7 – Summary of Roadway FPLOS Analysis (RECM, 5-year/8-hour design storm)

Node	Location	RECM Peak Stage (ft, NAVD88)	Low EOP Elevation (ft, NAVD88)	Existing Flood Depth (ft)
NRU0955	W Horatio St at S Audubon Ave (north side)	19.23	16.9	2.3
NRU0750	W Fountain Blvd at Fountain Park, Parkland Estates	19.21	15.2	4.0
NCL3510	W Cleveland St at S Habana Ave	19.65	19.1	0.5
NCL3450	W Horatio St at S Habana Ave	19.23	16.9	2.3
NCL3490	W Platt St at S Habana Ave	19.23	17.7	1.5
NRU0790	W Swann Ave at S Audubon Ave (north side)	19.22	15.9	3.3
NRU0970	W Horatio St at S Tampania Ave	19.23	17.4	1.8
NCL3520	S Arrawana Ave at W Cleveland St	19.37	19.0	0.4
NRU1050	W Platt St at S Armenia Ave	19.23	17.3	1.9
NCL3550	W Kennedy Blvd at S Habana Ave (north side)	20.51	18.8	1.7
NRU0960	W Azeele St at S Audubon Ave (south side)	19.23	17.0	2.2
NRU0785	W Swann Ave at S Audubon Ave (south side)	19.22	15.5	3.7
NRU1030	W Azeele St at S Armenia Ave (north side)	19.23	17.4	1.8
NBW2090	W De Leon St at S Gomez Ave	19.22	18.0	1.2

Node	Location	RECM Peak Stage (ft, NAVD88)	Low EOP Elevation (ft, NAVD88)	Existing Flood Depth (ft)
NRU0710	W Parkland Blvd at S Forest Dr	19.21	17.3	1.9
NCL3640	W Kennedy Blvd at Armenia Ave	20.51	19.6	0.9
NRU0740	W Parkland Blvd between S Forest Dr and Allen Pl	19.21	17.0	2.2
NRU0810	W Swann Ave at S Tampania Ave	19.22	16.8	2.4
NBW2050	W De Leon St at S Matanzas Ave	19.37	18.5	0.9
NRU0830	W De Leon St at S Audubon Ave	19.22	17.9	1.3
NCL3530	W Kennedy Blvd at S Habana Ave (south side)	20.51	18.8	1.7
NBW2070	W De Leon St at S MacDill Ave	19.37	18.0	1.4
NRU0650	W Morrison Ave at S Forest Dr	19.15	18.2	0.9
NRU0690	W Simms Blvd at S Forest Dr	19.20	17.9	1.3
NCL3250	W Horatio St at S Gomez Ave	19.22	17.2	2.0
NRU1090	W Parkland Blvd at W Fountain Blvd	19.22	16.2	3.0
NRU1110	S Lakeview Rd at W Parkland Blvd	19.22	16.4	2.8
NCL3630	W Kennedy Blvd at S Arawana Ave	20.50	18.6	1.9
NRU1010	W Horatio St at S Armenia Ave	19.23	18.2	1.0
NRU0965	W Azeele St at S Audubon Ave (north side)	19.23	16.9	2.3
NBW2110	W De Leon St at S Habana Ave	19.22	17.3	1.9
NRU0950	W Horatio St at S Audubon Ave (south side)	19.23	17.1	2.1
NCL3470	W Azeele St at S Habana Ave	19.23	16.8	2.4
NSH18	W Stroud Ave and S Howard Ave	15.74	15.3	0.4
NRU1040	W Azeele St at S Armenia Ave (south side)	19.23	17.2	2.0
NSH19	Palm Dr and S Howard Ave	11.55	11.3	0.3
NRU1070	W Cleveland St at S Armenia Ave	19.24	18.9	0.3
NRU0745	S intersection of W Parkland Blvd and Allen Pl	19.21	16.0	3.2
NRU1170	Intersection of W Bristol Ave and S Lakeview Rd	19.22	18.0	1.2
NCL3740	Intersection of W Horatio St and S Arrawana Ave	19.23	17.1	2.1

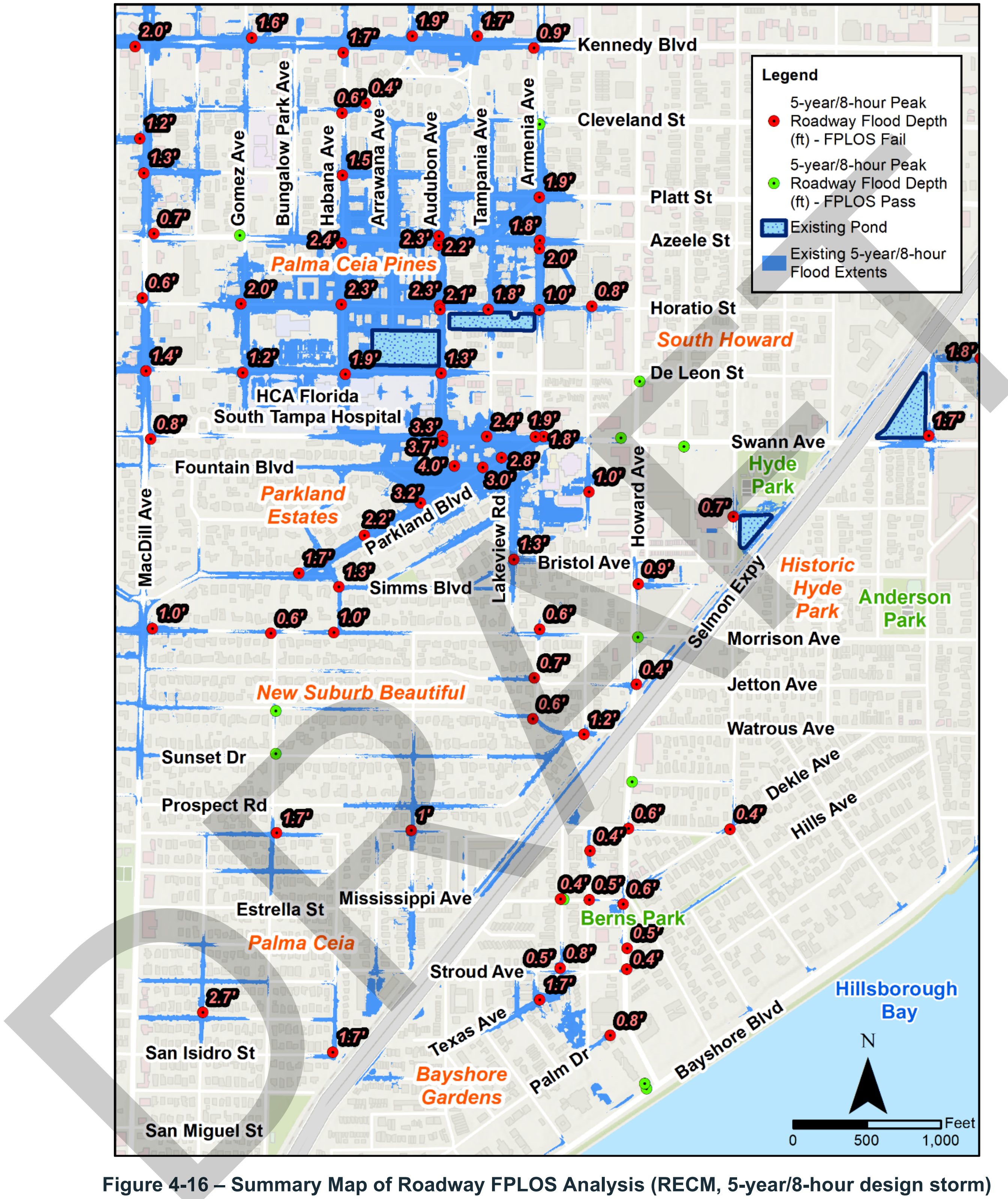

Figure 4-16 – Summary Map of Roadway FPLOS Analysis (RECM, 5-year/8-hour design storm)

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4.8.2 Predicted Flood Impacts

Table 4-8 below summarizes the severity of the predicted flooding for a range of design storm events, as well as the calibration event. These values are predicted using the RECM results, recently surveyed finished floor elevations for over 200 buildings (which include over 400 individual first floor homes and businesses) within Parkland Estates and Palma Ceia Pines, and the DEM.

Table 4-8 –Summary of Existing Flood Impacts for Simulated Events

Flood Impact	2.33-year/ 24-hour Design Storm (4.5 inches)	5-year/ 8-hour Design Storm (5.3 inches)	10-year/ 24-hour Design Storm (7.0 inches)	25-year/ 24-hour Design Storm (8.0 inches)	50-year/ 24-hour Design Storm (10.0 inches)	100-year/ 24-hour Design Storm (11.0 inches)	Hurricane Milton (13-14.5 inches*)
Existing Number of Homes/Businesses Inundated**	0	96	123	203	255	272	333
Existing Duration of Roadway Flooding on W Swann Ave (hours)	6	8	10	12	14	15	19
Existing Max. Depth of Roadway Flooding, Parkland Estates (feet)	3.2	4.0	4.3	4.6	4.9	5.1	5.4
Existing Max. Depth of Roadway Flooding, Palma Ceia Pines (feet)	1.9	2.5	2.9	3.2	3.5	3.7	4.0

*Hurricane Milton rainfall totals vary across the model's geographic limits, and were estimated by radar (source: NEXRAD)
**Includes total number of ground floor dwellings, including single family homes, businesses, and individual apartment or townhome units, within the 206 specific buildings surveyed in 2025 by the design-build team, as predicted by the RECM, and has not been otherwise verified.
Note: All values in the table are predicted using H&H model results and have not been field verified after observed rainfall events.

Figure 4-17 and Figure 4-18 below illustrate the flooding impacts predicted within the SHFR Flood Reduction Focus Area for the 5-year-hour/8-hour design storm event and 100-year/24-hour design storm event. The 100-year/24-hour design storm event is significant because it is commonly used for insurance and regulatory purposes **Figure 4-19** illustrates the predicted number of homes and businesses inundated by Hurricane Milton in 2024 based on the RECM's calibration, with the number of first floor dwellings labeled for each structure.

As mentioned in the footnotes of **Table 4-8**, the estimated total number of homes and businesses inundated refers to the number of first floor dwellings within buildings that have a surveyed FFE below the RECM's predicted flood stage. This number includes individual apartment and townhome units, and leased office spaces within commercial buildings. The certified survey of the FFEs evaluated for this project can be found in **Appendix D.**

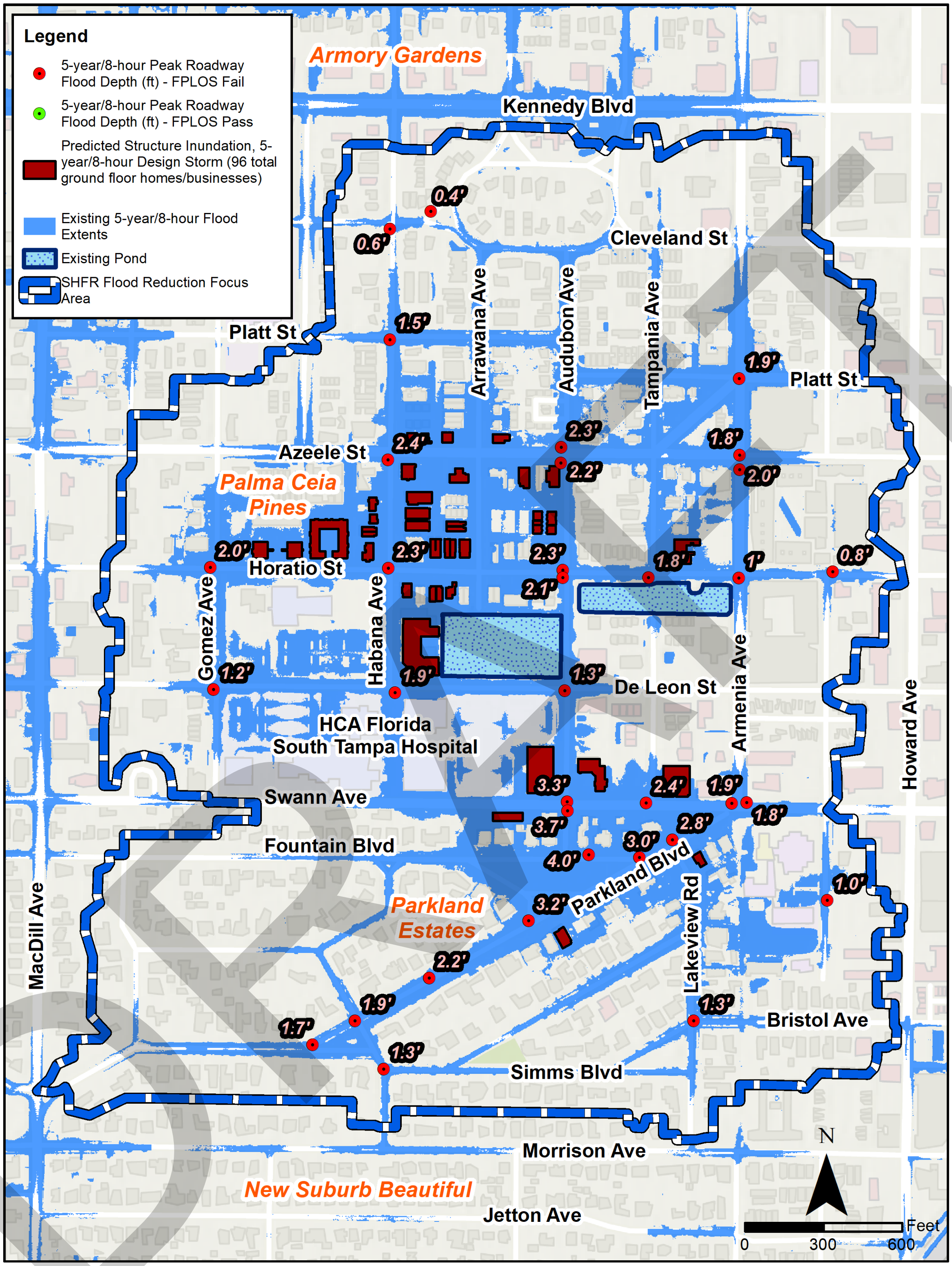

Figure 4-17 – SHFR Existing Condition 5-year/8-hour Flood Impacts

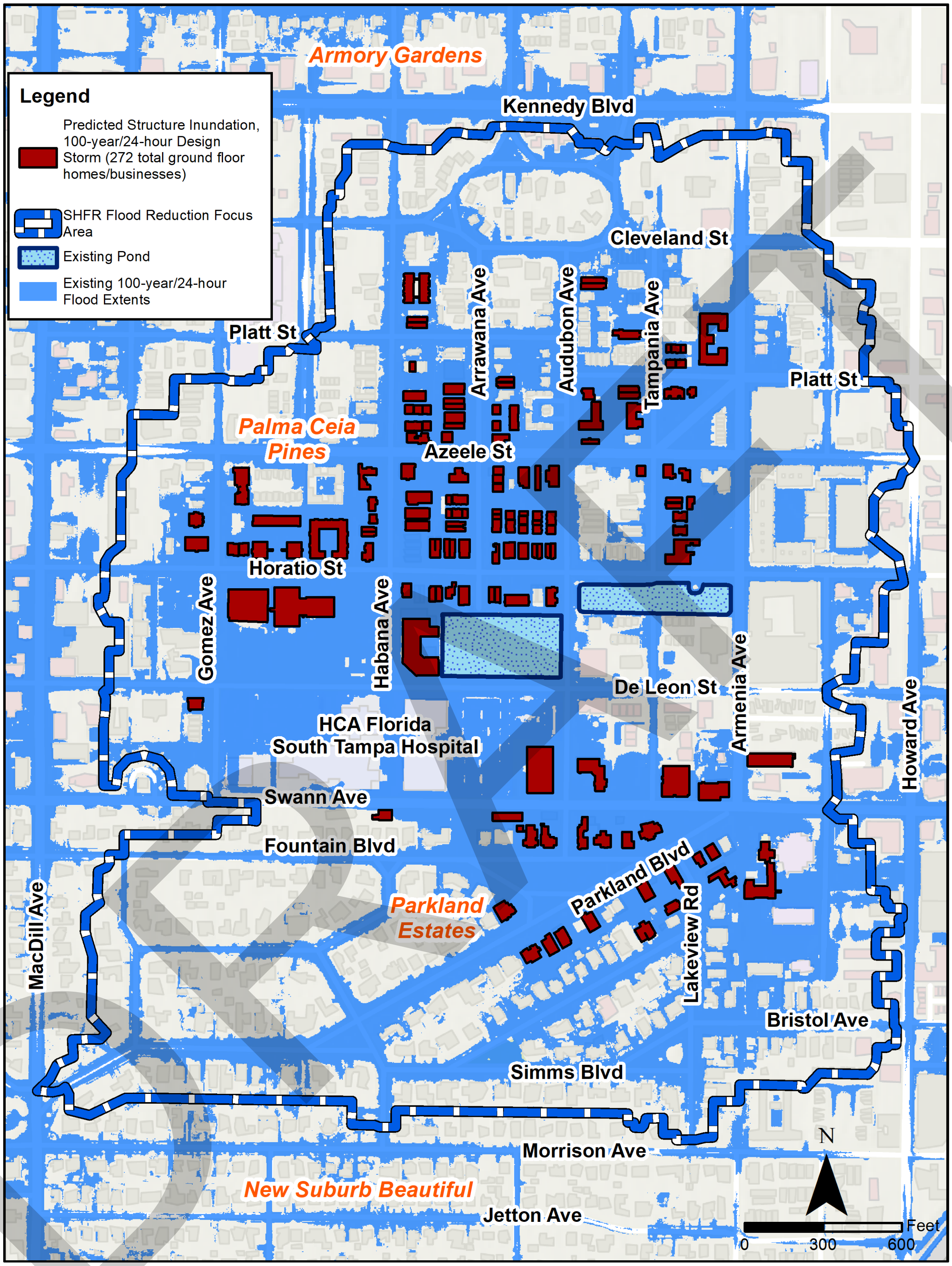

Figure 4-18 – SHFR Existing Condition 100-year/24-hour Flood Impacts

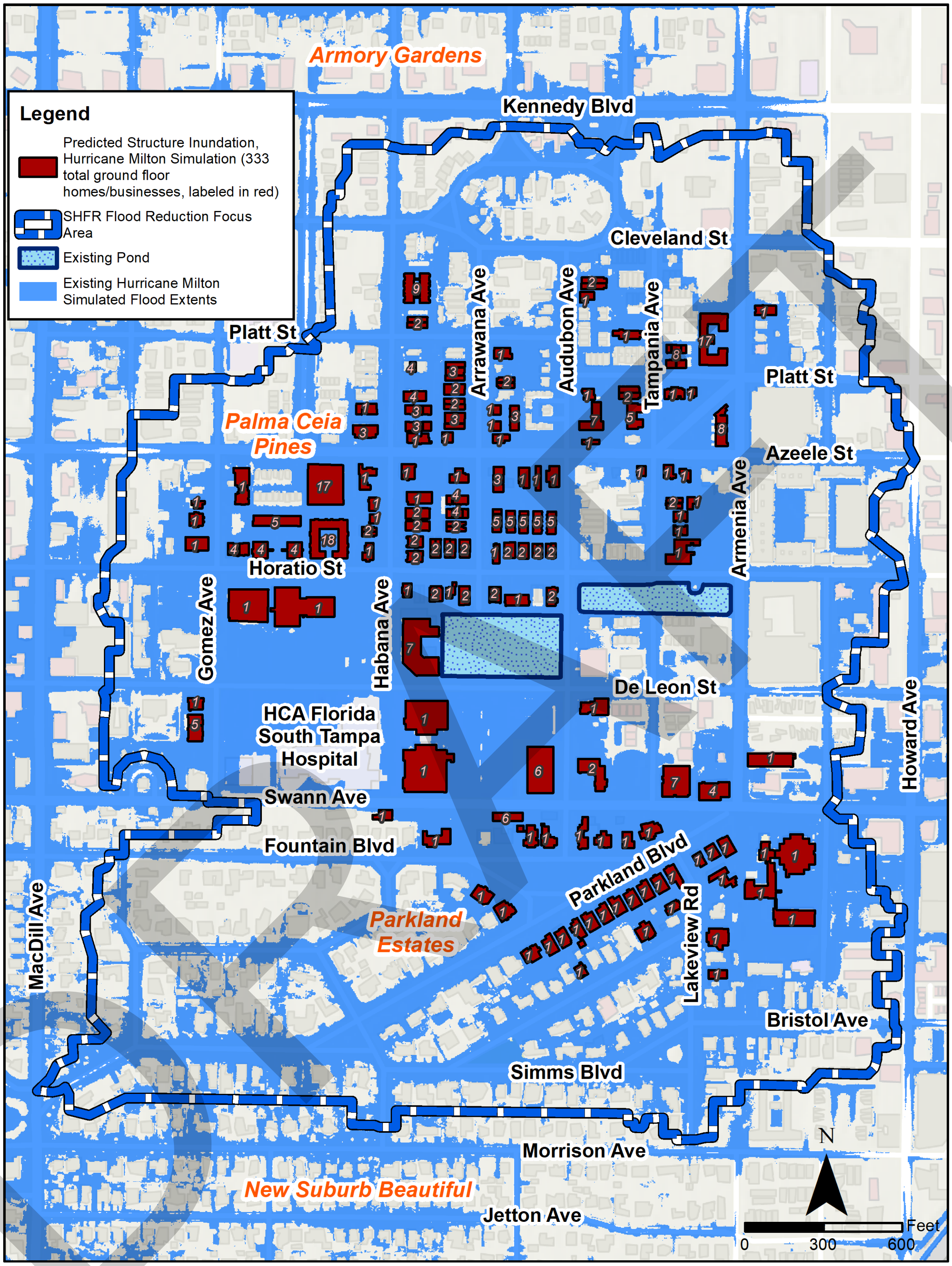

Figure 4-19 – SHFR Existing Condition Hurricane Milton Simulated Flood Impacts

5. Proposed Design Analysis

5.1 Sizing of Proposed Box Culvert and Pipes

5.1.1 Sizing Overview

Given the natural topography and drainage capacity challenges discussed in **Section 3**, a new or significantly upgraded stormwater conveyance system is needed to efficiently convey excess rainfall from the streets of Parkland Estates and Palma Ceia Pines into the bay and significantly reduce flooding in these neighborhoods.

The calibrated RECM was used as a base model to optimize a configuration of new pipes and box culverts that achieve the project's flood reduction goals in a hydraulically efficient, cost-effective way. To achieve this, the proposed conditions model (PCM) analyzed numerous iterations of design configurations to find the recommended solution. Changes made as part of the PCM development follow the same methodology discussed in **Section 4**. These **iterations began with the proposed system recommended in the project's Design Criteria Package (a 5'x10' box culvert terminating at W Swann Ave & S Audubon Ave) and progressed into larger box culvert sizes that extended further north, providing equity of flood reduction benefits between Parkland Estates and Palma Ceia Pines.**

The proposed infrastructure was sized to meet the FPLOS goal of 4 inches or less of flood depth over the lowest edge of pavement (EOP) within the SHFR Flood Reduction Focus Area, as defined in **Section 1.3**. Additional pipe connections have been added to the model to ensure that the trunkline is large enough to provide capacity for future flood reduction projects, which are discussed in **Sections 5.1.2 and 5.1.3** below.

Modeling efforts show that the following improvements are sufficient to meet the FPLOS goal, from downstream to upstream, consistent with the sequence of construction:

- The existing three 4'x6' box culverts beneath Bayshore Blvd at S Howard Ave, and its termination into Hillsborough Bay, will remain. No additional pipe or box culvert is proposed to discharge into the Bay.
- A 10'x10' box culvert (or equivalent conveyance) will convey stormwater beneath S Howard Ave between the existing triple box culverts at Bayshore Blvd and the Selmon Expressway.
- The existing 5'x10' box culvert along S Howard Ave beneath the CSX railroad and Selmon Expressway will remain and be supplemented by a parallel 60" pipe (to be installed via micro tunnel) for additional capacity.
- A 10'x10' box culvert will convey stormwater beneath S Howard Ave and other streets between the CSX railroad crossing at S Howard Ave and the intersection of W Swann Ave & S Audubon Ave, using one of three routes discussed in **Section 5.3.**
- A 10'x10' box culvert will convey stormwater beneath S Audubon Ave between the W Swann Ave and the AMI Pond, just north of W De Leon St. With a new adequate outfall, pond will now function as a massive stormwater inlet for the Palma Ceia Pines neighborhood during severe rainfall events, when surcharged pipe systems overflow into the pond using the adjacent low-lying roadway corridors as conveyance channels.
- The 10'x10' box culvert will discharge excess runoff directly from the pond into Hillsborough Bay and will use large weirs to control water levels within the pond, preserving the pond's permitted treatment function and capacity.
- New stormwater collection systems will need to extend from the AMI Pond or 10'x10' box culvert into portions of Parkland Estates and Palma Ceia Pines (among other locations). This is necessary to provide enough combined inlet and pipe capacity to meet the FPLOS goal for the entire SHFR Flood Reduction Focus Area.

The future phase collection systems, which are discussed in **Section 5.1.3** are a concept level design that provides the conveyance needed to meet the FPLOS goal within these areas once Phase I is constructed, and funding is secured.

While the conveyance system has been sized based on the 5-year/8-hour design storm, it also will provide significant reduction in flood stages for all storm events, including storms like Hurricane Milton. This was modeled to quantify flood reduction benefits if the proposed system had been in place prior to the 2024 wet season.

5.1.2 Proposed Conditions Model (PCM) Components – Phase I

5.1.2.1 Primary Box Culvert Trunkline

A 10'x10' box culvert will serve as a new major artery for conveyance of stormwater, allowing smaller collection systems to "tap in" along the culvert's route to Hillsborough Bay. In the PCM, the box culvert begins at S Howard Ave & Bayshore Blvd and ends at the AMI Pond on the west side of S Audubon Ave between W De Leon St and W Horatio St. This section discusses the recommended route selected. A discussion of all alternative routes evaluated can be found in **Sections 5.3 and 5.4** of this report.

Due to ground cover restrictions, dual 7'x7' box culverts are needed instead of a single 10'x10' box culvert for a portion of the trunkline along S Howard between W Palm Dr and Bayshore Blvd to shallow up the flowline and avoid a hydraulic sump condition in the trunkline's profile. This not only improves hydraulic efficiency but reduces maintenance needs for the City throughout the system's service life.

The most significant hydraulic restriction point in the new trunkline is located at its crossing with the CSX railroad and the Selmon Expressway. Due to constructability challenges beneath the railroad and overpass, the existing 5'x10' box culvert at this crossing will be supplemented with a new parallel pipe, to be installed with a microtunnel operation, eliminating the need to fully excavate this portion of South Howard Ave. While the combination of 5'x10' box culvert and 60" pipe represents a hydraulic restriction in the PCM, it provides enough conveyance to meet the project's FPLOS goal with a 10'x10' box culvert serving as the trunkline between this location and Palma Ceia Pines.

It can be thought of as a nozzle, like holding a thumb partially over the end of a garden hose. The restriction increases the velocity of flow through this short segment but still allows for a high enough flow rate to meet the project's FPLOS goal. Reducing the size of the entire stormwater trunkline to this equivalent conveyance would be like using a smaller diameter garden hose, which reduces the overall flow rate, and would not allow the project to meet its FPLOS goal due to significant additional friction losses.

A second hydraulic restriction in the proposed system occurs within the median of Bayshore Blvd at S Howard Ave, where the incoming dual 7'x7' box culverts meet the outgoing existing triple 4'x6' box culverts, which will discharge the system into Hillsborough Bay beneath Bayshore Blvd's northbound lanes and sidewalk. At this location, a large conflict structure is needed to accommodate the change in pipe size and to provide area for conveyance above and below the existing 48-inch diameter sanitary sewer gravity main that will continue through the structure. The interruption of flow through the conflict structure will result in hydraulic head loss to the system, however this configuration is needed to accommodate utilities and connect existing and proposed infrastructure.

Hydraulic head losses can be thought of as system inefficiencies. Designers do their best to avoid them to optimize a stormwater system's conveyance efficiency, however sometimes they are unavoidable. The anticipated hydraulic head loss associated with each restriction can be seen as a steeper slope of the hydraulic grade line profile, which is plotted in **Figure 6-1**, in **Section 6.1**.

Minor losses were introduced within the new box culvert trunkline using the following assumptions, consistent with the RECM's underlying methodology:

- At model nodes that represent locations within straight and continuous box culvert, entrance and exit loss coefficients were set to zero for pipe links that represent the box culvert, because nothing is significantly restricting conveyance through these locations.

- At the CSX railroad/Selmon crossing and at W Palm Dr, where the trunkline changes size, entrance and exit loss coefficients of 0.5 were given to account for the large junction structures needed to connect the trunkline segments.
- At Bayshore Blvd and S Howard Ave, an exit loss of 1 was given to the incoming dual 7’x7’ culverts due to the nature of the large conflict structure, which will include a sump beneath the large gravity sanitary sewer passing through the structure in front of the outgoing triple box culverts.
- The triple 4’x6’ box culverts were given an exit loss coefficient of 1 due to the static nature of the receiving water body (Hillsborough Bay).
- Pipe links entering 90-degree deflections within the box culvert alignment, which will likely consist of two continuous and precast 45-degree turns, were given an exit loss coefficient of 0.5 to account for the bend.

5.1.2.2 Parkland Estates

The configuration of stormwater infrastructure needed in Parkland Estates is dependent on the route of the 10’x10’ box culvert. The project scope identifies three alternative routes that use S Howard Ave to reach W Swann Ave at S Audubon Ave – W Morrison Ave, W Bristol Ave, and W Swann Ave. A detailed comparison of these three routes can be found in **Section 5.3**. For the W Bristol Ave and W Morrison Ave routes, which both navigate Parkland Estates along S Lakeview Rd, new inlets and smaller pipes would connect directly into the box culvert.

For the W Swann Ave route, the low-lying portions of W Fountain Blvd and W Parkland Blvd would connect to the box culvert on W Swann Ave using both the existing 42-inch pipe along S Audubon Ave and a new 72-inch pipe that uses W Parkland Blvd. Both pipes are needed because of significant backflow anticipated through the existing 48-inch x 76-inch elliptical pipe along W Parkland Blvd (Upper Peninsula East outfall system discussed previously in **Section 3.2.3**) that currently carries stormwater south through New Suburb Beautiful, Palma Ceia, and Bayshore Gardens before discharging to Hillsborough Bay. These three pipes will connect within a single structure near the lowest portion of W Fountain Blvd, at which point stormwater can take the path of least resistance to reach Hillsborough Bay. **Figure 5-1** below illustrates this connection and the proposed stormwater pipe configuration for the W Swann Ave route.

The proposed 30-inch pipe along S Lakeview Rd, which will be constructed as part of a future phase project, will allow the intersection of W Bristol Ave and S Lakeview Rd to meet the FPLOS goal once the recommended pipe along W Morrison Ave is constructed. If no upgrades were to occur on W Morrison Ave, the proposed pipe along S Lakeview Rd would need to extend south to W Bristol Ave to achieve the FPLOS goal at that intersection.

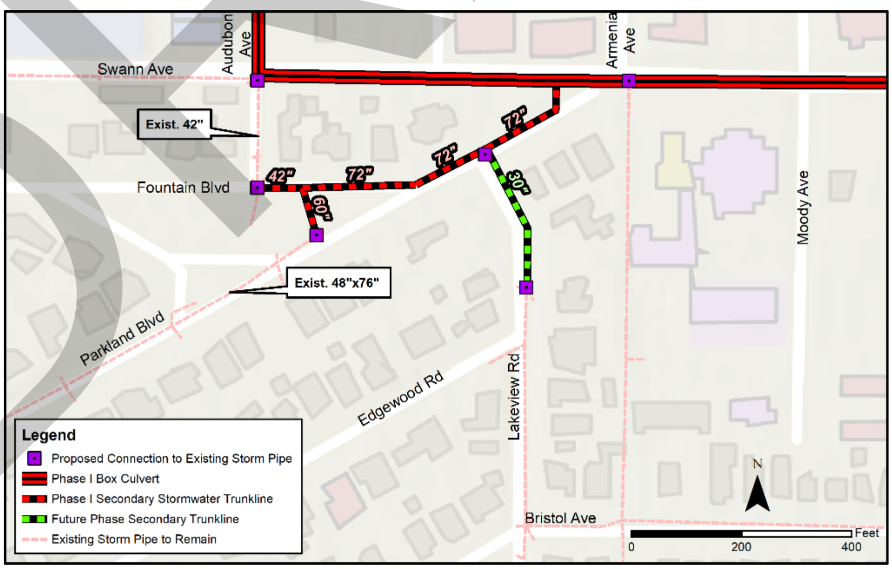

Figure 5-1 – Parkland Estates Proposed Stormwater Connections (W Swann Ave Route)

5.1.2.3 Selmon Expressway Connection Points

All proposed models for the SHFR project account for the South Selmon Capacity Project and reflect THEA's concept-level design plans documented as part of the project's ERP application. A new pipe is proposed along W Bristol Ave to receive discharges from Albany Pond as part of a proposed agreement between the City of Tampa and THEA, who is dependent on this new outfall for their South Selmon Capacity project, which includes the addition of lanes on the Selmon Expressway. The proposed agreement also includes a connection point at W Watrous Ave and S Howard Ave, where the proposed box culvert will receive discharge from the Selmon Expressway ditch that lies between the Selmon Expressway and the railroad.

- A 36" pipe along W Bristol Ave between S Howard Ave and the Albany Pond, which will connect to the pond's control structure.
- A 30" pipe along W Watrous Ave, terminating on the east side of the railroad track, which will connect to THEA's 24" pipe entering the W Watrous Ave right of way from a proposed ditch system. This pipe was sized to accommodate a future extension of the system west beneath the railroad tracks, which will alleviate flooding in New Suburb Beautiful, as discussed in **Section 5.1.3.4.**

The volume and discharge rates of stormwater runoff that the box culvert will receive from these locations are very small in comparison to the stormwater runoff from Parkland Estates and Palma Ceia Pines. The conceptual drainage design and impervious footprint for the Selmon Expressway project, as documented in ERP application 915140, is included in the proposed conditions models for the SHFR project. The locations of these connection points are shown in **Figure 5-2**.

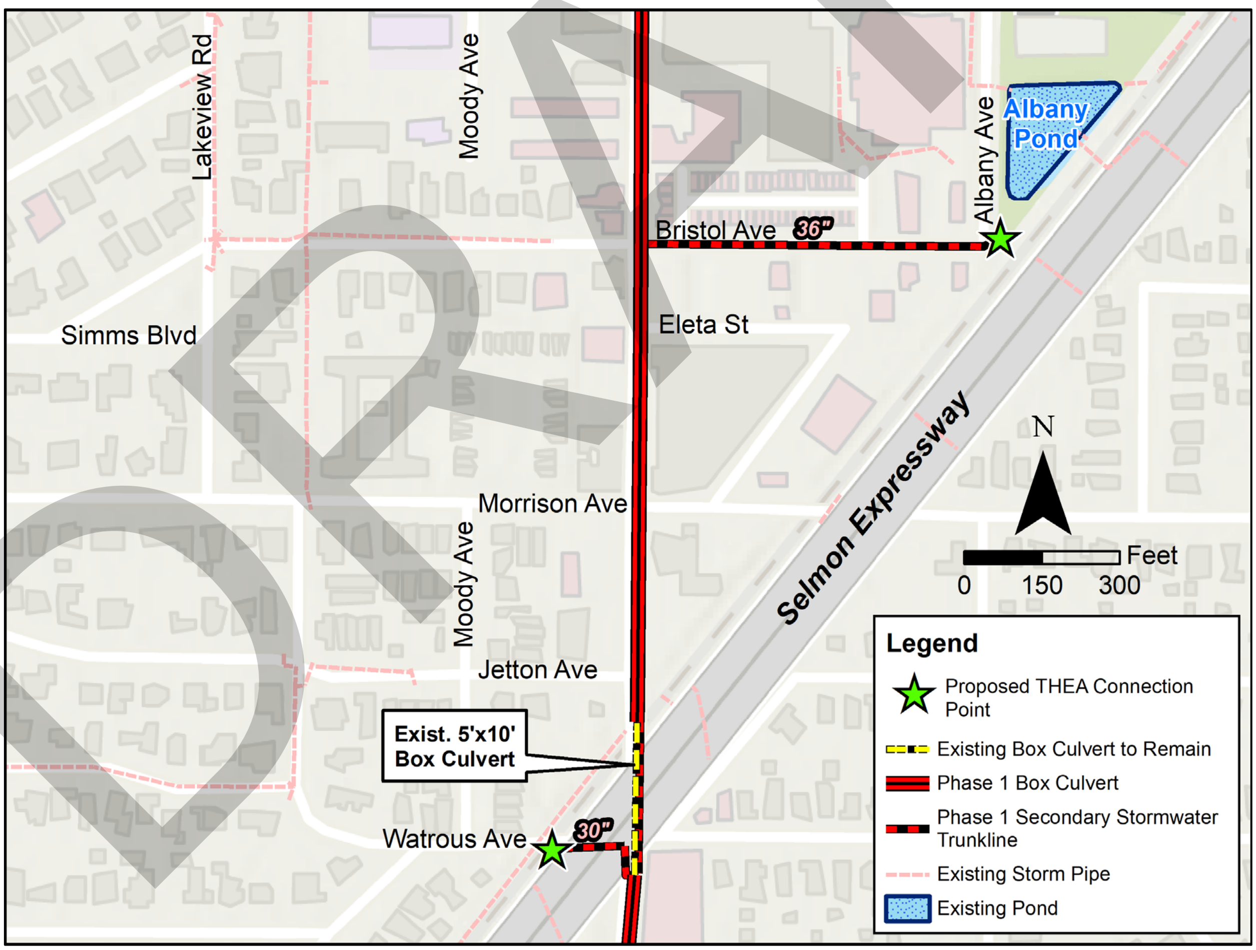

Figure 5-2 – Selmon Expressway Project Connection Points

5.1.2.4 W Kennedy Blvd (by others)

The Florida Department of Transportation (FDOT) began construction on W Kennedy Blvd in October 2025 to upgrade the existing roadway surface and drainage system along the corridor. The proposed stormwater collection system upgrades are included in the PCM to evaluate the future benefit to W Kennedy Blvd upon completion of both projects. However, for the SHFR project's benefit-cost analysis discussed in this report, the ongoing work along Kennedy Blvd was excluded from that version of the PCM so that the analysis did not take credit for drainage improvements that are not reflected in the BCA's project cost.

Because the W Kennedy Blvd system directly to the north of the SHFR Flood Reduction Focus Area outfalls through a City system (along S Habana Ave and into the AMI Pond) and the pipes leaving the W Kennedy Blvd right of way will not change as part of FDOT's project, it is unlikely that the FDOT project alone will result in an increase in runoff into Palma Ceia Pines. According to the SHFR models, most of the flow that enters Palma Ceia Pines from W Kennedy Blvd occurs as overland flow from an easily overwhelmed pipe system.

The SHFR project's H&H models show that **until the significant overland flows onto W Kennedy Blvd from the north are addressed by increasing capacity of City stormwater pipes north of Kennedy, these FDOT improvements will do very little to alleviate flooding on Kennedy, even if the existing S Habana Ave system between Kennedy and the AMI Pond were to be upsized.** Discussion of this issue along with potential solutions can be found in **Section 5.1.4.**

A map that illustrates the drainage improvements currently under construction on W Kennedy Blvd can be found below in **Figure 5-3.**

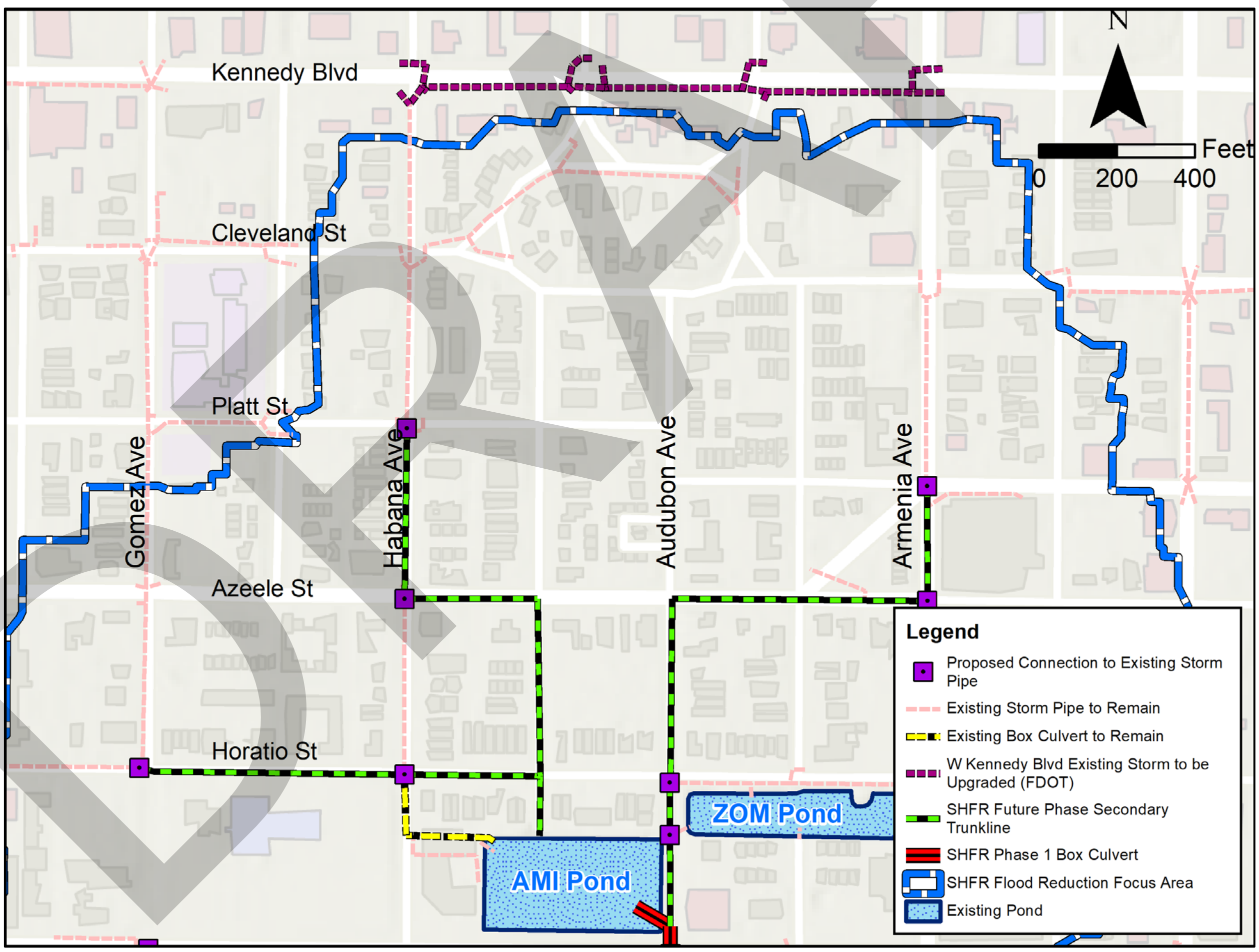

Figure 5-3 – W Kennedy Blvd Drainage Improvements (FDOT)

5.1.3 Proposed Conditions Model (PCM) Components – Future Phases

5.1.3.1 Palma Ceia Pines Collection Systems

An iterative modeling analysis was carried out to provide a concept-level design solution that collects water within Palma Ceia Pines and brings it into the new 10'x10' box culvert in an efficient and cost-effective way, achieving the FPLOS goal within the SHFR Flood Reduction Focus Area, while maintaining existing stormwater treatment within detention ponds to the extent possible.

The concept design includes several weir structures that preserve stormwater treatment capacity within the AMI and ZOM ponds during manageable rainfall events while allowing excess runoff during severe rainfall events to bypass those ponds and use the new box culvert trunkline. These collections systems are critical to meeting the FPLOS goal within Palma Ceia Pines. They not only convey direct runoff generated within the SHFR Flood Reduction Focus Area, but also bring in stormwater from west of S MacDill Ave, which is forced east through the existing pipes along W Horatio St and W De Leon St. Although designed to flow west toward Old Tampa Bay (as discussed previously in **Section 3**), in the proposed condition these systems will temporarily reverse flow during heavy rainfall and will discharge into the AMI pond and the new box culvert trunkline, which becomes the path of least resistance for the overwhelmed existing systems. This will provide some flood relief to the western portion of Palma Ceia Pines and other areas to the west along the Upper Peninsula West Outfall and Cleveland Street Outfall systems.

To reduce the size of the proposed secondary collection systems, an 18-inch-tall weir has been introduced (in the model) within the bottom of the proposed three-way junction structure at the intersection of S Gomez Ave and W Horatio St to limit backflows from the west. These backflows occur within the large existing elliptical pipe that is part of the Cleveland Street Outfall system, as discussed previously in **Section 3.2.1**.

The conceptual future phase pipes north of W Swann Ave demonstrate the conveyance needed to meet the FPLOS goal and assume that the existing trunklines within the same corridor will be removed and replaced. There will likely be opportunities to use existing pipes in certain areas and construct an additional trunkline alongside them, reducing the size of the new pipes and potentially reducing construction costs. These value engineering opportunities will be evaluated further during the design phase of the future project, when topographic survey and subsurface utility exploration is complete. Potential locations for these opportunities include W Horatio St between S Gomez Ave and S Habana Ave, W De Leon St between S Gomez Ave and S Habana Ave, and S Armenia Ave between W Platt St and W Horatio St. Because this hasn't been fully evaluated, and requires additional survey and data collection, a formal cost estimate has not been finalized for these future systems.

Figure 5-4 below provides a map of the Palma Ceia Pines conceptual design developed as part of this analysis.

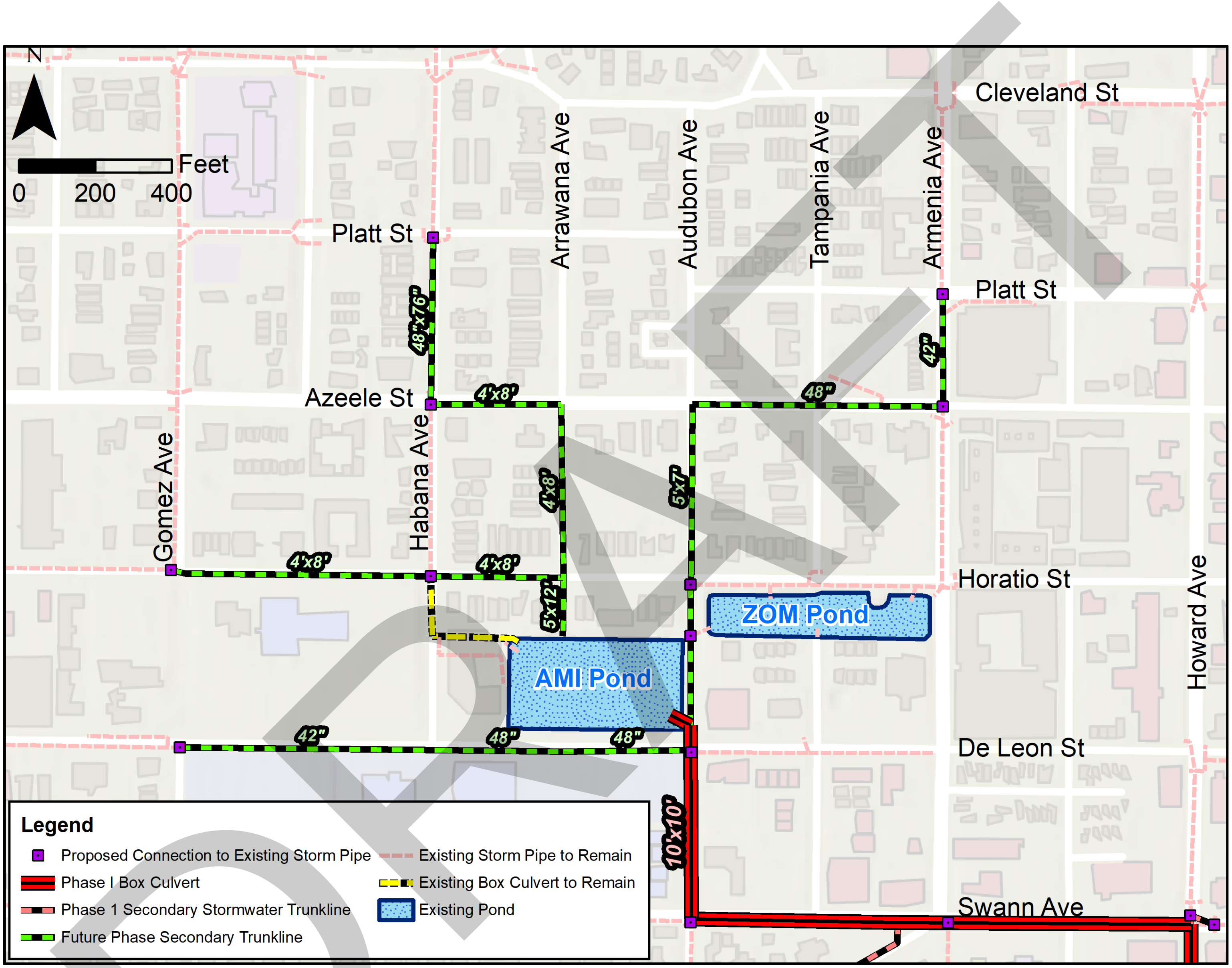

Figure 5-4 – Palma Ceia Pines Future Phase Conceptual Design

5.1.3.2 W Texas Ave

W Texas Ave, between South Carolina Ave and S Alabama Ave, experiences roadway flooding during heavy rainfall due to its elevation relative to the surrounding area and an undersized pipe system that carries runoff south and east to Bayshore Blvd through several private properties. The RECM predicts 5-year/8-hour flood depths over the roadway that exceed 18 inches at the lowest point – the intersection with S Glen Ave. This localized flooding also impacts W Stroud Ave, S Lorenzo Ave, S Bay Villa Ave, and S Moody Ave. A series of stormwater pipes that range in size between 24-inch and 36-inch diameter have been sized in the PCM to connect the low areas along W Texas Ave to the proposed box culvert along S Howard Ave. These pipes would supplement and connect to the existing 24-inch pipe that provides drainage to this area today. A 36-inch pipe stub-out will be provided on W Stroud Ave at S Howard Ave as part of the Phase I project to accommodate this as a future project. A map of these future concept-level improvements can be found in **Figure 5-5** below.

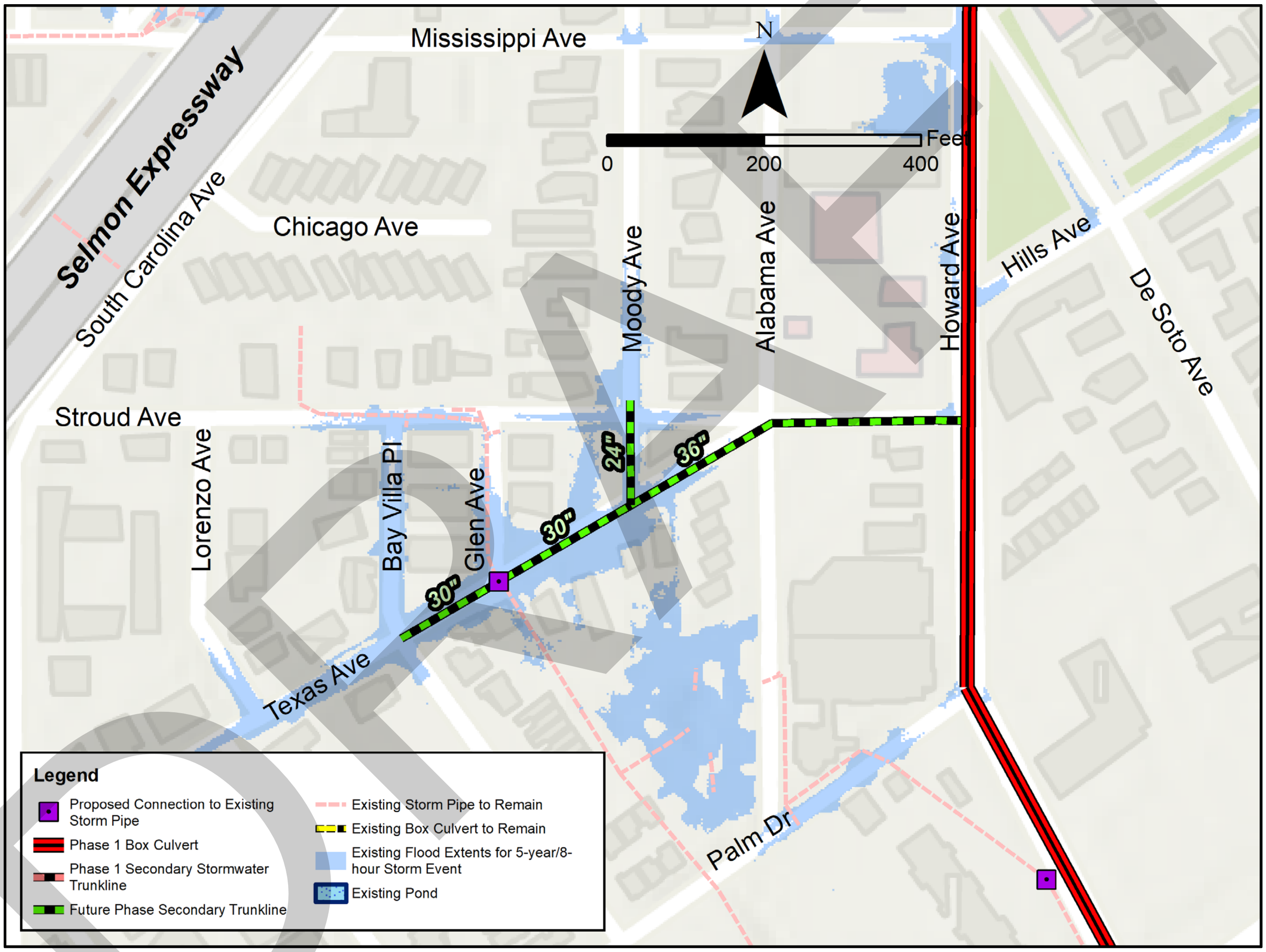

Figure 5-5 – Future W Texas Ave Drainage Improvements

5.1.3.3 W Morrison Ave and S Armenia Ave

The RECM predicts 5-year/8-hour flood depths between 7 and 9 inches over the lowest edges of pavement along W Morrison Ave at S Armenia Ave, and along W Jetton Ave at S Armenia Ave. For the W Swann Ave route**,** a 30" pipe along W Morrison Ave between the South Howard box culvert and S Armenia Ave was analyzed and achieves two goals:

- Reduces peak stages on W Morrison Ave to meet FPLOS goal.
- Provides a secondary outlet for runoff at W Bristol Ave and S Lakeview Rd, allowing FPLOS goal to be met at that location without constructing a new pipe along the full length of S Lakeview Rd between W Bristol Ave and W Parkland Blvd.

This future system eliminates the need for approximately 430 feet of stormwater pipe installation, utility relocations, and roadway restoration on S Lakeview Rd, which reduces construction costs, impacts to residents, and impacts to the many large oak trees that line this corridor. A 30-inch pipe stub-out will be provided on W Morrison Ave at S Howard Ave as part of the Phase I project to accommodate this as a future project. A map of these future concept-level improvements can be found in **Figure 5-6** below.

5.1.3.4 W Watrous Ave

The RECM predicts a peak 5-year/8-hour flood depth of 15 inches above the low edge of pavement along W Watrous Ave, just west of the CSX railroad crossing and S Howard Ave. To achieve the FPLOS at this location, a new 18" pipe is needed to carry runoff from this area beneath the railroad tracks and into the new box culvert system. This pipe will need to be installed using a jack and bore method, and construction will need to be coordinated with and permitted through CSX. Without this new pipe, the project can still provide a reduction in flooding to this location, however it will not be enough to meet the FPLOS goal. An 18-inch pipe stub-out will be provided on W Watrous Ave near the Selmon Expressway as part of the Phase I project to accommodate this as a future project. A map of these future concept-level improvements can be found in **Figure 5-6** below.

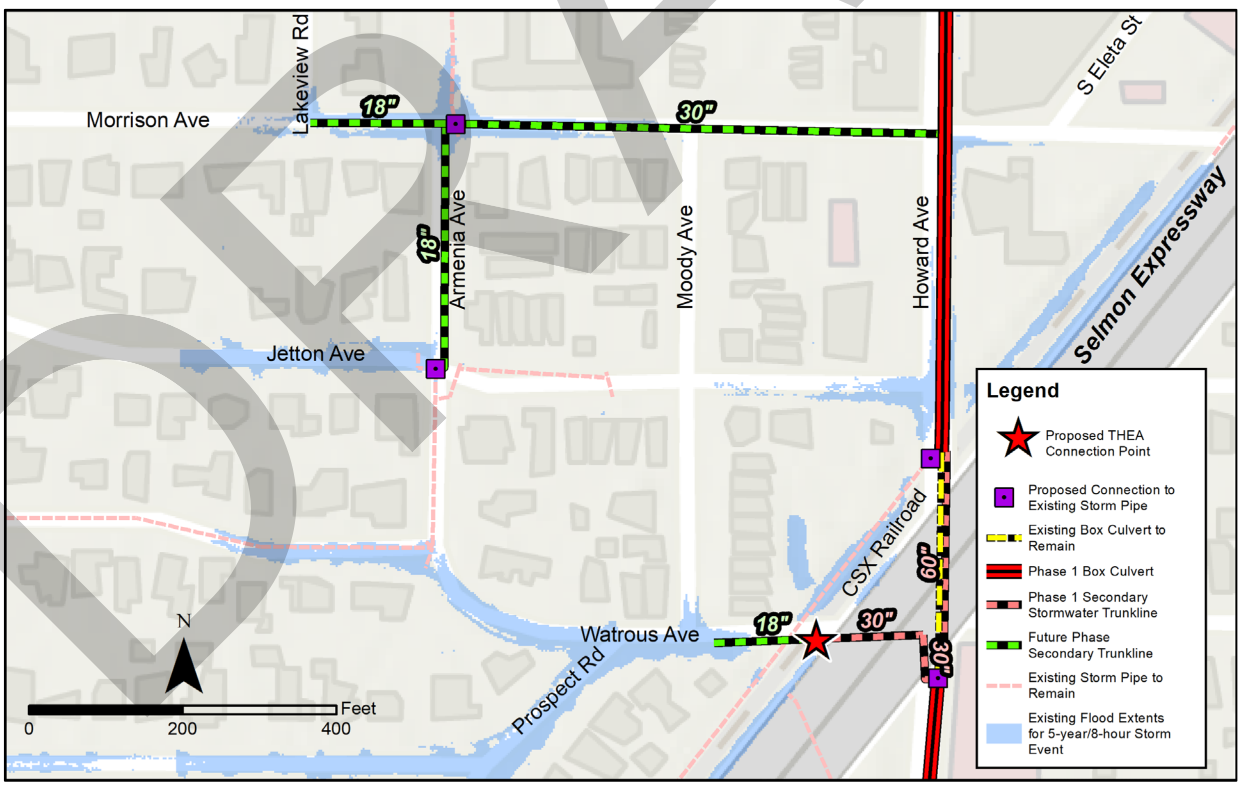

Figure 5-6 – Future W Morrison Ave, S Armenia Ave, and W Watrous Ave Drainage Improvements

5.1.3.5 W Eleta St

W Eleta St is a roughly 400 LF section of roadway to the east of S Howard Ave, one block to the south of W Bristol Ave. The RECM predicts significant street flooding at its intersection with S Howard Ave due to poor roadway grading and lack of stormwater infrastructure. Two permitted detention ponds along the north side of W Eleta St discharge excess runoff across the existing sidewalk and into the roadway, contributing to the flooding and creating a hazard to pedestrians.

There are also numerous isolated ponding issues along the south side of W Eleta St and along S Eleta St between W Eleta St and W Morrison Ave, due to lack of a drainage system at low points within the roadway profile. The SHFR project presents an opportunity to address these issues by extending new storm inlets and pipes east to capture runoff and carry it directly into the box culvert along S Howard Ave.

Extending a pipe along W Eleta St to S Eleta St will provide a connection point for a future system that can alleviate the ponding along S Eleta St. Regrading of the roadway may also be necessary to facilitate drainage and eliminate ponding, and would be prudent along S Eleta St to reduce the number of inlets needed to solve the problem. It has been determined that an 18" pipe that connects directly into the 10'x10' box culvert on S Howard Ave will be adequate to meet the FPLOS goal on W Eleta St and S Eleta St.

An 18-inch pipe stub-out will be provided on W Eleta St to the east of S Howard Ave as part of the Phase I project to accommodate this as a future project.

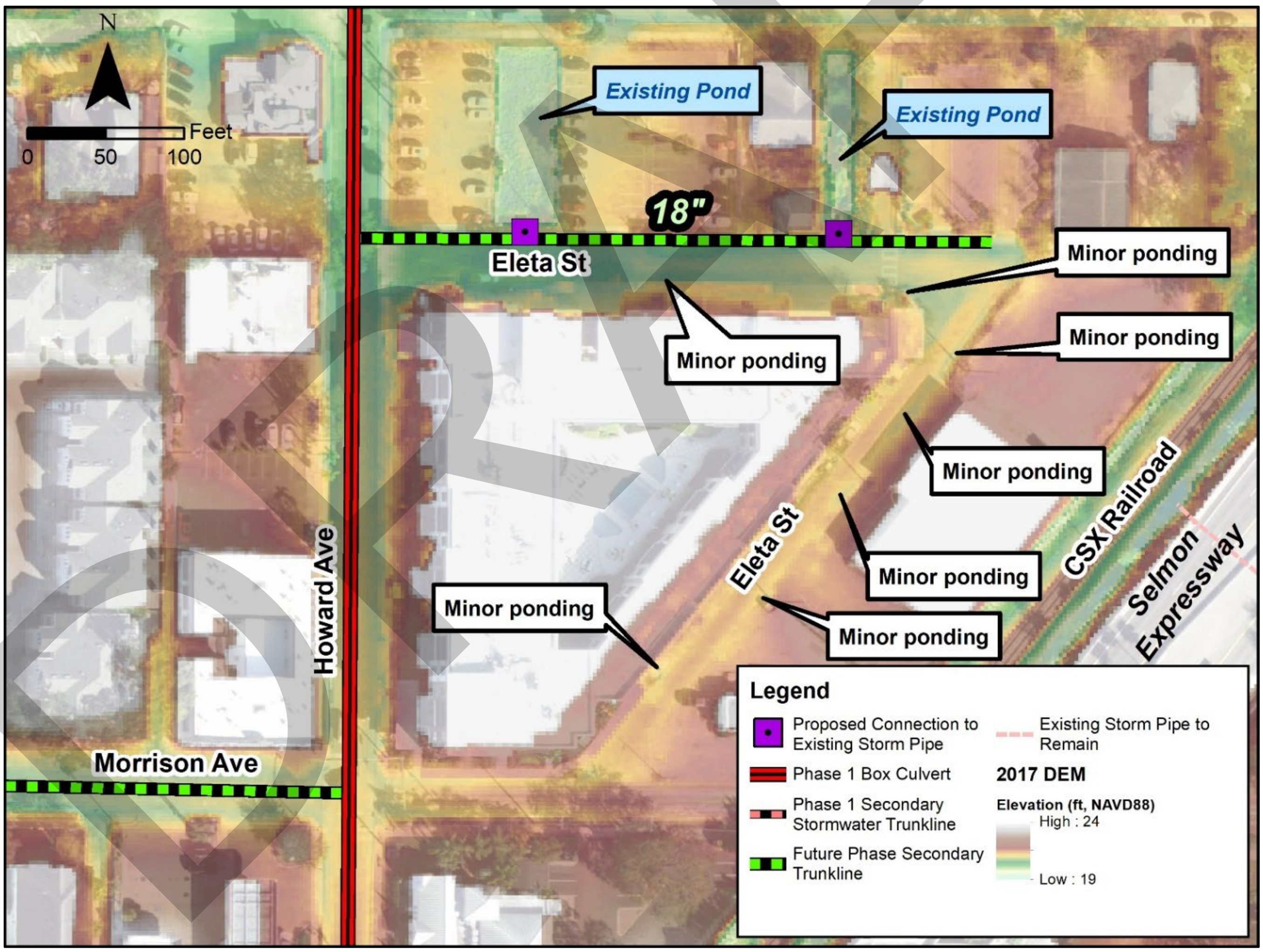

Figure 5-7 – Future W Eleta St Drainage Improvements

5.1.4 Opportunity for Additional Future Flood Relief Projects

The improvements discussed in this section were evaluated at a concept level by the design team as potential future projects that can either benefit from or provide benefit to the SHFR project. Pipe stub-outs will be provided along S Howard Ave during the construction of Phase I to accommodate the future W Mississippi Ave, W Dekle Ave, and W Marjory Ave improvements. While promising opportunities have been identified in the other future improvements discussed in this section, their design is beyond the scope of the SHFR project and they will need to be evaluated further.

5.1.4.1 Cypress Street Outfall Extension

The RECM predicts significant overland stormwater flow reaching W Kennedy Blvd from the Armory Gardens neighborhood to the north because of inadequate capacity within the pipe systems designed to drain this neighborhood. A portion of this flow comes from as far north as Midtown, between W Cypress St and I-275. The existing storm pipes that serve Armory Gardens are part of the Cleveland Street Outfall system, which in its entirety is severely undersized, as discussed in **Sections 2.1 and 3.2**.

The overland flow reaching W Kennedy Blvd totals a combined peak flow rate of approximately 200 cfs during the 5-year/8-hour design storm, and reaches W Kennedy Blvd along the north-south roadways between (and including) N MacDill Ave and N Armenia Ave. When the Kennedy Blvd storm sewer system becomes overwhelmed (which happens frequently), excess stormwater is then carried south over land as sheet flow into Palma Ceia Pines, contributing to the flooding that the SHFR project intends to reduce.

Based on an initial evaluation of the recently constructed (2023) Cypress Street Outfall system's design documentation, its box culvert system has additional capacity available and a portion of the overland flow that reaches Kennedy Blvd could be intercepted and diverted into it. This would provide flood relief to Armory Gardens, W Kennedy Blvd, and Palma Ceia Pines.

While there appears to be capacity available, the scale to which these overland flows can be intercepted will need to be evaluated further. **There is a limit to the amount of additional stormwater runoff the Cypress Street Outfall system can handle, and it is apparent from the models that there is not enough capacity available to use it as an alternative to the SHFR project.** This is evident by the peak flow rates shown in **Table 5-1** below, which reflect only the flows generated to the north of W Kennedy Blvd, which reach W Kennedy Blvd between MacDill Ave and Armenia Ave.

A version of the PCM has been evaluated under the assumption that all these overland flows are intercepted, and while it certainly can reduce the size of the Palma Ceia Pines secondary collection systems, a large box culvert trunkline with a new outfall to the bay is still needed to meet the project's FPLOS goal. However, any runoff that can be intercepted before reaching Kennedy Blvd is an added benefit and would further reduce both roadway and structure flooding within Palma Ceia Pines.

Reducing the hydraulic burden placed on the SHFR project's 10'x10' box culvert would provide capacity that opens the door for even more future stormwater improvements projects in this region. It could be a cost-effective way to help the overburdened Cleveland Street Outfall system. A summary of the modeled peak rate of overland flows reaching W Kennedy Blvd between S MacDill Ave and S Armenia Ave for a range of rainfall event simulations within the RECM are shown below in **Table 5-1**.

Table 5-1 – Combined Peak Overland Flow Rates Reaching W Kennedy Blvd

Model Simulation	Combined Peak Flow Rate (CFS)
2.33-year/24-hour (Mean-Annual)	172
5-year/8-hour	214
10-year/24-hour	372
25-year/24-hour	446
50-year/24-hour	589
100-year/24-hour	659
Calibration Event (Hurricane Milton, 2024)	374

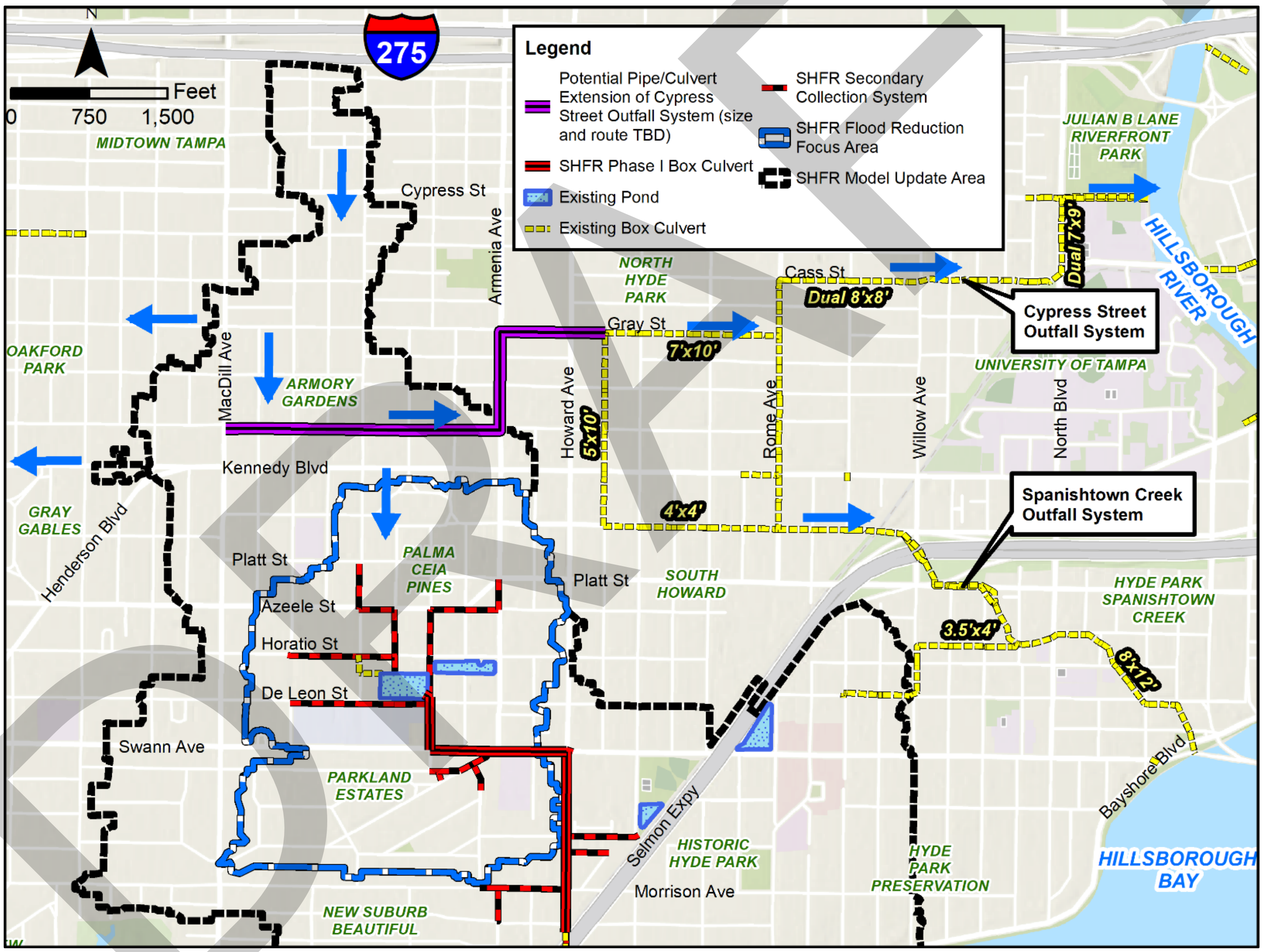

Figure 5-8 – Potential Future Extension of the Cypress Street Outfall System

5.1.4.2 W Kennedy Blvd

As mentioned previously in **Section 5.1.2.4**, FDOT is in the process of upgrading its storm sewer system along W Kennedy Blvd. However, based on analysis of the SHFR H&H models, until the significant overland flows onto W Kennedy Blvd from the north are addressed by increasing capacity of City stormwater pipes north of the corridor, these FDOT improvements will do very little to alleviate flooding on Kennedy Blvd during the significant rainfall events analyzed in this report.

Once these overflows are addressed, flooding conditions will improve along W Kennedy Blvd. For W Kennedy Blvd (between S Habana Ave and S Armenia Ave) to meet the FPLOS goal of the SHFR project, the pipe system along S Habana Ave, that serves as the outfall for this portion of W Kennedy Blvd, will need to be upsized between W Kennedy Blvd and W Platt St. This assumes that the secondary collection systems shown in **Figure 5-4** and **Figure 5-8** are constructed as currently modeled in the PCM (extending north to W Platt St and S Habana Ave). The need to upsize the S Habana Ave trunkline is also discussed by the W Kennedy Blvd project's design team within their design documentation.

5.1.4.3 S MacDill Ave

The model identifies several roadway FPLOS deficiencies that will remain in the proposed condition to the west of the SHFR Flood Reduction Focus Area, along S MacDill Ave, particularly at the intersections with W Swann Ave, W De Leon St, W Azeele St, W Platt St, and W Cleveland St.

There is an opportunity to size the future phase collection systems in Palma Ceia Pines to accommodate future projects that further alleviate roadway flooding on S MacDill Ave. Because upgrading its multiple outfalls (which travel over 2 miles to Old Tampa Bay) would be challenging, **a more feasible way to alleviate flooding on S MacDill Ave could be to use the SHFR trunkline and/or an extension of the Cypress Street Outfall** (discussed in **Section 5.1.4.1**). A map showing one potential future configuration that reduces this flooding can be found below in **Figure 5-9.**

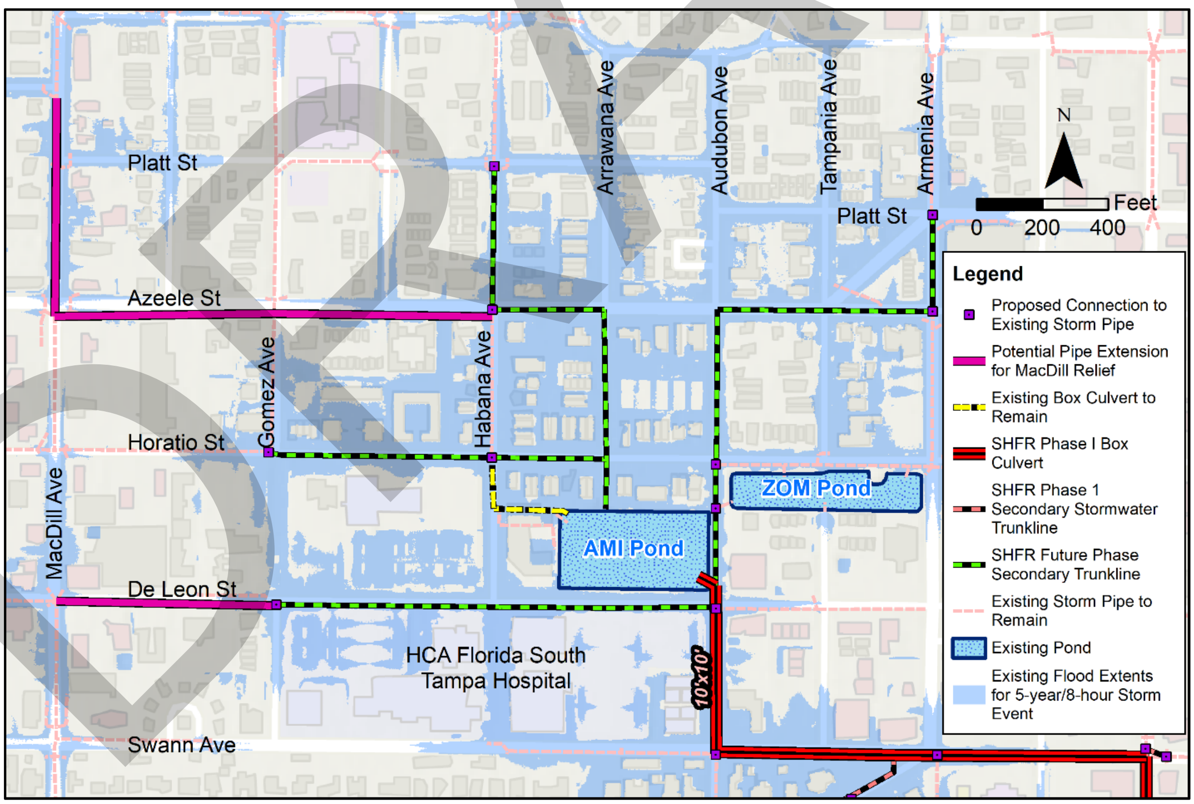

Figure 5-9 – Potential Concept for Future MacDill Ave Flood Relief

5.1.4.4 W Mississippi Ave

Minor roadway flooding occurs on W Mississippi at S Moody Ave and S Alabama Ave due to a lack of stormwater infrastructure at the low portions the roadway. Although not included in the PCM, it was determined through a separate model iteration that a new 18-inch pipe connecting these intersections to the S Howard Ave box culvert is adequate to handle the relatively small peak flow rates that reach these intersections, and that this pipe connection would not impact predicted flood reduction benefits upstream. An 18-inch pipe stub-out will be provided on W Mississippi Ave at S Howard Ave as part of the Phase I project to accommodate this as a future project.

5.1.4.5 W Dekle Ave and W Marjory Ave

Similar to the issues on W Mississippi Ave, nuisance ponding occurs at the intersections of W Dekle Ave & S Albany Ave and W Marjory Ave & S Albany Ave due to lack of stormwater infrastructure. Although not included in the PCM, it was determined through a separate model iteration that a new 18-inch pipe connecting W Dekle Ave at S Albany Ave to the S Howard Ave box culvert using W Southview Ave is adequate to handle the relatively small peak flow rates that reach these intersections, and that this pipe connection would not impact predicted flood reduction benefits upstream. To eliminate the nuisance ponding at S Albany Ave & W Marjory Ave, S Albany Ave would need to be regraded between W Marjory Ave and W Dekle Ave to ensure that stormwater can flow to future inlets at W Dekle Ave and S Albany Ave. An 18-inch pipe stub-out will be provided along W Southview Ave at S Howard Ave as part of the Phase I project to accommodate this as a future project.

A map of these future concept-level improvements can be found in **Figure 5-10** below.

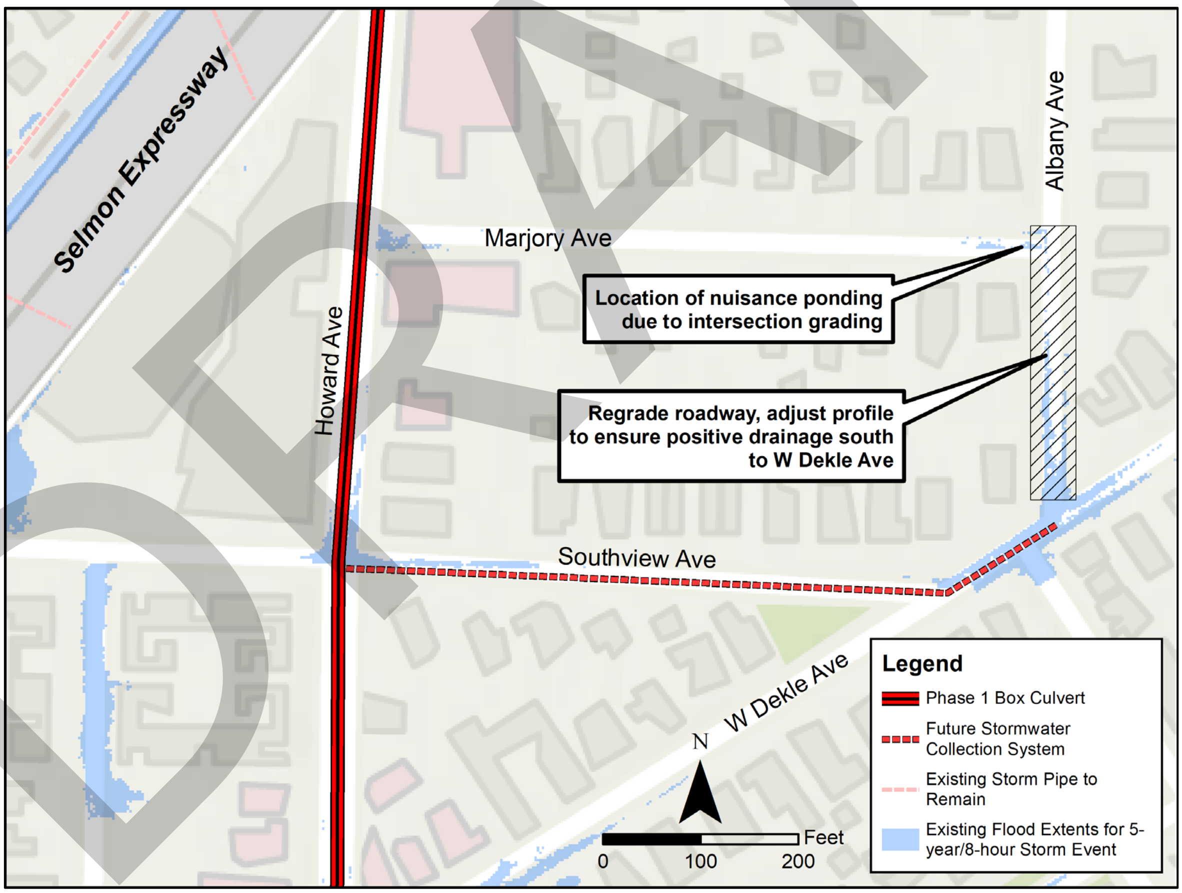

Figure 5-10 – Potential Future Drainage Improvements- S Albany Ave: W Dekle Ave to W Marjory Ave

5.1.4.6 S Dakota Ave and W De Leon St

The SHFR project will significantly reduce flooding around Swann Pond during the 5-year/8-hour design storm by diverting a portion of the existing stormwater taken there today into the new 10’x10’ box culvert at S Howard Ave. This adds capacity to Swann Pond in the proposed condition, which overtops its bank during the 5-year/8-hour design storm in the existing condition. It should be noted that the PCM accounts for the impervious area added as part of the Selmon Expressway widening project and the resulting additional runoff into Swann Pond.

Field investigation of this area in 2025 revealed that an existing pipe that once entered Swann Pond from the intersection of W De Leon St and S Rome Ave has since been filled with grout, disconnecting the flood-prone W De Leon St from Swann Pond. While the RECM’s 5-year/8-hour peak stages are similar between the pond and this intersection (6 inches higher in Swann Pond), the SHFR proposed condition lowers peak stages in Swann Pond and creates a 1.7-foot differential in peak stage, as shown in **Figure 5-11** below**.**

This provides an opportunity to reestablish this connection and provide flood relief to the low-lying portion of W De Leon St between S Rome Ave and S Orleans Ave, which experience 5-year/8-hour flood depths of nearly 2 feet at the intersection of W De Leon St and S Dakota Ave. This connection could also provide treatment for stormwater runoff that currently discharges directly to Hillsborough Bay through the Spanishtown Creek box culvert system, with no treatment.

Figure 5-11 below illustrates the 5-year/8-hour flood reduction anticipated from the SHFR project and shows a conceptual layout of the potential connection discussed. The flood reduction predicted by the new connection is not shown.

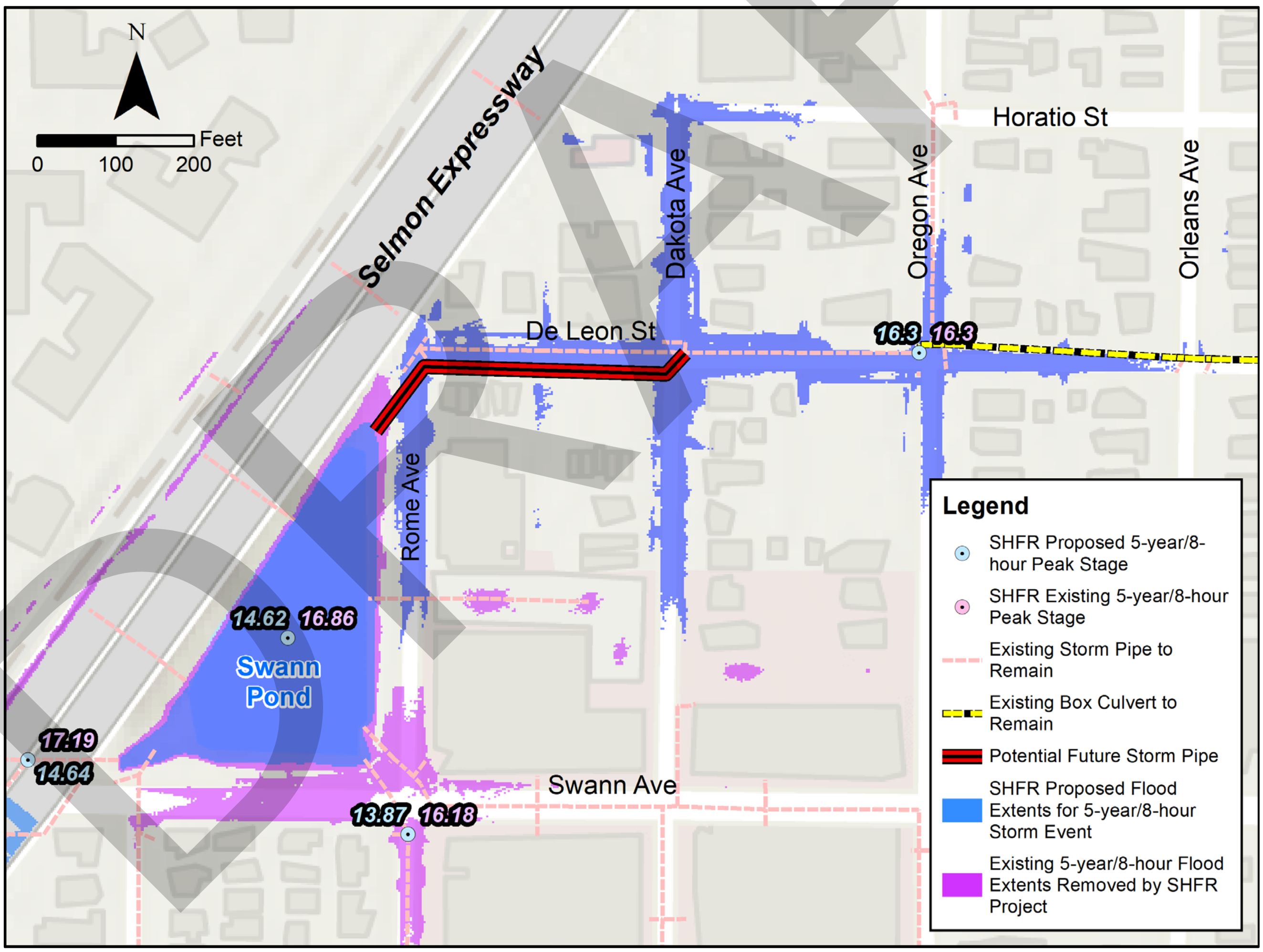

Figure 5-11 – Potential Future De Leon St Connection to Swann Pond

5.2 Inlet Capacity

The project's H&H models assume there is no restriction of runoff entering a pipe system due to lack of inlet capacity along the roadways. This assumption ensures that the project's proposed pipes and culverts are sized adequately at this conceptual level design phase.

As the project progresses into its final design phase, peak runoff rates for each model subbasin will be used to ensure that enough inlets are designed and constructed along the project corridor to provide the flood relief predicted by the model. The runoff rates used to size the combined inlet capacity along the project's route will include direct runoff from the subbasin and overland flows coming in from adjacent subbasins as sheet flow or as channelized flow through curb and gutter systems, which occurs when underground pipe systems become overwhelmed.

5.3 Comparison of Primary Design Alternatives

5.3.1 Route Study Criteria

The three primary alternatives evaluated by the project scope are shown in **Figure 5-12.** Each alternative uses S Howard Ave to provide a new hydraulic connection between Hillsborough Bay and Palma Ceia Pines, picking up stormwater runoff from Parkland Estates along the way. The three alternatives were compared based on the following criteria:

- Construction cost
- Constructability challenges
- Environmental impacts (tree canopy reduction)
- Traffic impacts
- Residences impacted
- Businesses impacted
- Hydraulic efficiency and flood reduction benefit

Kimmins Contracting provided preliminary cost estimates for the three primary alternatives based on proposed box culvert size and depth, knowledge of existing site conditions (such as corridor widths and utilities), the current market and cost of materials, and comparison to actual costs for similar projects such as the Lower Peninsula Stormwater Improvements Project.

Because the estimated cost for all three was very similar, construction cost was considered irrelevant for this comparative analysis. The concept-level cost estimate for the recommended alternative can be found in **Appendix L.**

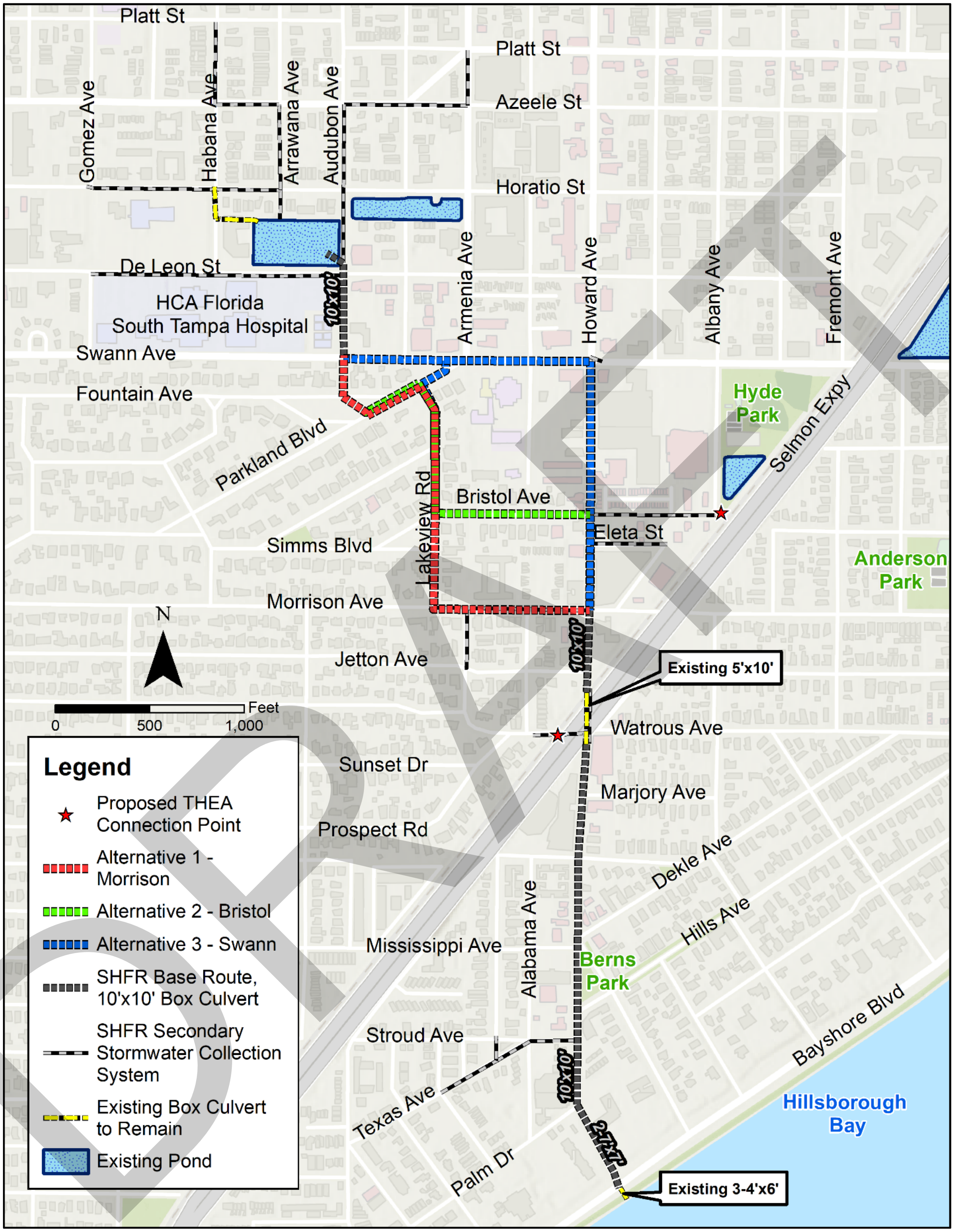

Figure 5-12 – Comparison Map for SHFR Primary Alternatives (Morrison, Bristol, and Swann)

Each alternative was evaluated by the design-build team for constructability challenges using desktop resources and data collected in the field. A summary of the evaluation criteria is listed below:

- The most recent parcel information from the Hillsborough County Property Appraiser website was used along with site visits to identify the stakeholders – both residential and commercial, that would see impacts due to construction.
- Property boundaries and inventory of the City's water and wastewater utilities (discussed in **Section 3.3**) were used to evaluate constructability challenges, including complexity of anticipated utility relocations.
- The tree survey discussed in **Section 2.6.6** was used to determine how many oak trees would likely be impacted during construction, and how many oak trees likely could be preserved, based on size, condition and location. The comparison was limited to oak trees because most of the others surveyed are palms and exotics. The tree inventory developed as part of the SHFR project, which includes all species, can be found in **Appendix C**.
- Traffic data, as discussed in **Section 2.6.7**, was used to determine estimated traffic volumes impacted by each alternative. The new traffic data collected for the SHFR project can be found in **Appendix E**.
- A H&H model was developed for each of the three primary alternatives, and the model results were compared to identify differences in hydraulic efficiency.

Because both the flood reduction benefits and estimated cost for each of the three primary alternatives are similar, a formal benefit-cost analysis was only performed for the recommended alternative – W Swann Ave. This benefit-cost analysis uses SWFWMD's Stormwater Improvement Flood Protection (SIFP) Benefit Cost Analysis Tool, which was developed to estimate a present-day dollar value of benefits over a flood relief project's life cycle based on reduction of roadway and property damages, as well as reduction in duration of undriveable roadway conditions. This analysis is discussed in **Section 6.6.**

5.3.2 Shared Improvements Between Primary Alternatives

Each of the three primary alternatives shares the following components, which were excluded from the comparative analysis:

- Box culvert trunkline and secondary collection systems within Palma Ceia Pines (north of W Swann Ave), as described in **Sections 5.1.2.1 and 5.1.3.1.**
- THEA connections for the Selmon Expressway project discussed in **Section 5.1.2.3.**
- Future secondary collection systems proposed to the south of W Morrison Ave and along W Eleta St, which are discussed in **Section 5.1.3.**

The comparative analysis of the three primary alternatives only includes construction of the proposed primary box culvert trunkline between Bayshore Blvd and the intersection of W Swann Ave and S Audubon Ave, and the secondary stormwater collection systems needed in Parkland Estates, to the west of S Howard Ave.

5.3.3 Alternative 1 – W Morrison Ave Route

5.3.3.1 Description of Alternative 1

Alternative 1 uses W Morrison Ave, S Lakeview Rd, W Parkland Blvd, W Fountain Blvd, and S Audubon Ave to reach W Swann Ave through the Parkland Estates neighborhood. This alternative follows the route recommended in the JMT report, which can be found in **Appendix A.**

While hydraulically effective, this alternative comes with significant constructability challenges given the size and depth of the proposed box culvert near residential properties. Box culvert construction and utility relocation through the narrow residential corridors of Parkland Estates will require significant oak tree canopy removal and damage to the character of a historic Tampa neighborhood.

Figure 5-13 below provides an overview map of the proposed improvements and flood reduction associated with Alternative 1.

5.3.3.2 Alternative 1 Flood Reduction Benefits

A comparison of peak stage elevations between the RECM and the Alternative 1 PCM for the 5-year/8-hour storm event is shown in **Table 5-2** below. Alternative 1 meets the FPLOS goal for the 5-year/8-hour design storm simulation and does not cause adverse flood impacts to any node within the study area for the nine simulated storm events**.**

While flood reduction near Swann Pond and S Rome Ave were not the primary goal of the project, the three primary alternatives provide a reduction in flooding in this area because they intercept stormwater runoff that currently discharges to the pond, so it has been included in the analysis for comparison.

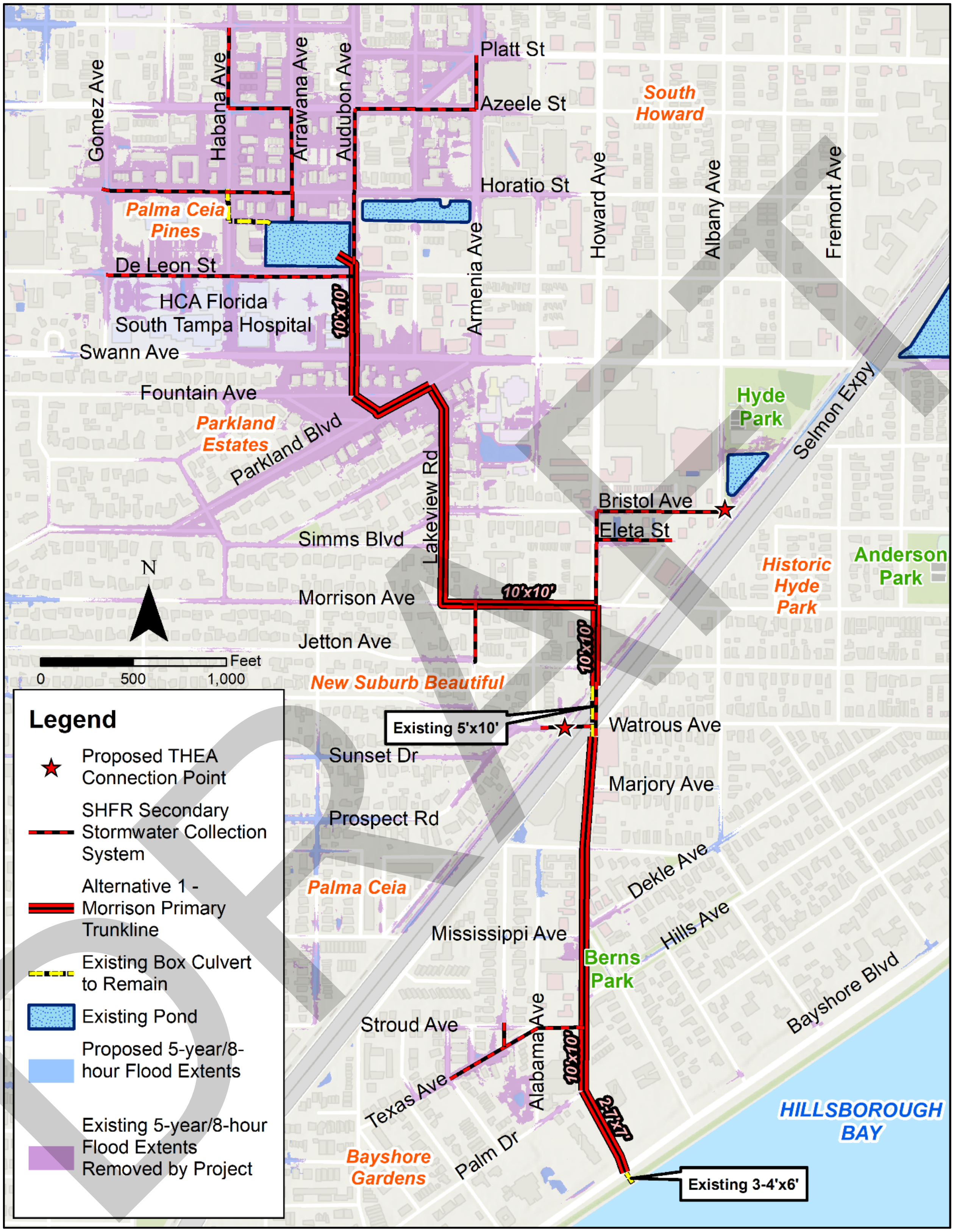

Figure 5-13 – Alternative 1 Concept Plan and Flood Reduction Map

Table 5-2 – Summary of Roadway FPLOS Analysis (Alternative 1, 5-year/8-hour)

Node	Location	RECM Peak Stage (ft, NAVD88)	PCM Peak Stage (ft, NAVD88)	Peak Stage Difference (ft)	Low EOP Elevation (ft, NAVD88)	Proposed Flood Depth (ft)
NRU0750	W Fountain Blvd at Fountain Park, Parkland Estates	19.21	15.54	-3.67	15.2	0.34*
NCL3510	W Cleveland St at S Habana Ave	19.65	19.47	-0.18	19.1	0.37*
NCL3450	W Horatio St at S Habana Ave	19.23	16.70	-2.53	16.9	-0.20
NCL3490	W Platt St at S Habana Ave	19.23	17.86	-1.37	17.7	0.16
NRU0790	W Swann Ave at S Audubon Ave (north side)	19.22	15.86	-3.36	15.9	-0.04
NRU1050	W Platt St at S Armenia Ave	19.23	17.64	-1.59	17.3	0.34*
NRU0960	W Azeele St at S Audubon Ave (south side)	19.23	17.13	-2.10	17.0	0.13
NRU1030	W Azeele St at S Armenia Ave (north side)	19.23	17.38	-1.85	17.4	-0.02
NBW2090	W De Leon St at S Gomez Ave	19.22	18.37	-0.85	18.0	0.37*
NCL3250	W Horatio St at S Gomez Ave	19.22	17.44	-1.78	17.2	0.24
NRU1010	W Horatio St at S Armenia Ave	19.23	17.12	-2.11	18.2	-1.08
NRU0965	W Azeele St at S Audubon Ave (north side)	19.23	17.24	-1.99	16.9	0.34*
NBW2110	W De Leon St at S Habana Ave	19.22	17.21	-2.01	17.3	-0.09
NCL3470	W Azeele St at S Habana Ave	19.23	17.12	-2.11	16.8	0.32
NRU1040	W Azeele St at S Armenia Ave (south side)	19.23	17.22	-2.01	17.2	0.02
NRU1070	W Cleveland St at S Armenia Ave	19.24	17.89	-1.35	18.9	-1.01
NRU1170	W Bristol Ave at S Lakeview Rd	19.22	14.41	-4.81	18.0	-3.59
NCL3740	W Horatio St at S Arrawana Ave	19.23	16.50	-2.73	17.1	-0.60
Pond B	W Swann Ave at S Rome Ave (Swann Pond)	16.86	15.68	-1.18	15.2	0.48

*Proposed flood depths in the table that are greater than 4 inches are highlighted in red. However, because the DEM was used to estimate the low edge of pavement elevations at this conceptual level of design, and there is often opportunity to elevate the low edge of pavement slightly during the final design phase, proposed peak stages within an inch of the FPLOS target are considered acceptable for this analysis.

5.3.3.3 Impacted Residents and Businesses

Construction of Alternative 1 directly impacts the most residents, in comparison to Alternatives 2 and 3. An estimated 35 residential homes and 338 multifamily units will be impacted by significant excavation directly in front of the property. This alternative will also temporarily impact access to 27 businesses along the project route. **Figure 5-14** below shows the residences and businesses impacted along the project route between W Swann Ave and the Selmon Expressway. This is the area where impacts differ between the three primary alternatives. Note that the comparative analysis in this section does not include any of the proposed work north of W Swann Ave, which has been added to the Phase I project scope.

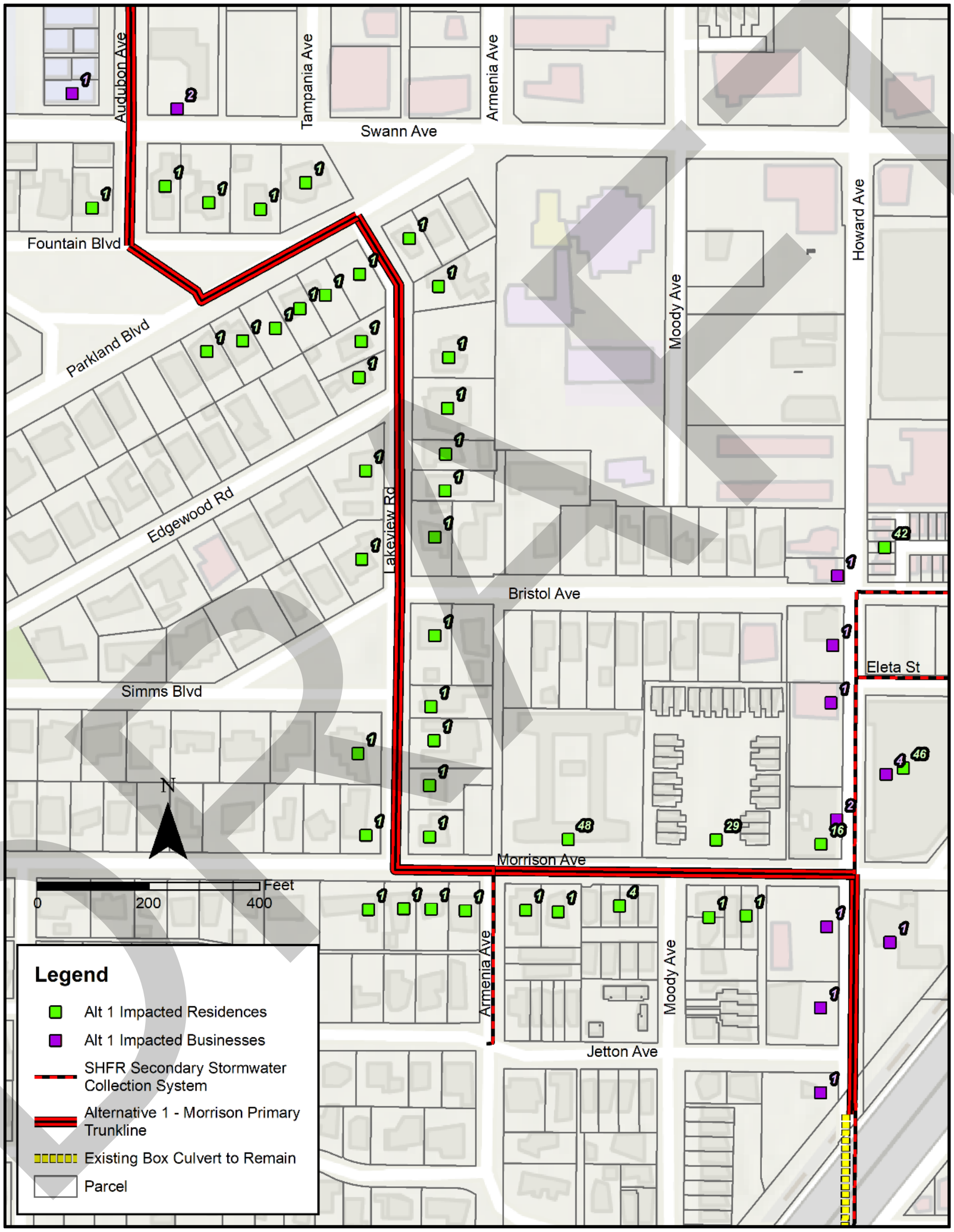

Figure 5-14 – Alternative 1 Impacted Residences and Businesses

5.3.3.4 Impacted Trees

Construction of Alternative 1 will likely result in removing 5 of the 27 grand trees and 48 of the 165 non-grand oak trees encountered along the route. Tree disposition (whether the tree is likely to remain or be removed) was estimated based on proximity of each tree to the anticipated limits of excavation for box culvert construction. It is assumed that smaller storm pipes can be constructed in a way that does not require removal of a tree**. Figure 5-15** below summarizes the anticipated impacts to grand trees and non-grand oaks along the Alternative 1 route between W Swann Ave and the Selmon Expressway. This is the area where impacts differ between the three primary alternatives.

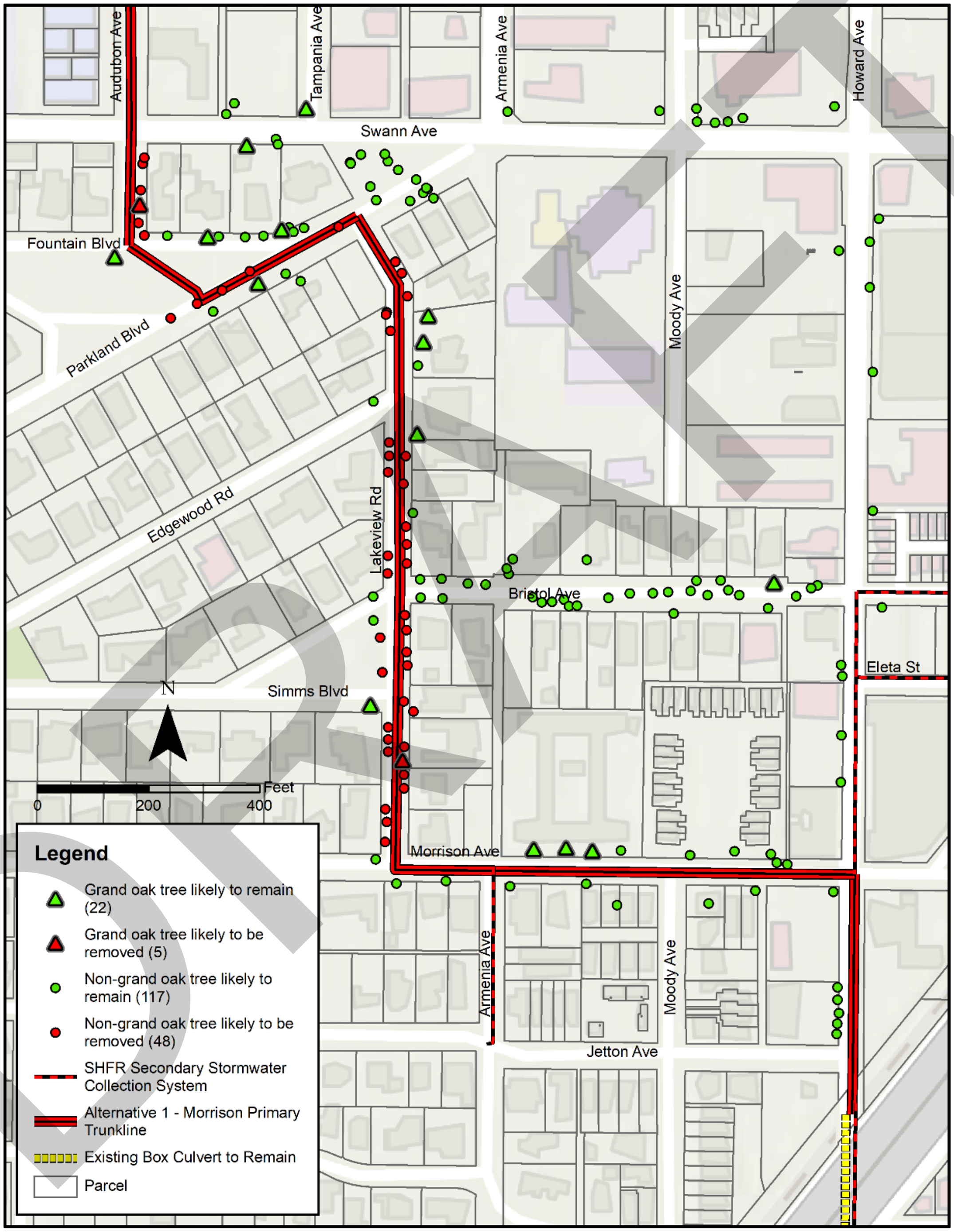

Figure 5-15 – Alternative 1 Tree Impacts

5.3.3.5 Impacts on Traffic

Most traffic impacts associated with this alternative will come from the box culvert installation along S Howard Ave. Using the traffic data discussed in **Section 2.6.7**, **a weighted average AADT of 5,876 was calculated** for the entire route between Bayshore Blvd and the W Swann Ave intersection with S Audubon Ave. This was done to compare traffic impacts between the three primary alternatives and is shown below in **Table 5-3.**

Table 5-3 – Alternative 1 Weighted AADT Calculation

Segment	Roadway	Segment AADT	Length of Segment (feet)	% of Total Length	AADT * % of Total Length
1	S Howard Ave (south of Selmon Expy)	9000	2500	44%	3982
2	S Howard Ave (north of Selmon Expy)	12000	430	8%	913
3	W Morrison Ave	4400	830	15%	646
4	S Lakeview Rd	1000	1200	21%	212
5	W Parkland Blvd	1000	320	6%	57
6	W Fountain Blvd	1000	150	3%	27
7	S Audubon Ave	1000	220	4%	39
Totals			**5650**	**100%**	**5876**

5.3.3.6 Utility Impacts

Construction of Alternative 1 will include relocation and reconstruction of existing potable water, reclaimed and wastewater pipes which are standard for this type of project. Maps illustrating the existing water and wastewater utilities in this area can be found in **Section 3.3**. A high-level summary of the anticipated impacts is listed below:

- Reclaimed water mains up to 12-inch in diameter will be impacted within Parkland Estates, and notably along S Lakeview Rd where a 12-inch diameter line connects W Parkland Blvd and W Morrison Ave. It is likely that all of these lines will need to be relocated. The box culvert will cross an existing 8-inch line that runs along Bayshore Blvd.
- Aside from the large sanitary sewer force main and gravity main at Bayshore Blvd (discussed in **Section 3.3**), box culvert installation will be accompanied by widespread reconstruction of 8-inch sanitary sewer gravity mains alongside construction of the box culvert for much of the route. Individual service lines will be replaced within the right of way.
- Potable water mains ranging from 2-inches and 8-inches in diameter will need relocation within Parkland Estates. This is typically done ahead of box culvert installation and requires a short disruption to water service for residents when each property's service line is transferred to the new main. An existing 12-inch diameter main will also need to be relocated along S Howard Ave and Bayshore Blvd.

5.3.4 Alternative 2 – W Bristol Ave Route

5.3.4.1 Description of Alternative 2

Alternative 2 uses W Bristol Ave, S Lakeview Rd, W Parkland Blvd, W Fountain Blvd, and S Audubon Ave to reach W Swann Ave from S Howard Ave, through the Parkland Estates neighborhood. Similar to Alternative 1, this alternative comes with significant constructability challenges given the size and depth of the proposed box culvert through residential streets. Box culvert construction and utility relocation through the narrow residential corridors in Parkland Estates will come with significant oak tree canopy removal.

While hydraulically effective, this alternative has significant constructability concerns given the size and depth of the proposed box culvert near residential properties.

Figure 5-16 below provides an overview map of the proposed improvements and flood reduction associated with Alternative 2.

5.3.4.2 Alternative 2 Flood Reduction Benefits

A comparison of peak stage elevations between the RECM and the Alternative 2 PCM for the 5-year/8-hour storm event is shown in **Table 5-4** below. Alternative 2 meets the FPLOS goal for the 5-year/8-hour design storm simulation and does not cause adverse flood impacts to any node within the study area for the nine simulated storm events.

While flood reduction near Swann Pond and S Rome Ave were not the primary goal of the project, the three primary alternatives provide a reduction in flooding in this area because they intercept stormwater runoff that currently discharges to the pond, so it has been included in the analysis for comparison.

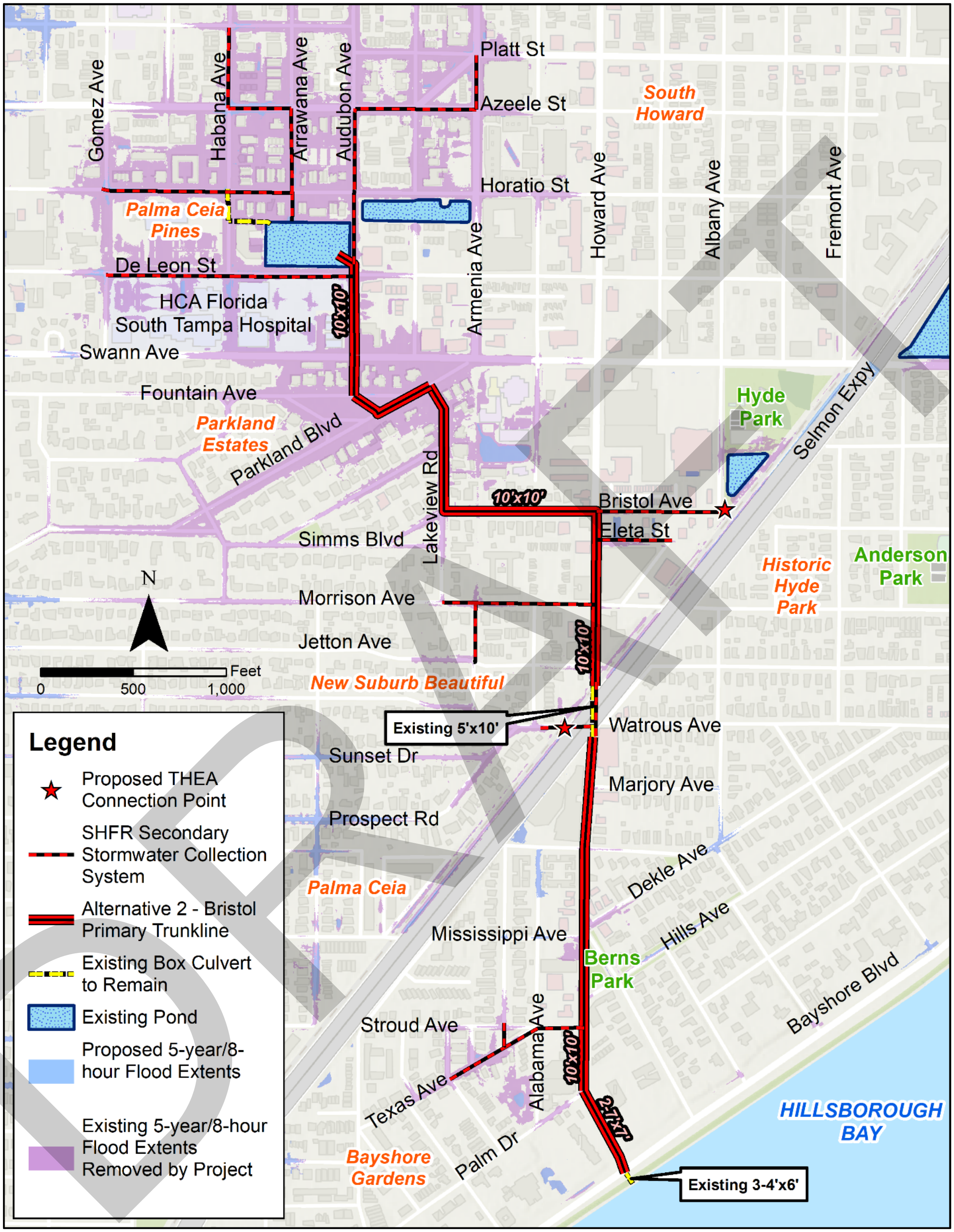

Figure 5-16 – Alternative 2 Concept Plan and Flood Reduction Map

Table 5-4 – Summary of Roadway FPLOS Analysis (Alternative 2, 5-year/8-hour)

Node	Location	RECM Peak Stage (ft, NAVD88)	PCM Peak Stage (ft, NAVD88)	Peak Stage Difference (ft)	Low EOP Elevation (ft, NAVD88)	Proposed Flood Depth (ft)
NRU0750	W Fountain Blvd at Fountain Park, Parkland Estates	19.21	15.55	-3.66	15.2	0.35*
NCL3510	W Cleveland St at S Habana Ave	19.65	19.46	-0.19	19.1	0.36*
NCL3450	W Horatio St at S Habana Ave	19.23	16.71	-2.52	16.9	-0.19
NCL3490	W Platt St at S Habana Ave	19.23	17.83	-1.40	17.7	0.13
NRU0790	W Swann Ave at S Audubon Ave (north side)	19.22	15.88	-3.34	15.9	-0.02
NRU1050	W Platt St at S Armenia Ave	19.23	17.54	-1.69	17.3	0.24
NRU0960	W Azeele St at S Audubon Ave (south side)	19.23	17.04	-2.19	17.0	0.04
NRU1030	W Azeele St at S Armenia Ave (north side)	19.23	17.30	-1.93	17.4	-0.10
NBW2090	W De Leon St at S Gomez Ave	19.22	18.37	-0.85	18.0	0.37*
NCL3250	W Horatio St at S Gomez Ave	19.22	17.44	-1.78	17.2	0.24
NRU1010	W Horatio St at S Armenia Ave	19.23	17.04	-2.19	18.2	-1.16
NRU0965	W Azeele St at S Audubon Ave (north side)	19.23	17.15	-2.08	16.9	0.25
NBW2110	W De Leon St at S Habana Ave	19.22	17.22	-2.00	17.3	-0.08
NCL3470	W Azeele St at S Habana Ave	19.23	17.08	-2.15	16.8	0.28
NRU1040	W Azeele St at S Armenia Ave (south side)	19.23	17.15	-2.08	17.2	-0.05
NRU1070	W Cleveland St at S Armenia Ave	19.24	17.79	-1.45	18.9	-1.11
NRU1170	W Bristol Ave at S Lakeview Rd	19.22	14.18	-5.04	18.0	-3.82
NCL3740	W Horatio St at S Arrawana Ave	19.23	16.51	-2.72	17.1	-0.59
Pond B	W Swann Ave at S Rome Ave (Swann Pond)	16.86	15.68	-1.18	15.2	0.48

*Proposed flood depths in the table that are greater than 4 inches are highlighted in red. However, because the DEM was used to estimate the low edge of pavement elevations at this conceptual level of design, and there is often opportunity to elevate the low edge of pavement slightly during the final design phase, proposed peak stages within an inch of the FPLOS target are considered acceptable for this analysis.

5.3.4.3 Impacted Residents and Businesses

Construction of Alternative 2 directly affects the most single-family homes, in comparison to Alternatives 1 and 3. This comes with damage to the neighborhood's character, as construction will significantly alter the aesthetic of these quiet, tree-lined neighborhood streets, which will be difficult to reconstruct. This alternative directly impacts less residents overall than Alternative 1 because of the large number of multifamily units along W Morrison Ave. An estimated 46 residential homes and 270 multifamily units will be impacted by construction directly in front of the property. This alternative will also temporarily impact access to 27 businesses along the project route. **Figure 5-17** below summarizes residences and businesses impacted along the project route between W Swann Ave and the Selmon Expressway. This is the area where impacts differ between the three primary alternatives. Note that the comparative analysis in this section does not include any of the proposed work north of W Swann Ave, which has been added to the Phase I project scope.

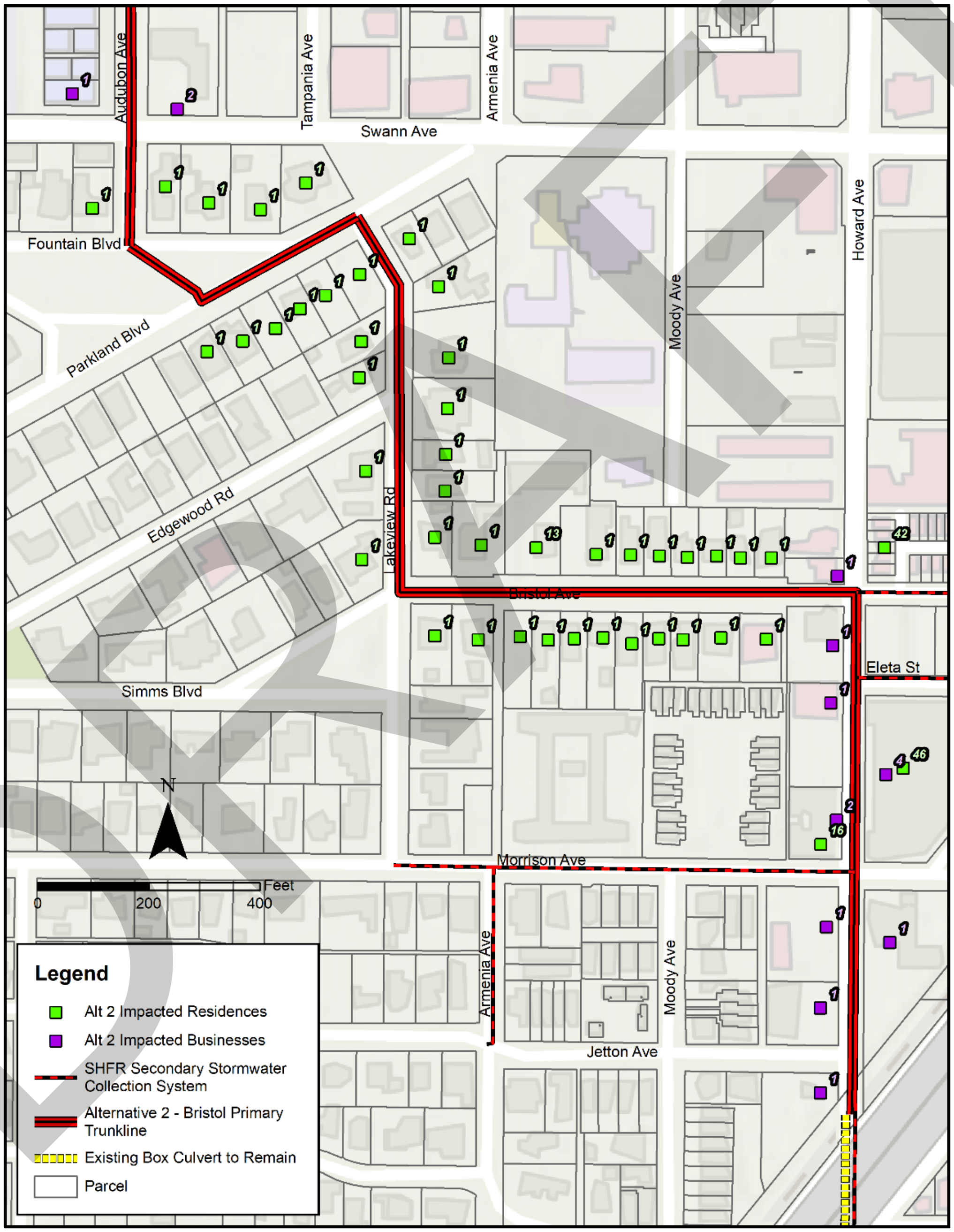

Figure 5-17 – Alternative 2 Impacted Residences and Businesses

5.3.4.4 Impacted Trees

Construction of Alternative 2 will likely result in removing 5 of the 27 grand trees and 58 of the 165 non-grand oak trees encountered along the route. Tree disposition (whether the tree is likely to remain or be removed) was estimated based on proximity of each tree to the anticipated limits of excavation for box culvert construction. It is assumed that smaller storm pipes can be constructed in a way that does not require removal of a tree, as the design-build team has successfully demonstrated in other City stormwater improvements projects**. Figure 5-18** below summarizes the anticipated impacts to grand trees and non-grand oaks along the Alternative 2 route between W Swann Ave and the Selmon Expressway. This is the area where impacts differ between the three primary alternatives.

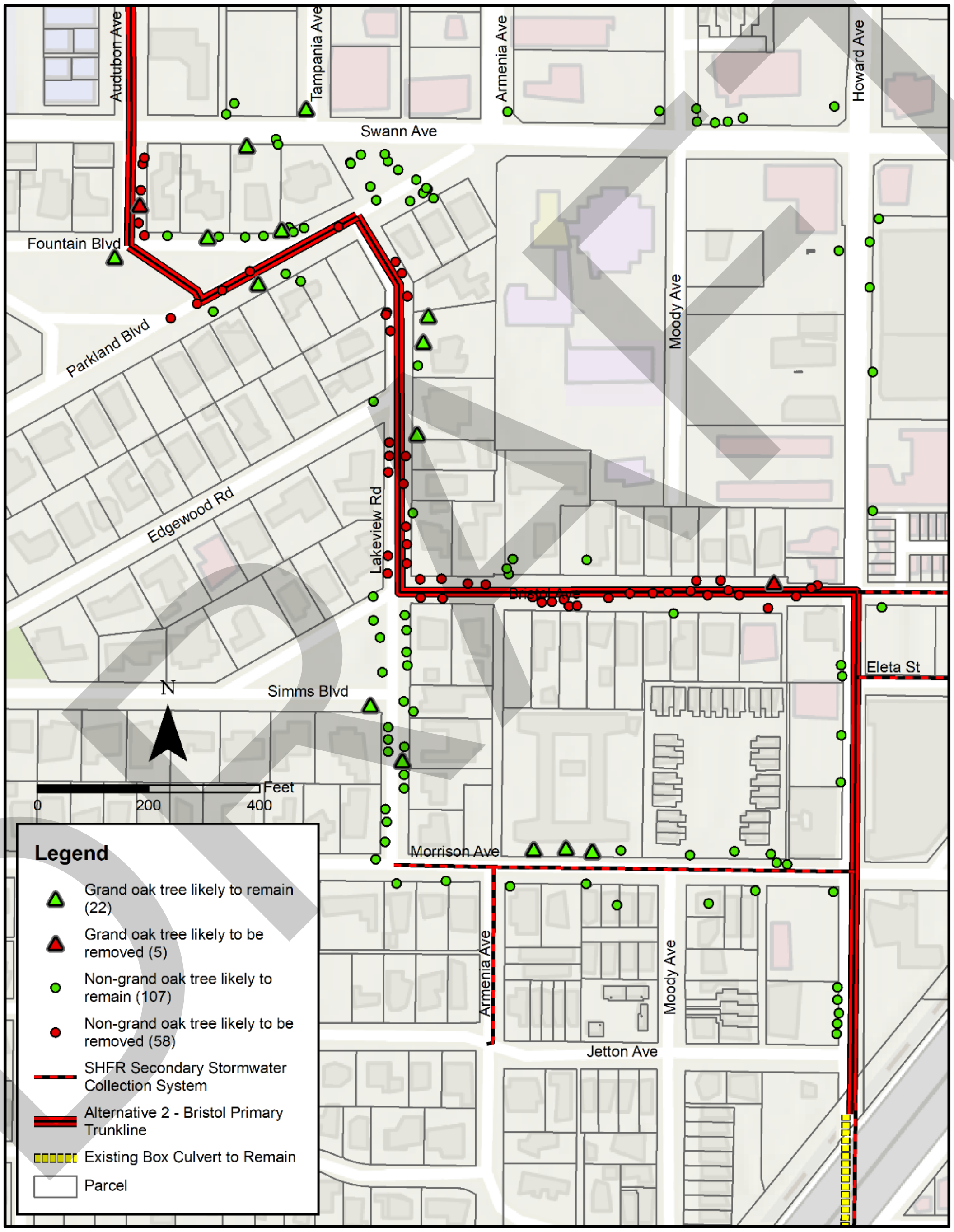

Figure 5-18 – Alternative 2 Tree Impacts

5.3.4.5 Impacts on Traffic

Most traffic impacts associated with this alternative will come from box culvert installation along S Howard Ave. Using the traffic data discussed in **Section 2.6.7**, **a weighted average AADT of 6,370 was calculated** for the entire route between Bayshore Blvd and the W Swann Ave intersection with S Audubon Ave. This was done to compare traffic impacts between the three primary alternatives. This calculation is shown below in **Table 5-5.**

Table 5-5 – Alternative 2 Weighted AADT Calculation

Segment	Roadway	Segment AADT	Length of Segment (feet)	% of Total Length	AADT * % of Total Length
1	S Howard Ave (south of Selmon Expy)	9000	2500	44%	3982
2	S Howard Ave (north of Selmon Expy)	12000	940	17%	1996
3	W Bristol Ave	1000	820	15%	145
4	S Lakeview Rd	1000	700	12%	124
5	W Parkland Blvd	1000	320	6%	57
6	W Fountain Blvd	1000	150	3%	27
7	S Audubon Ave	1000	220	4%	39
Totals			**5650**	**100%**	**6370**

5.3.4.6 Utility Impacts

Construction of Alternative 2 will include relocation and reconstruction of existing potable water, reclaimed and wastewater pipes which is standard for this type of project. Maps illustrating the existing water and wastewater utilities in this area can be found in **Section 3.3**. A high-level summary of the anticipated impacts is listed below:

- Reclaimed water mains up to 12-inch in diameter will be impacted within Parkland Estates, and notably along S Lakeview Rd where a 12-inch diameter line connects W Parkland Blvd and W Morrison Ave. It is likely that all of these lines will need to be relocated. The box culvert will cross an existing 8-inch line that runs along Bayshore Blvd.
- Aside from the large sanitary sewer force main and gravity main at Bayshore Blvd (discussed in **Section 3.3**), box culvert installation will be accompanied by widespread reconstruction of 8-inch sanitary sewer gravity mains alongside construction of the box culvert for much of the route. Individual service lines will be replaced within the right of way.
- Potable water mains ranging from 2-inches and 8-inches in diameter will need relocation within Parkland Estates. This is typically done ahead of box culvert installation and requires a short disruption to water service for residents when each property's service line is transferred to the new main. An existing 12-inch diameter main along S Howard Ave and Bayshore Blvd.

5.3.5 Alternative 3 – W Swann Ave Route

5.3.5.1 Description of Alternative 3

Alternative 3 uses W Swann Ave and S Howard Ave to convey stormwater from the intersection of W Swann Ave and S Audubon Ave into Hillsborough Bay. This alternative is minimally invasive to the surrounding neighborhoods, reducing impacts to Parkland Estates and New Suburb Beautiful. Alternative 3 creates temporary impacts to more businesses than Alternatives 1 and 2, but nearly all the businesses along the route can be provided with temporary access from adjacent streets, therefore that access can be maintained for the duration of construction.

Figure 5-19 below provides an overview map of the proposed improvements and flood reduction associated with Alternative 2.

5.3.5.2 Alternative 3 Flood Reduction Benefits

A comparison of peak stage elevations between the RECM and the Alternative 3 PCM for the 5-year/8-hour storm event is shown in **Table 5-6** below. Alternative 3 meets the FPLOS goal for the 5-year/8-hour design storm simulation and does not cause adverse flood impacts to any node within the study area for the nine simulated storm events.

While flood reduction near Swann Pond and S Rome Ave were not the primary goal of the project, the three primary alternatives provide a reduction in flooding in this area because they intercept stormwater runoff that currently discharges to the pond, so it has been included in the analysis for comparison.

This alternative provides more flood relief to locations along W Swann Ave and S Howard Ave in comparison to Alternatives 1 and 2, by providing a second outfall for the existing system along W Swann Ave that currently conveys stormwater into Swann Pond. Comparing **Table 5-6** below to **Table 5-2 and Table 5-4** shows that Alternative 3 allows W Swann Ave near S Rome Ave to meet the project's FPLOS goal, while Alternatives 1 and 2 do not.

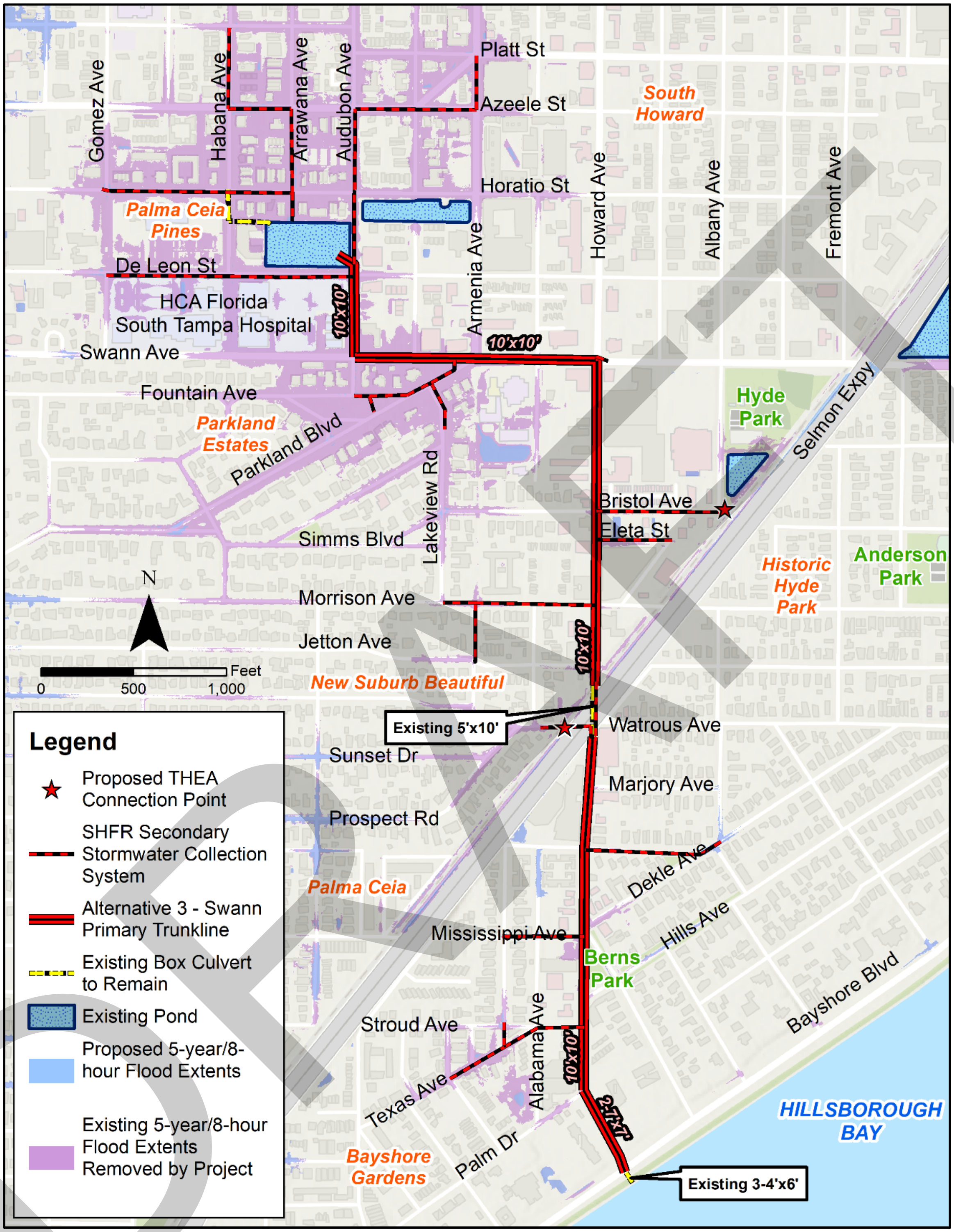

Figure 5-19 – Alternative 3 Concept Plan and Flood Reduction Map

Table 5-6 – Summary of Roadway FPLOS Analysis (Alternative 3, 5-year/8-hour)

Node	Location	RECM Peak Stage (ft, NAVD88)	UCM Peak Stage (ft, NAVD88)	Peak Stage Difference (ft)	Low EOP Elevation (ft, NAVD88)	Proposed Flood Depth (ft)
NRU0750	W Fountain Blvd at Fountain Park, Parkland Estates	19.21	15.62	-3.59	15.2	0.42**
NCL3510	W Cleveland St at S Habana Ave	19.65	19.44	-0.21	19.1	0.34*
NCL3450	W Horatio St at S Habana Ave	19.23	16.60	-2.63	16.9	-0.30
NCL3490	W Platt St at S Habana Ave	19.23	17.72	-1.51	17.7	0.02
NRU0790	W Swann Ave at S Audubon Ave (north side)	19.22	15.59	-3.63	15.9	-0.31
NRU1050	W Platt St at S Armenia Ave	19.23	17.50	-1.73	17.3	0.20
NRU0960	W Azeele St at S Audubon Ave (south side)	19.23	17.04	-2.19	17.0	0.04
NRU1030	W Azeele St at S Armenia Ave (north side)	19.23	17.29	-1.94	17.4	-0.11
NBW2090	W De Leon St at S Gomez Ave	19.22	18.33	-0.89	18.0	0.33
NCL3250	W Horatio St at S Gomez Ave	19.22	17.36	-1.86	17.2	0.16
NRU1010	W Horatio St at S Armenia Ave	19.23	17.06	-2.17	18.2	-1.14
NRU0965	W Azeele St at S Audubon Ave (north side)	19.23	17.15	-2.08	16.9	0.25
NBW2110	W De Leon St at S Habana Ave	19.22	17.13	-2.09	17.3	-0.17
NCL3470	W Azeele St at S Habana Ave	19.23	16.98	-2.25	16.8	0.18
NRU1040	W Azeele St at S Armenia Ave (south side)	19.23	17.17	-2.06	17.2	-0.03
NRU1070	W Cleveland St at S Armenia Ave	19.24	17.75	-1.49	18.9	-1.15
NRU1170	W Bristol Ave at S Lakeview Rd	19.22	18.24	-0.98	18.0	0.24
NCL3740	W Horatio St at S Arrawana Ave	19.23	16.40	-2.83	17.1	-0.70
Pond B	W Swann Ave at S Rome Ave (Swann Pond)	16.86	14.62	-2.24	15.2	-0.58

*Proposed flood depths in the table that are greater than 4 inches are highlighted in red. However, because the DEM was used to estimate the low edge of pavement elevations at this conceptual level of design, and there is often opportunity to elevate the low edge of pavement slightly during the final design phase, proposed peak stages within an inch of the FPLOS target are considered acceptable for this analysis.

**Based on the SHFR project's preliminary roadway design, which is at the 30 percent phase at the time of this report, it is likely that the lowest edge of pavement elevation along W Fountain Blvd will be elevated by several inches, which will reduce the anticipated flood depth here to less than four inches.

5.3.5.3 Impacted Residents and Businesses

Construction of Alternative 3 directly impacts the lowest number of residents in comparison to Alternatives 1 and 2. The tradeoff is an increased number of businesses impacted, due to construction within the commercial South Howard Ave corridor between W Swann Ave and W Bristol Ave. As mentioned previously, because nearly all the businesses along the route can be provided with temporary access from adjacent streets, the design-build team is confident that access can be maintained for the duration of construction.

An estimated 23 residential homes (primarily due to construction of smaller pipes within Parkland Estates) and 285 multifamily units will be impacted by construction directly in front of the property.

This alternative will temporarily impact access to 57 businesses along the project route, but not at once and not for the entire duration of the project. Construction will move forward in segments, with full restoration of one segment occurring before another is started. This minimizes the duration of road closures along S Howard Ave and W Swann Ave during construction. **Figure 5-20** below summarizes residences and businesses impacted along the project route between W Swann Ave and the Selmon Expressway. This is the area where impacts differ between the three primary alternatives. Note that the comparative analysis in this section does not include any of the proposed work north of W Swann Ave, which has been added to the Phase I project scope.

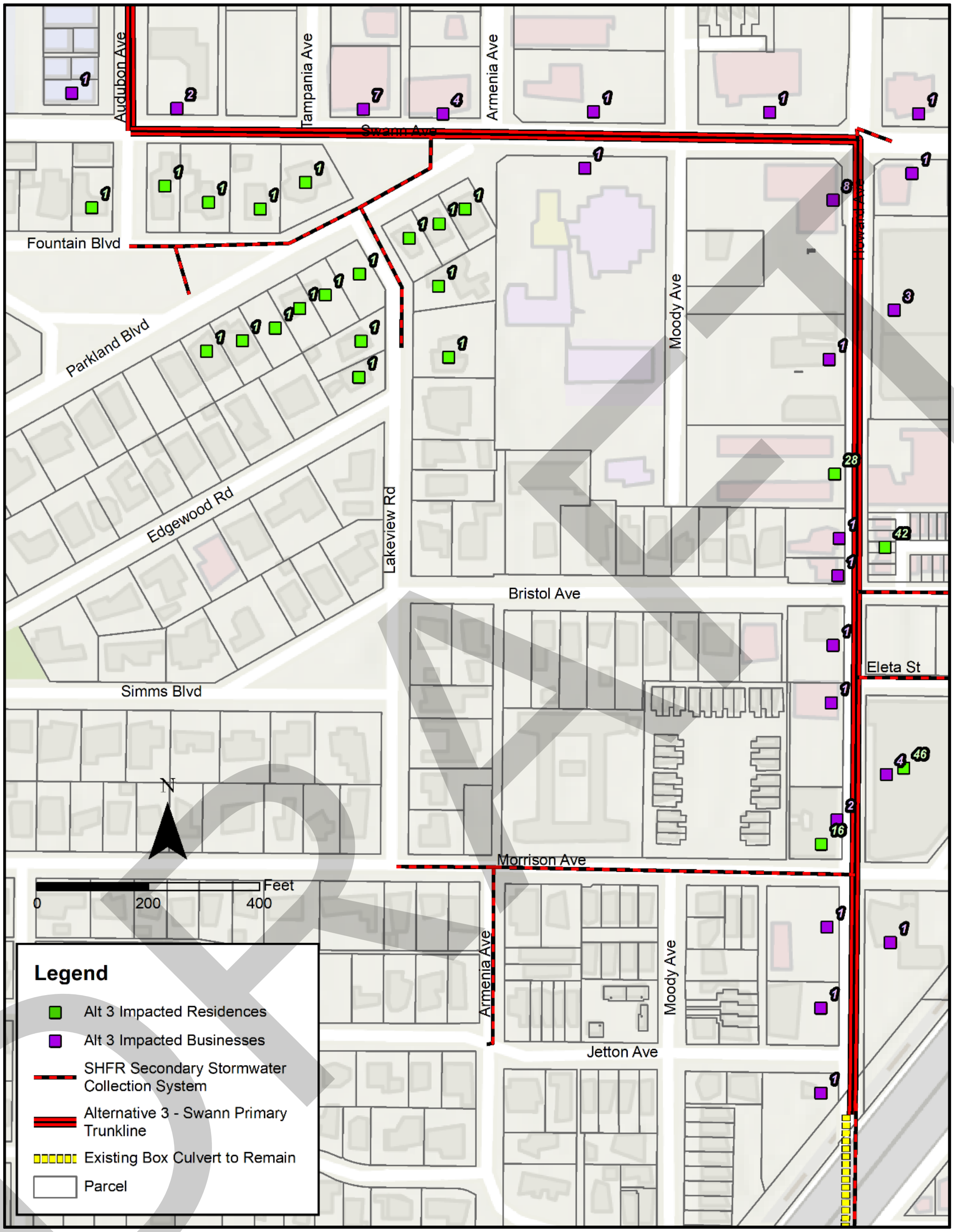

Figure 5-20 – Alternative 3 Impacted Residences and Businesses

5.3.5.4 Impacted Trees

Construction of Alternative 3 will likely result in removing 4 of the 27 grand trees and 13 of the 165 non-grand oak trees encountered along the route. Tree disposition (whether the tree is likely to remain or be removed) was estimated based on proximity of each tree to the anticipated limits of excavation for box culvert construction. It is assumed that smaller storm pipes can be constructed in a way that does not require removal of a tree, as the design-build team has successfully demonstrated in other City stormwater improvements projects**. Figure 5-21** below summarizes the anticipated impacts to grand trees and non-grand oaks along the Alternative 3 route between S Audubon Ave and the Selmon Expressway. This is the area where impacts differ between the three primary alternatives.

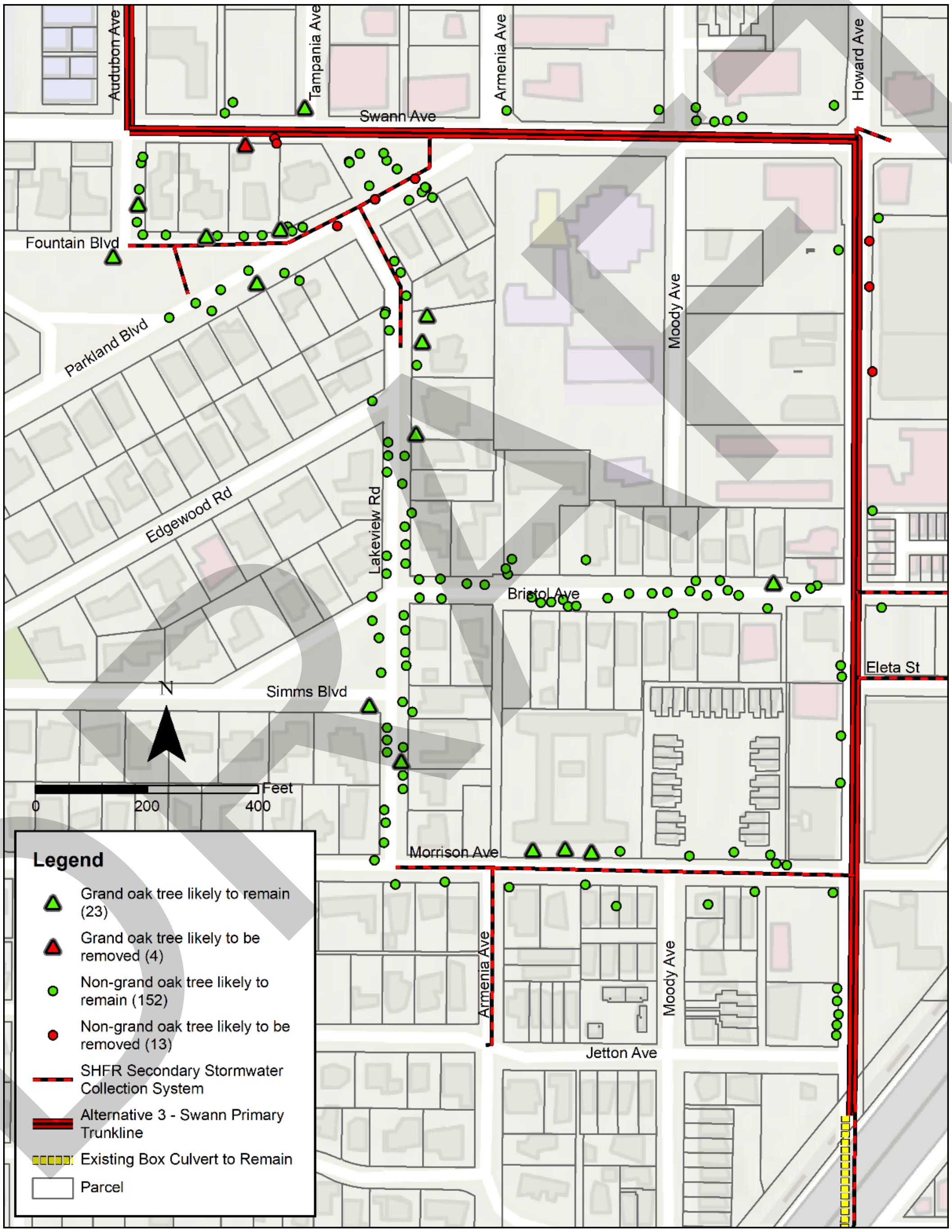

Figure 5-21 – Alternative 3 Tree Impacts

5.3.5.5 Impacts on Traffic

Most traffic impacts associated with this alternative will come from box culvert installation along S Howard Ave and W Swann Ave. Using the traffic data discussed in **Section 2.6.7**, **a weighted average AADT of 10,649 was calculated** for the entire route between Bayshore Blvd and the W Swann Ave intersection with S Audubon Ave. This was done to compare traffic impacts between the three primary alternatives. This calculation is shown below in **Table 5-7.**

Table 5-7 – Alternative 3 Weighted AADT Calculation

Segment	Roadway	Segment AADT	Length of Segment (feet)	% of Total Length	AADT * % of Total Length
1	S Howard Ave (south of Selmon Expy)	9000	2500	45%	4054
2	S Howard Ave (north of Selmon Expy)	12000	1750	32%	3784
3	W Swann Ave	12000	1300	23%	2811
Totals			**5550**	**100%**	**10649**

5.3.5.6 Utility Impacts

Construction of Alternative 3 will include relocation and reconstruction of existing potable water, reclaimed and wastewater pipes which is standard for this type of project. Maps illustrating the existing water and wastewater utilities in this area can be found in **Section 3.3**. A high-level summary of the anticipated impacts are listed below:

- Reclaimed water mains up to 12-inch in diameter will be impacted within Parkland Estates, and notably along S Lakeview Rd where a 12-inch diameter line connects W Parkland Blvd and W Morrison Ave. It is likely that all of these lines will need to be relocated. The box culvert will cross an existing 8-inch line that runs along Bayshore Blvd.
- Aside from the large sanitary sewer force main and gravity main at Bayshore Blvd (discussed in **Section 3.3**), box culvert installation will be accompanied by widespread reconstruction of 8-inch sanitary sewer gravity mains alongside construction of the box culvert for much of the route. Individual service lines will be replaced within the right of way.
- Potable water mains ranging from 2-inches and 8-inches in diameter will need relocation within Parkland Estates. This is typically done ahead of box culvert installation and requires a short disruption to water service for residents when each property's service line is transferred to the new main. An existing 12-inch diameter main along S Howard Ave and Bayshore Blvd.

5.3.6 Primary Alternative Summary and Recommendations

As discussed in **Section 5.3.1**, the three primary alternatives have very similar estimated construction costs and flood reduction benefits, so those two metrics were not used to select a recommended route. While the Swann route impacts more daily traffic and businesses along the commercial corridors, managing this is preferred over the significant impacts to historic residential neighborhood expected with Alternatives 1 and 2. Alternative 3 is less impactful to the character of the Parkland Estates neighborhood and removes less oak tree canopy. It also provides more opportunities for the low-lying areas surrounding and directly east of Swann Pond for flood relief. **Based on this comparative analysis, Alternative 3 was selected.**

A comparison matrix of the three primary alternatives is shown below in **Table 5-8**. The value that has the advantage over the other two for each metric is shown in bold.

Table 5-8 – Primary Alternative Comparison Summary Matrix

Criteria	1-Morrison	2-Bristol	3-Swann
Phase I Total Project Cost (design and construction)	*$95M-$100M*	*$95M-$100M*	*$95M-$100M*
Constructability Challenges	High	High	**Medium**
Estimated Grand Trees Removed	5	5	**4**
Estimated Non-Grand Oak Trees Removed	48	58	**13**
Average AADT	**5876**	6370	10649
Total Number of Residential Homes Directly Impacted	35	46	**23**
Total Number of Apartment/Condo/Townhome Units Directly Impacted	338	**270**	285
Total Number of Businesses/Schools/Churches Impacted	**27**	**27**	57
Utility Impacts	Medium	Medium	Medium

5.4 Other Alternatives Considered

5.4.1 Alternative Projects Analyzed for S Howard Businesses

In 2025 the design-build team evaluated several potential alternative projects (aside from the three primary alternatives in the project scope) that could achieve the SHFR Project's flood reduction goal while reducing impacts on the many businesses along S Howard Ave. A memo was developed for an organized group of businesses along S Howard Ave that discussed the findings of this analysis, which can be found in **Appendix M.**

In the memo, six project alternatives were evaluated for feasibility and hydraulic efficiency, including the recommended project that uses W Swann Ave and S Howard Ave to convey stormwater runoff into Hillsborough Bay through a 10'x10' box culvert. This section provides a high-level summary of the five other alternatives.

5.4.1.1 W Swann Ave Gravity System

This alternative consists of approximately 7700 LF of 10'x10' box culvert between the AMI Pond in Palma Ceia Pines and the intersection of Bayshore Blvd & W Swann Ave, using the S Audubon Ave and W Swann Ave corridors. A new outfall will need to be constructed into Hillsborough Bay.

This alternative increases the length of box culvert trunkline by approximately 30 percent, and therefore the construction cost increases by approximately 30 percent in comparison to the project's recommended route. The duration of construction will also be significantly longer, due to the increased length and utility conflicts – most notably the 48-inch diameter sanitary sewer force main at S Rome Ave, which is discussed in **Section 3.3**. Construction of a new outfall into Hillsborough Bay will have significant impacts to northbound traffic on Bayshore Blvd and traffic onto Davis Islands.

While model results show that the project's flood reduction goal can be met with this alternative, a 96-inch diameter pipe (with a 108-inch diameter steel casing) will need to be installed beneath the CSX railroad and Selmon Expressway rather than two smaller pipes with equivalent conveyance, due to conflict with an existing pipe that cannot be relocated. This is discussed in **Appendix M.**

A microtunnel operation for a pipe this large will be costly, and difficult to permit through CSX, whose maximum allowable steel casing size is 72 inches. The project will cost substantially more to provide the same level of flood relief, reducing the benefit-ratio.

Furthermore, **this alternative will not reduce temporary impacts to residents and businesses – it will just transfer them to a different (and larger) group of stakeholders along W Swann Ave between S Howard Ave and Bayshore Blvd, including Hyde Park Village.**

A map of this alternative is shown below in **Figure 5-22.**

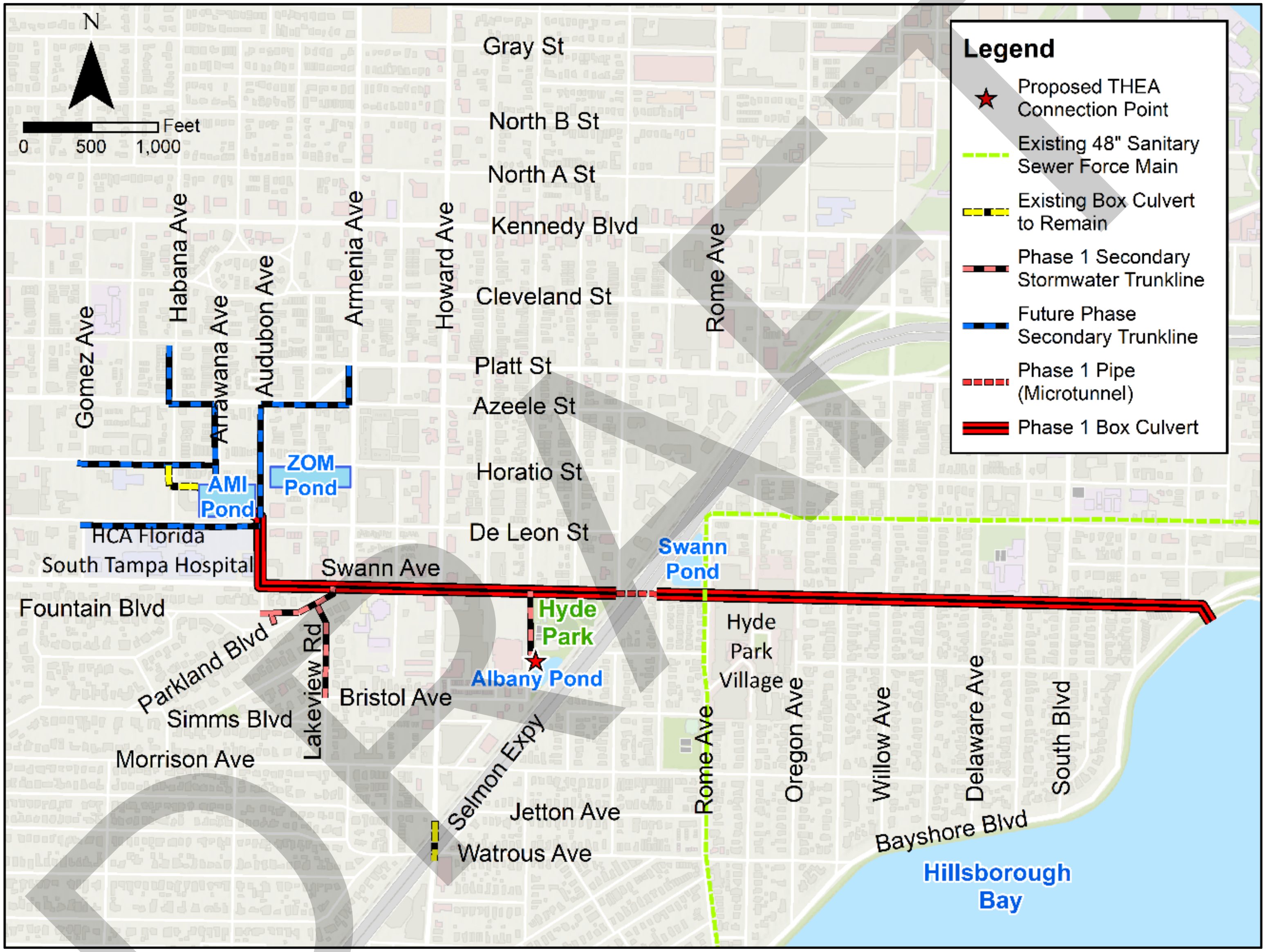

Figure 5-22 – W Swann Ave Gravity System

5.4.1.2 Detention Ponds within Parkland Estates and Palma Ceia Pines

A common suggestion over the years has been to implement a regional stormwater pond in Parkland Estates or Palma Ceia Pines to hold the stormwater runoff. This alternative was modeled to include three hydraulically connected stormwater detention ponds within the lowest portions of Parkland Estates and Palma Ceia Pines that provide enough storage for runoff to meet the project's LOS goal without constructing a new conveyance system to Hillsborough Bay.

Iterations of the model were evaluated until the ponds and their associated pipe connections provided similar results to the recommended alternative. This alternative alleviates roadway flooding around the HCA Florida South Tampa Hospital, on W Swann Ave, and along the roadways that have not been converted into a stormwater pond.

Constructing an adequate regional stormwater pond in lieu of a new stormwater conveyance system and outfall to the bay **will displace hundreds of residents and businesses and** require the use of the eminent domain process. The eminent domain process requires a genuine public need for property, and lack of safe and feasible alternatives. In this case, a new stormwater trunkline, like the one recommended, provides a valid alternative that does not displace property owners, making a regional stormwater pond unlikely to pass the eminent domain process. Furthermore, **the estimated property value alone exceeds $150 million and acquiring these properties will come with significant legal fees.** It is estimated that this alternative will cost more than $200 million.

While this alternative is not justifiable due to the relocation impacts to residents and businesses, it demonstrates the magnitude of storage volume needed to mitigate the flooding without constructing a new outfall. **The combined ponds will need to store over 70 acre-ft of stormwater above the pond's normal water surface to meet the project's FPLOS goal.**

A map of this alternative is shown below in **Figure 5-23.**

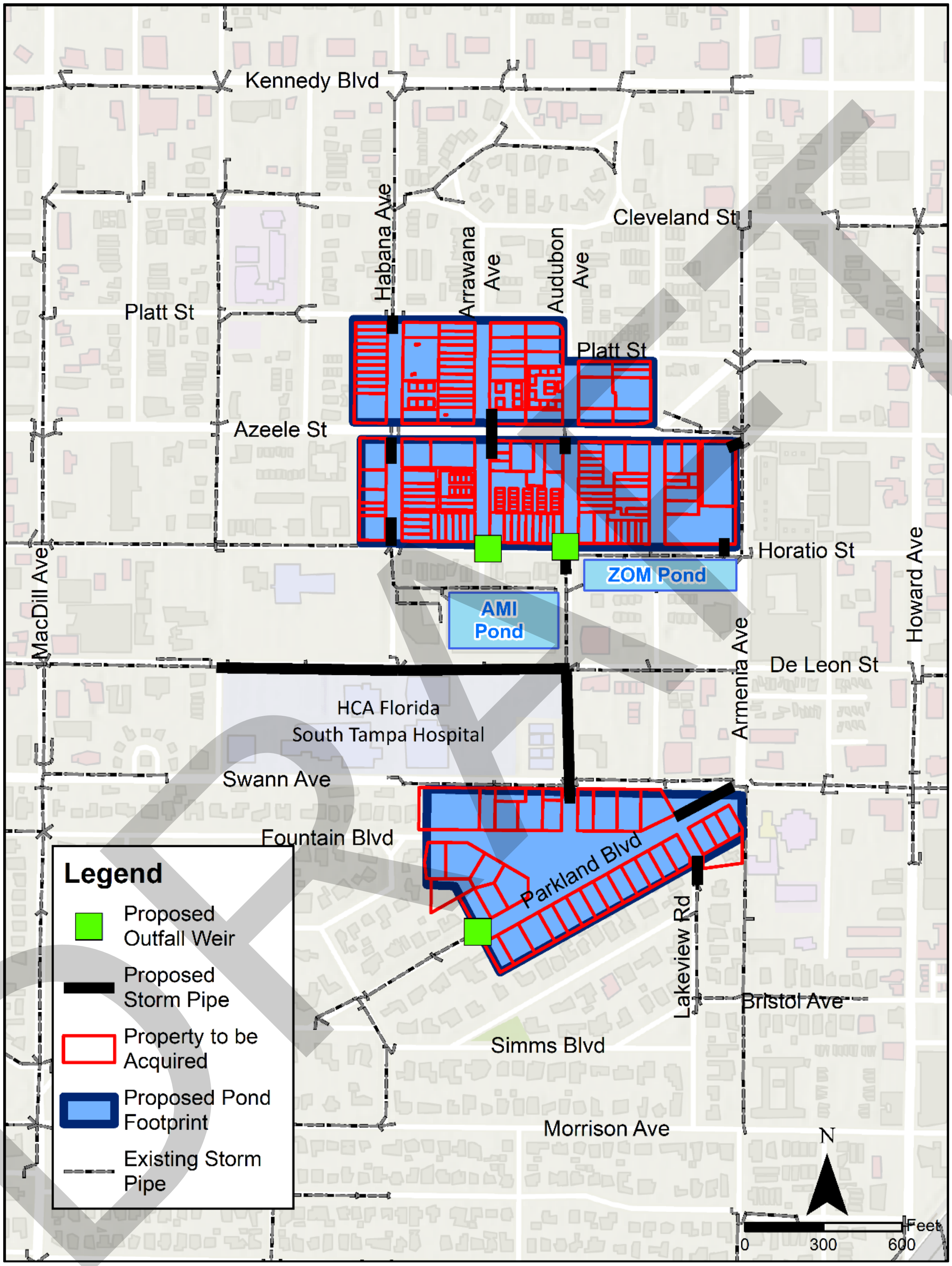

Figure 5-23 – Detention Ponds within Parkland Estates and Palma Ceia Pines

5.4.1.3 Parkland Estates Stormwater Pump Station

Because of significant operation and maintenance costs and risk of failure during severe storm events, stormwater pump stations should be considered a "last resort" solution to drainage issues. They are commonly used when there is a lack of sufficient hydraulic head (change in elevation between upstream and downstream water surfaces of a conveyance system) for a gravity system to work effectively. This is applicable on some barrier islands or places where ground elevations are not much higher than the nearby ocean or other large receiving water body. This is not the case here – **the lowest elevations in Parkland Estates are 15 feet above Hillsborough Bay and can be drained effectively using a gravity system.**

A stormwater pump station also **eliminates the opportunity to alleviate localized flooding downstream of the pump station using this project's infrastructure.** The smaller gravity systems discussed in **Section 6.1.2** will not be able to "tap in" to a pressurized force main like they can with the box culvert solution that relies on gravity flow. The recommended solution for this project is a passive, low maintenance system that lets gravity do the work, rather than a power intensive collection of pumps.

With that said, two pump station alternatives that achieve the project's flood reduction goal were modeled and evaluated. A 600-CFS (or 270,000 gallons per minute) capacity stormwater pump station in Parkland Estates, located above a new half-acre underground stormwater vault could be constructed in lieu of a new gravity system. This will be located within open space between W Fountain Blvd and W Parkland Blvd at S Audubon Ave.

This pump station will need to discharge through a 10-foot diameter force main pipe that outfalls into Hillsborough Bay, so **construction impacts along S Howard Ave (or any alternative route) will be comparable to those of the recommended solution.** This alternative will also be more expensive to construct than the recommended box culvert solution, and the pump station will bring permanent noise and aesthetic impacts to the Parkland Estates neighborhood.

A map of this alternative is shown below in **Figure 5-24.**

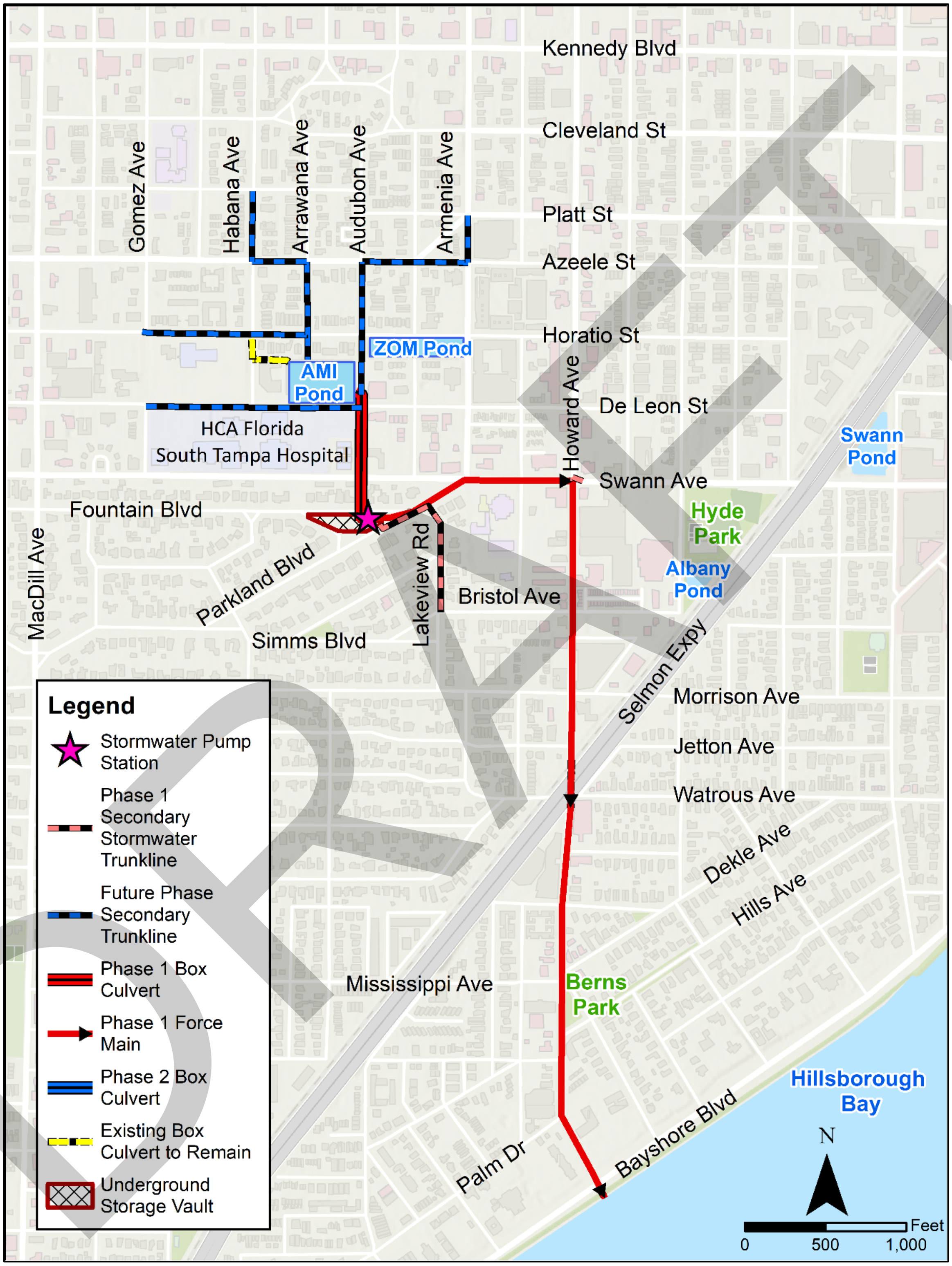

Figure 5-24 – Parkland Estates Stormwater Pump Station

5.4.1.4 Hyde Park Softball Field Stormwater Pump Station

Using the City-owned park on the south side of W Swann Ave between S Albany Ave and the CSX railroad to construct an underground storage vault on the order of 30 feet deep for stormwater runoff will allow for a smaller stormwater pump station than the Parkland Estates Stormwater Pump Station alternative, but it **will not eliminate the need for a new outfall to Hillsborough Bay**.

At 30 feet below ground, the vault is well below the groundwater table as well as sea level and will need a substantial pump. Model results show that a 300-CFS (135,000 gallons per minute) capacity pump station and a 7-foot diameter main pipe into Hillsborough Bay will still be needed to meet the FPLOS goal, provided it could be constructed with a 3-acre underground stormwater vault and pump station wet well. Given the anticipated groundwater conditions, this will be difficult and costly to construct.

This alternative has the same challenges as the pump station discussed in **Section 5.4.1.3** and will require installation of approximately 3,000 linear feet of box culvert to convey stormwater runoff between Palma Ceia Pines and the pump station's wet well. The cost of this alternative will be substantially more than the estimated cost of the recommended alternative and will result in unnecessary power consumption and operating costs.

A map of this alternative is shown below in **Figure 5-25.**

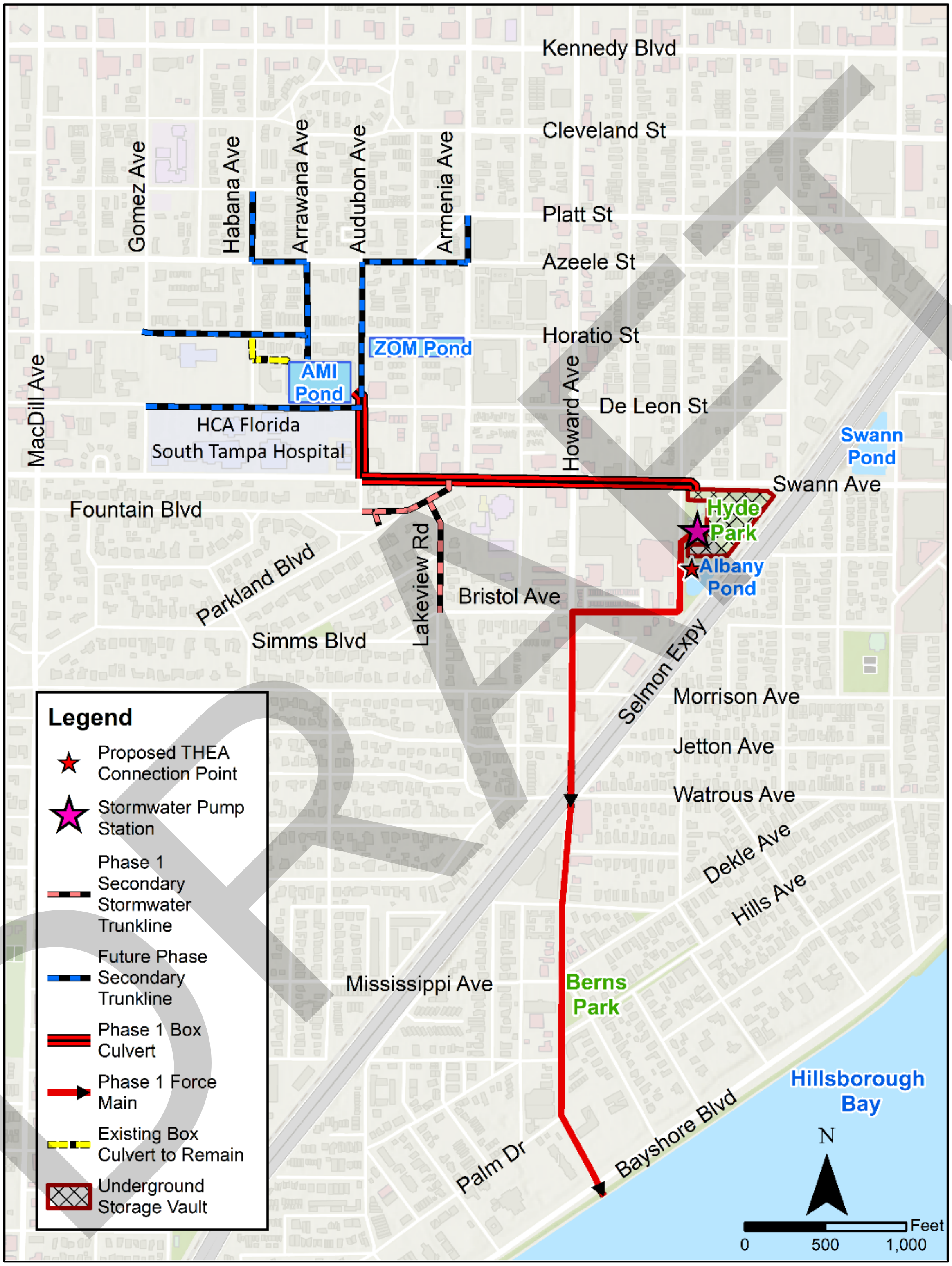

Figure 5-25 – Hyde Park Softball Field Stormwater Pump Station

5.4.1.5 Increased Stormwater Conveyance Alongside CSX Railroad and Selmon Expressway

This alternative has been suggested numerous times by members of the community because it will lessen temporary construction impacts for residents, businesses, and motorists. However, because of the significant right of way acquisition and constructability challenges associated with the infrastructure required, and increased route length, this alternative is not feasible and therefore was not modeled.

The capacity of the existing ditch system along this route is a fraction of what is required to efficiently convey the volume of runoff from Parkland Estates and Palma Ceia Pines and will need to be significantly upsized (similar conveyance to a 10'x10' box culvert) to handle these flow rates. The ditch is also several feet higher than the low roadway elevations in those neighborhoods, so an upsized gravity conveyance system will need a deep installation, "below the bowl", to provide flood relief using gravity.

CSX generally requires that construction activities stay 25 feet away from the center of the tracks, which leaves a 10- to 12-foot-wide corridor to install the conveyance system between the railroad tracks and the Selmon Expressway's wall.

Given the size and depth of the conveyance system needed (either gravity or force main), this is not a feasible solution. **Figure 5-26** below was taken in July 2025 and shows the narrow corridor provided for construction of this alternative, looking southwest from W Swann Ave.

Even if the CSX right of way was available, this alternative will increase the overall project length by 80%, which will result in significantly higher construction costs to achieve the same goal. The rate of stormwater runoff now flowing to the Rubideaux Street outfall will require a significant increase in outfall capacity to avoid worsening flooding within Palma Ceia and Bayshore Gardens. **There is no existing stormwater outfall in this region that can provide the additional conveyance necessary for this alternative – a new outfall to Hillsborough will be required to achieve the SHFR project's flood reduction goal.**

A map of this alternative is shown below in **Figure 5-27.**

Figure 5-26 – Existing shallow ditch system between Selmon Expressway & CSX Railroad

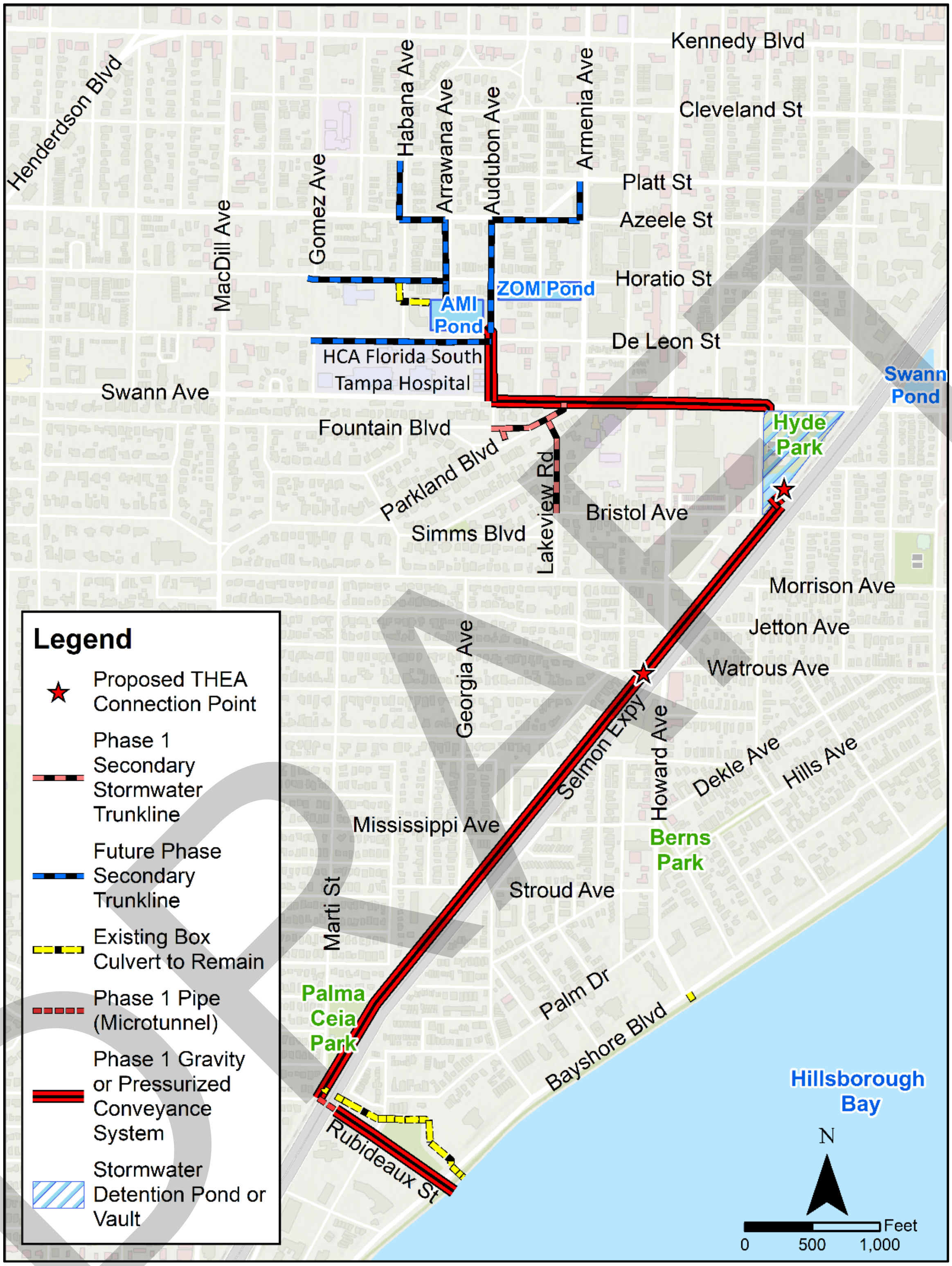

Figure 5-27 – Increased Stormwater Conveyance Alongside CSX Railroad and Selmon Expressway

5.4.2 Other Routes Suggested by the Public

The five alternatives discussed in this section were provided by the public in the spring of 2025. These alternatives were screened for feasibility and constructability but were not modeled or analyzed as those discussed in **Section 5.4.1** were**.** Three of these alternatives are variations of the CSX/Selmon route discussed previously in **Section 5.4.1.5** and therefore have the same challenges. Further development of these alternatives requires understanding of the conveyance capacity and/or storage volume required to provide noticeable flood relief to Parkland Estates and Palma Ceia Pines and meet the project's FPLOS goal.

5.4.2.1 S Georgia Ave to W Mississippi Ave

This scenario **increases the length of box culvert by over 30%** between W Swann Ave and Hillsborough Bay, which increases construction cost and duration. Similar to Alternatives 1 and 2 discussed in **Section 5.3**, the narrow residential corridors of S Lakeview Rd and S Georgia Ave make the deep installation of a 10'x10' box culvert and utility relocations difficult and will impact the character of the Parkland Estates and New Suburb Beautiful neighborhoods. The limited right of way available along W Mississippi Ave at the railroad and Selmon Expressway crossing limits additional stormwater conveyance through this location, making it difficult to meet the project's flood reduction goal.

A map of this alternative, provided by the community, is shown below in **Figure 5-28.**

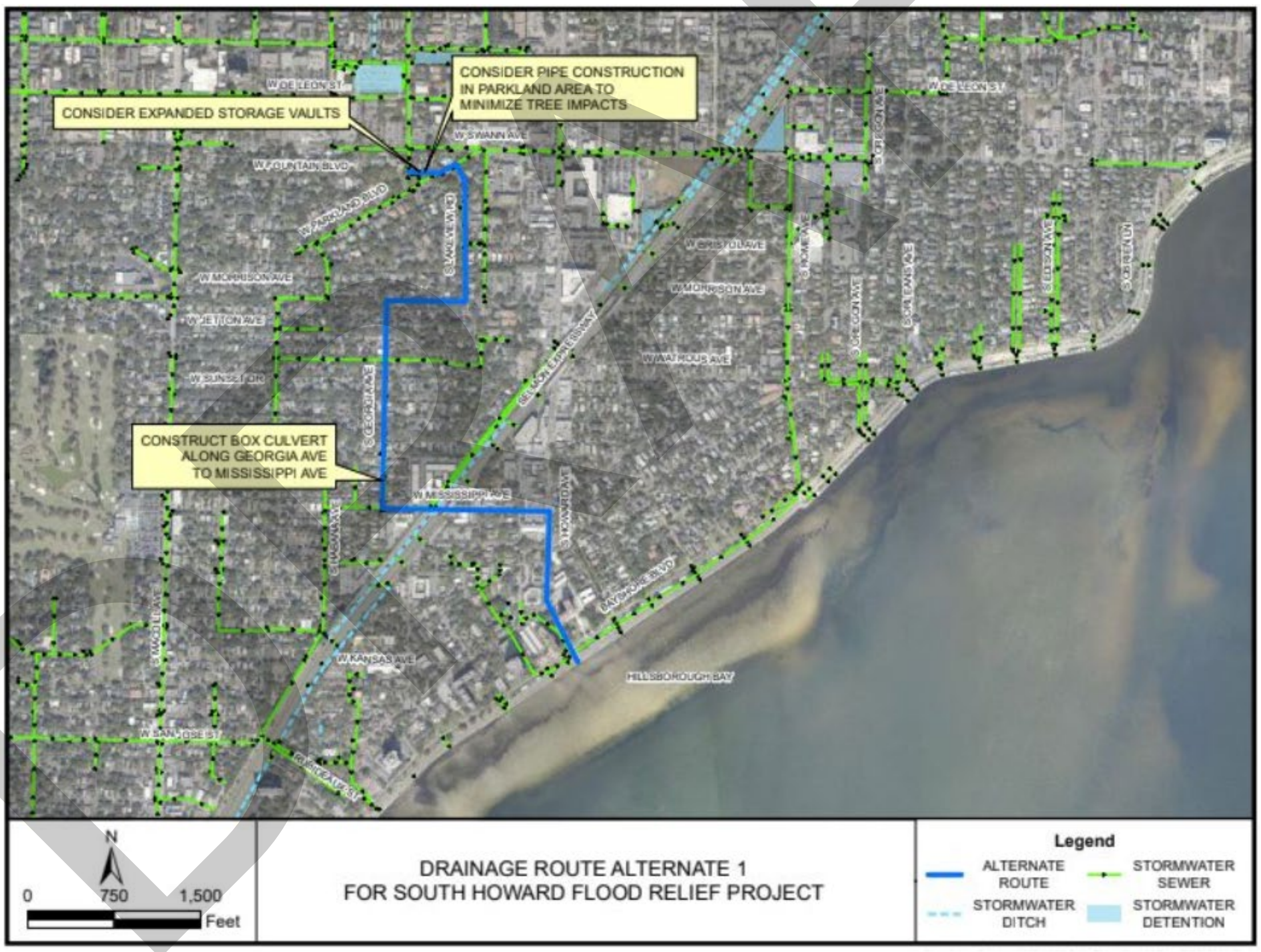

Figure 5-28 – S Georgia Ave to W Mississippi Ave

5.4.2.2 W Morrison Ave to S Rome Ave

This scenario **increases the length of box culvert by nearly 20%** between W Swann Ave and Hillsborough Bay. Like the S Georgia Ave alternative, this route will impact the narrow residential corridors within Parkland Estates and Historic Hyde Park, impacting the character of these neighborhoods.

Using the S Rome Ave corridor for a new box culvert trunkline and outfall at Bayshore Blvd will require a costly and time-consuming relocation of the existing 48-inch diameter sanitary sewer force main, as discussed in **Section 3.3**.

A new outfall into Hillsborough Bay will increase the cost and duration of construction and will result in additional traffic impacts to Bayshore Blvd. Lack of available space for conveyance beneath the CSX railroad along W Morrison Ave limits the hydraulic capacity of the new system in comparison to the S Howard Ave alternatives. Similar (or less) flood reduction benefits along with much higher construction costs substantially reduce the project's benefit-cost ratio.

A map of this alternative, provided by the community, is shown below in **Figure 5-29.**

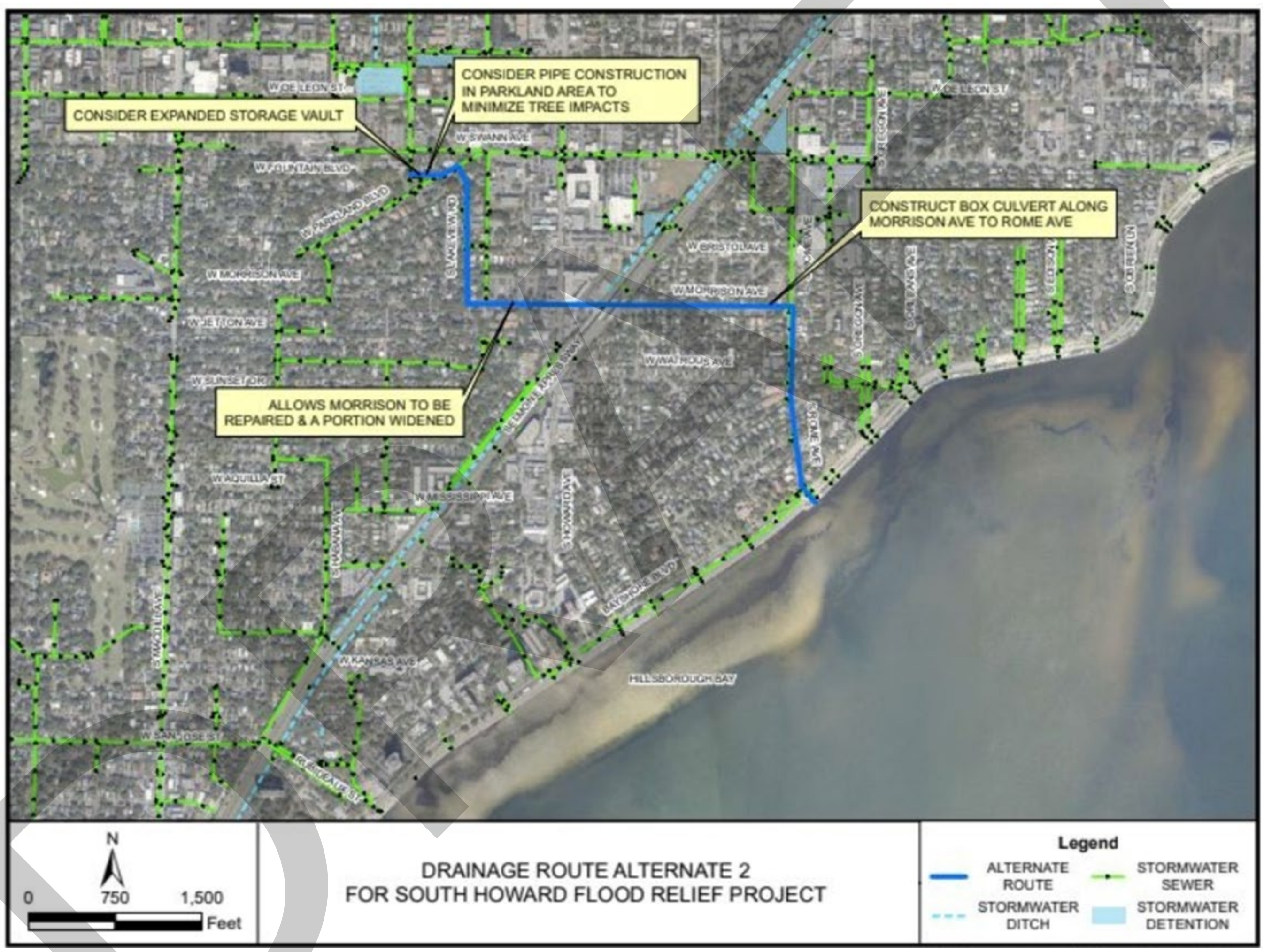

Figure 5-29 – W Morrison Ave to S Rome Ave

5.4.2.3 CSX Route 1

Discussion of this alternative can be found in **Section 5.4.1.5**. A map of this alternative, provided by the community, is shown below in **Figure 5-30.**

Figure 5-30 – CSX Route 1

5.4.2.4 CSX Route 2

This scenario is not hydraulically effective without upsizing the S Rome Ave system or constructing a new outfall between the CSX right of way and Hillsborough Bay. As mentioned previously, there is no existing stormwater outfall in this region that can provide the additional conveyance of stormwater required to achieve the SHFR project's flood reduction goal, therefore a new outfall to Hillsborough Bay is needed.

A new system and outfall along S Rome Ave presents the same construction and utility challenges discussed **Section 5.4.2.2**. The existing conveyance capacity of the ditch system along the railroad is a fraction of what is needed to meet the project's flood reduction goal and will provide little additional benefit.

As discussed in **Section 5.4.1.4**, even adding a 3-acre vault to depths of 30 feet below the park will not eliminate the need for a new outfall to the bay. There is simply too much stormwater that needs to be efficiently removed from Parkland Estates and Palma Ceia Pines to meet the project's flood reduction goal.

A map of this alternative, provided by the community, is shown below in **Figure 5-31.**

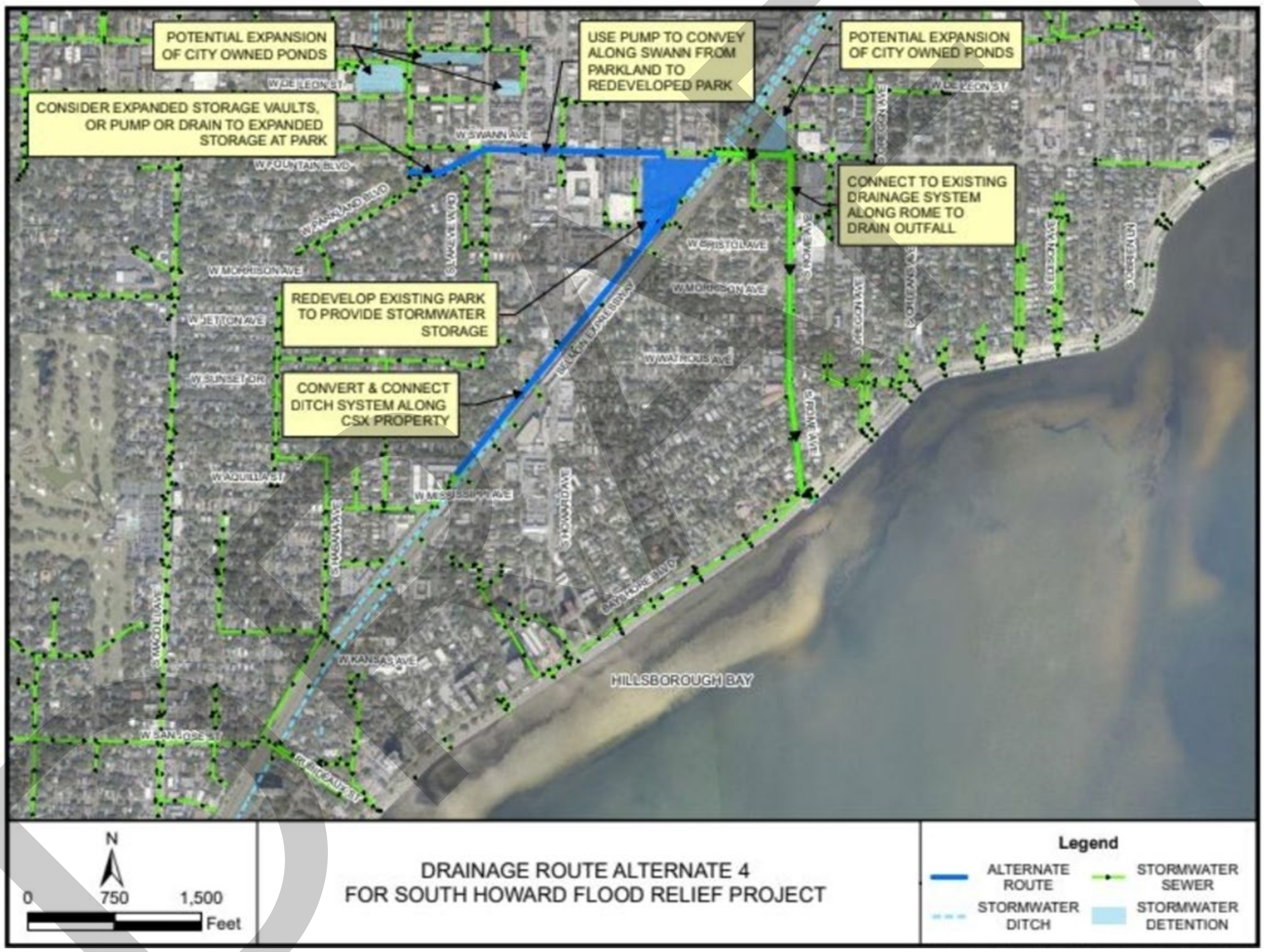

Figure 5-31 – CSX Route 2

5.4.2.5 CSX Route 3

The challenges presented by the CSX corridor are discussed in **Section 5.4.1.5.**

As discussed in **Section 5.1.4.1**, there is a limit to the amount of additional stormwater runoff the Cypress Street Outfall system can handle, and the project's H&H models indicate there is not enough capacity available to use it as an alternative to the SHFR project. The existing Spanishtown Creek system has limited capacity during heavy rainfall events and cannot accommodate the additional flows.

Providing adequate conveyance to the north and east along W Kennedy Blvd toward the Hillsborough River is not hydraulically efficient and will require over 10,000 linear feet of new trunkline. Furthermore, W Kennedy Blvd is a state road, and any new system that uses this corridor will need to be designed and constructed by FDOT. Even if this made sense hydraulically, and FDOT agreed to move forward with such a project, it will delay the SHFR project's completion date by years.

Splitting the project into two new trunklines and outfalls is not practical and will further increase the cost and duration of construction.

A map of this alternative, provided by the community, is shown below in **Figure 5-32.**

Figure 5-32 – CSX Route 3

6. Recommended Project

6.1 Overview

Based on the evaluation of alternatives discussed in **Sections 5.3 and 5.4**, along with routes previously mentioned in the drainage studies discussed in **Section 2.1**, Alternative 3 has the lowest capital costs, the shortest duration of construction, and is the least impactful to the environment, while achieving the project's flood reduction goals. **For these reasons, and at the recommendation of the design-build team, the City has decided to move forward with Primary Alternative 3 – W Swann Ave to S Howard Ave as the most cost-effective solution to reduce flooding within Parkland Estates, Palma Ceia Pines, and other neighborhoods adjacent to the project's route.**

The individually modeled components of the recommended alternative are discussed in **Section 5.1**. This section will build upon **Section 5.1** and focus on the PCM results and predicted flood reduction benefits. It is important to remember that even though this report consistently refers to the SHFR Flood Reduction Focus Area, the recommended system has capacity to alleviate flooding at other locations outside of this area. The PCM includes all the future phase projects discussed in **Section 5.1.3**, along with the primary box culvert trunkline, which has been designed to include capacity for other future drainage connections to use the system to provide regional flood relief.

Key project details, findings, and assumptions for the recommended alternative are listed below:

- A new 10'x10' box culvert trunkline from Bayshore Blvd to the AMI detention pond, along S Audubon Ave between W De Leon St and W Horatio St.
- Existing box culverts remain in place beneath Bayshore Blvd, Selmon Expressway, and the CSX railroad.
- Additional parallel 60" pipe is to be installed beneath Selmon Expressway and CSX railroad via microtunnel.
- The route includes S Howard Ave, W Swann Ave, and S Audubon Ave corridors.
- A new weir that controls water levels within and discharges from the City-maintained AMI Pond, eliminating the need for the existing pump that recovers the pond's available storage and treatment volume. The pond's primary existing outfall – a 4'x8' box culvert along W Horatio St – will remain to function as a secondary outfall.
- **Estimated Phase I Construction Cost: $92,136,452** (cost estimate is based on 30% design and can be found in **Appendix L**)
- Future project phases will include smaller stormwater trunklines throughout Palma Ceia Pines and local roads adjacent to the main trunkline's route to collect stormwater runoff and address FPLOS deficiencies.

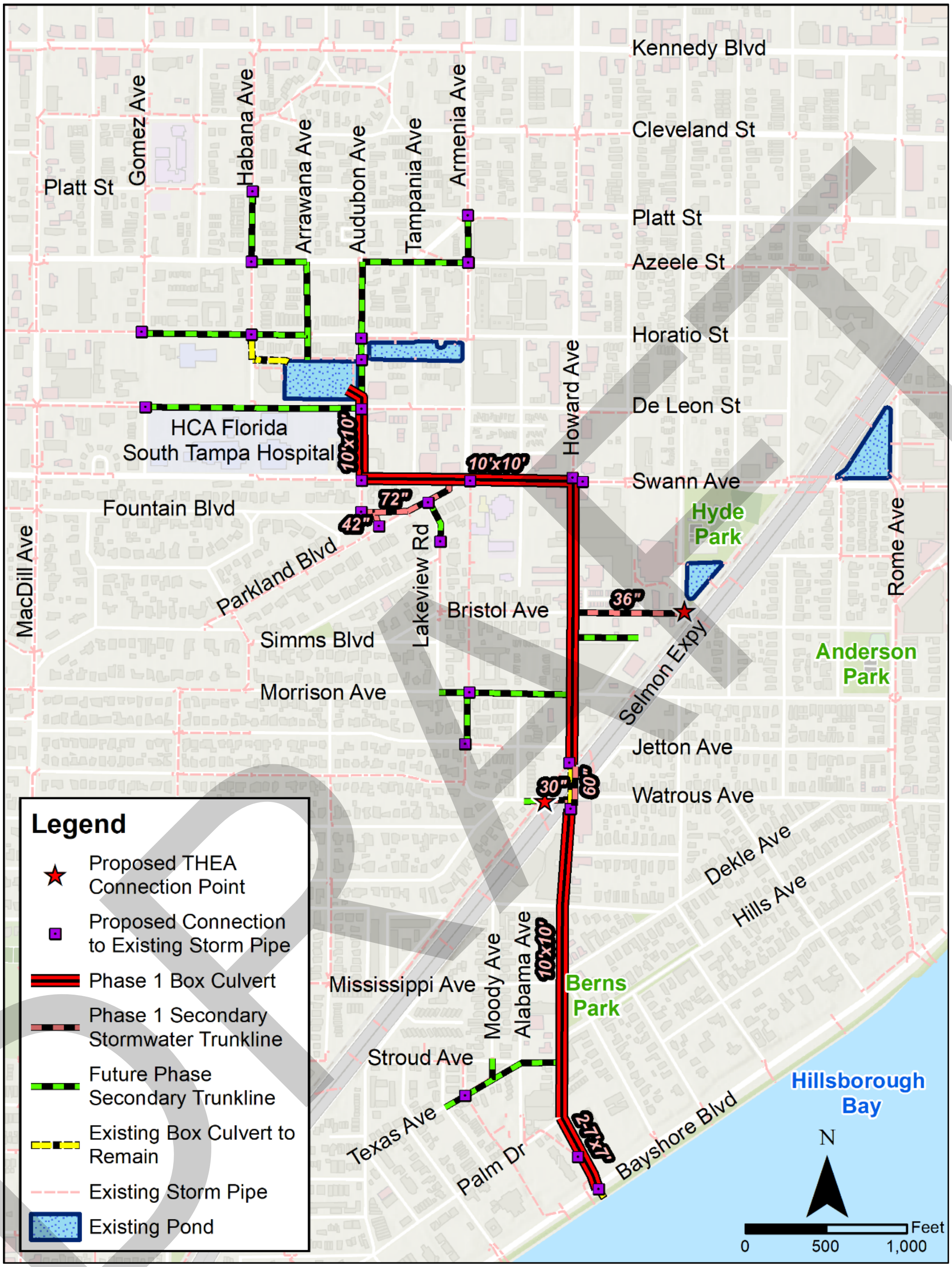

Figure 6-1 – SHFR Project Recommended Alternative

6.1.1 Hydraulic Grade Line (HGL)

Figure 6-2 and Figure 6-3 illustrate a profile view of the proposed trunkline between the AMI pond and Hillsborough Bay. The figures illustrate the existing and proposed hydraulic grade line (HGL) profiles as predicted by the models for the 5-year/8-hour and 100-year/24-hour design storm events, respectively.

The hydraulic grade line can be considered a graphical representation of the energy available to push water through the culvert at any given point along the route. It generally reflects what elevation the water surface will reach within or above the system's pipes, inlets, and manholes during the peak flood conditions of the respective rainfall event. A HGL profile below the ground surface reflects a peak water level that is contained during the event, while a HGL profile above the ground surface reflects flooding above a surcharged system during the event.

The slope of the HGL indicates energy losses due to friction within the culvert (major losses) and minor losses due to localized areas of turbulence, such as deflections within the culvert alignment or intersection with another major conveyance system. A steeper slope means more friction due to a large amount of water being forced through a tight space. A sudden rise in HGL reflects a significant restriction in the system, like the crossing beneath the railroad and Selmon Expressway or the large conflict structure at Bayshore Blvd.

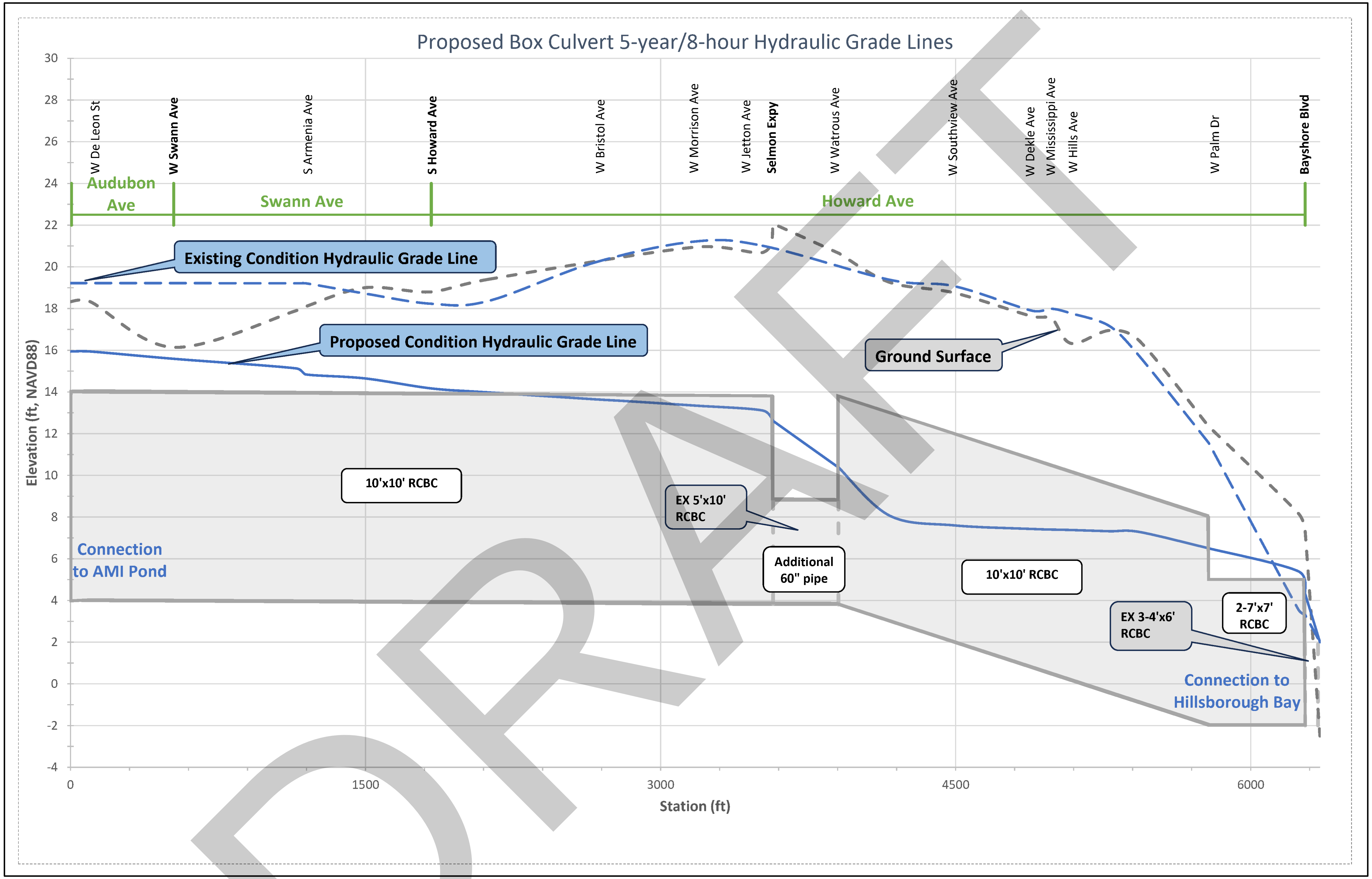

Figure 6-2 – Recommended Alternative Profile View and 5-year/8-hour HGL Comparison

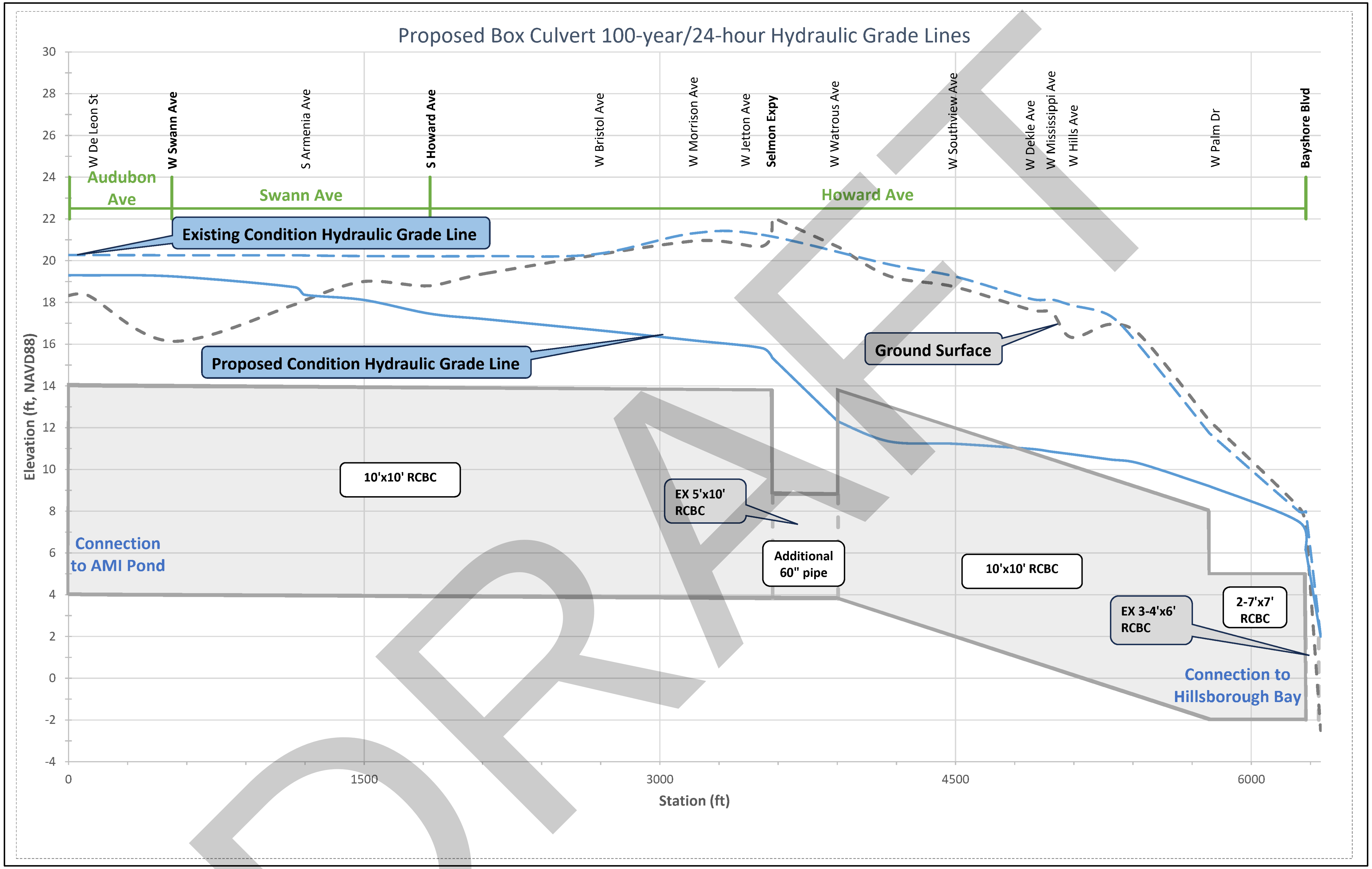

Figure 6-3 – Recommended Alternative Profile View and 100-year/24-hour HGL Comparison

6.2 Phase I Flood Reduction Benefits

While future phase projects are ultimately needed to meet the FPLOS goal and keep water off roadways, **Phase I significantly reduces the duration of roadway flooding both inside and outside of the SHFR Flood Reduction Focus Area. It will also provide significant structure flooding reduction and protection to homes and businesses during severe rainfall events.**

Phase I provides the major artery needed for stormwater conveyance and future phases connections. These future projects will further reduce flooding to allow specific roadways and intersections to meet the FPLOS goal. **Table 6-1** below provides a summary of benefits anticipated after the construction of **only Phase I.**

Table 6-1 – Summary of Proposed Phase I Flood Reduction Benefits

Flood Impact/Reduction Benefit	2.33-year/ 24-hour Design Storm (4.5 inches)	5-year/ 8-hour Design Storm (5.3 inches)	10-year/ 24-hour Design Storm (7.0 inches)	25-year/ 24-hour Design Storm (8.0 inches)	50-year/ 24-hour Design Storm (10.0 inches)	100-year/ 24-hour Design Storm (11.0 inches)	Hurricane Milton (13-14.5 inches*)
Existing Duration of Roadway Flooding on S Habana Ave at W Horatio St (hours)	3	6	8	9	11	12	15
Proposed Duration of Roadway Flooding on S Habana Ave at W Horatio St (hours)	0	1	2	2	3	4	5
Existing Number of Homes/Businesses Inundated**	0	96	123	203	255	272	333
Proposed Reduction of Inundated Homes/Businesses**	N/A	96	113	172	183	153	225
% Reduction of Inundated Homes/Businesses**	N/A	100%	92%	85%	72%	56%	68%

*Hurricane Milton rainfall totals vary across the model's geographic limits, and were estimated by radar (source: NEXRAD)
**Includes predicted total number of ground floor dwellings, including single family homes, businesses, and individual apartment or townhome units, within the 206 specific buildings surveyed in 2025 by the design-build team.
Note: Benefits reflect all proposed Phase I improvements as depicted in red in **Figure 6-4.** Additional future projects that reduce runoff to this area will further increase these benefits. All values in the table are predicted using H&H model results and have not been field verified after observed rainfall events.

6.2.1 Structure Flooding Reduction

Table 6-1 provides a summary of the predicted reduction in structure flooding for each event simulated. The middle row shows how many of the structures that flood in the existing condition no longer flood during the same rainfall event, after Phase I is complete. The bottom row specifies what percentage of inundated structures will now be protected and no longer flood after Phase I is complete. While the project was designed to reduce roadway flooding, the additional benefit to vulnerable homes and businesses is tremendous, even during generational events like Hurricane Milton.

6.2.2 Flooding Extents Reduction

Figure 6-4 shows the reduction in flood extents for the 5-year/8-hour design storm for only the Phase I project. The purple shading represents existing flooding extents predicted by the model that will be eliminated during the same storm event once the project is complete. **What is not visible is the significant reduction in structure flooding and the duration of roadway flooding after the completion of Phase I.** It is anticipated that Phase I alone will eliminate all structure flooding within the SHFR Flood Reduction Focus Area for the 5-year/8-hour design storm (see **Table 6-1**).

Flood reduction maps for a variety of simulated rainfall events can be found in **Appendix K**.

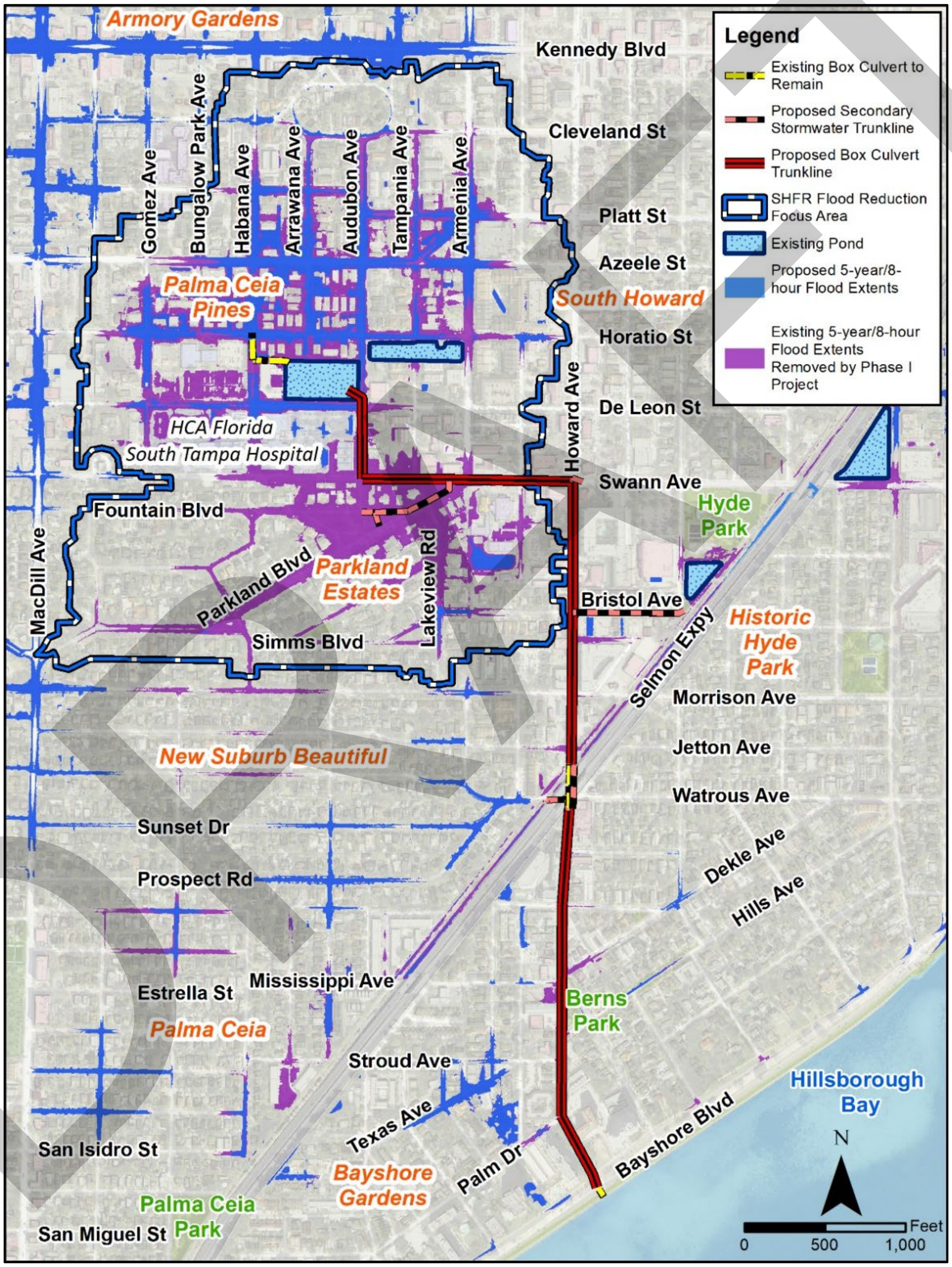

Figure 6-4 – Phase I - 5-year/8-hour Proposed Flood Extents Reduction

6.2.3 Flooding Depth Reduction

Table 6-2 and Table 6-3 show the predicted reduction in peak stage for only the Phase I project, for the 5-year/8-hour and 100-year/24-hour design storm events, respectively.

Table 6-2 – Summary of 5-year/8-hour Flood Reduction and Proposed Flood Depths (Phase I only)

Node	Location	RECM Peak Stage (ft, NAVD88)	Phase I PCM Peak Stage (ft, NAVD88)	Peak Stage Difference (ft)	Low EOP Elevation (ft, NAVD88)	Proposed Flood Depth (ft)
NRU0750	W Fountain Blvd at Fountain Park, Parkland Estates	19.21	14.26	**-4.95**	15.2	-0.94
NCL3510	W Cleveland St at S Habana Ave	19.65	19.64	**-0.01**	19.1	0.54
NCL3450	W Horatio St at S Habana Ave	19.23	17.77	**-1.46**	16.9	0.87
NCL3490	W Platt St at S Habana Ave	19.23	18.74	**-0.49**	17.7	1.04
NRU0790	W Swann Ave at S Audubon Ave (north side)	19.22	14.18	**-5.04**	15.9	-1.72
NRU1050	W Platt St at S Armenia Ave	19.23	18.55	**-0.68**	17.3	1.25
NRU0960	W Azeele St at S Audubon Ave (south side)	19.23	18.52	**-0.71**	17	1.52
NRU1030	W Azeele St at S Armenia Ave (north side)	19.23	18.55	**-0.68**	17.4	1.15
NBW2090	W De Leon St at S Gomez Ave	19.22	18.71	**-0.51**	18.0	0.71
NCL3250	W Horatio St at S Gomez Ave	19.22	18.56	**-0.66**	17.2	1.36
NRU1010	W Horatio St at S Armenia Ave	19.23	18.42	**-0.81**	18.2	0.22
NRU0965	W Azeele St at S Audubon Ave (north side)	19.23	18.52	**-0.71**	16.9	1.62
NBW2110	W De Leon St at S Habana Ave	19.22	18.29	**-0.93**	17.3	0.99
NCL3470	W Azeele St at S Habana Ave	19.23	18.48	**-0.75**	16.8	1.68
NRU1040	W Azeele St at S Armenia Ave (south side)	19.23	18.54	**-0.69**	17.2	1.34
NRU1070	W Cleveland St at S Armenia Ave	19.24	18.96	**-0.28**	18.9	0.06
NRU1170	W Bristol Ave at S Lakeview Rd	19.22	18.73	**-0.49**	18.0	0.73
NCL3740	W Horatio St at S Arrawana Ave	19.23	18.26	**-0.97**	17.1	1.16
PondB	W Swann Ave at S Rome Ave (Swann Pond)	16.86	14.62	**-2.24**	15.2	-0.58

*Proposed flood depths in the table that are greater than 4 inches are highlighted in red. However, because the DEM was used to estimate the low edge of pavement elevations at this conceptual level of design, and there is often opportunity to elevate the low edge of pavement slightly during the final design phase, proposed peak stages within an inch of the FPLOS target are considered acceptable for this analysis.

Table 6-3 – Summary of 100-year/24-hour Flood Reduction and Proposed Flood Depths (Phase I only)

Node	Location	RECM Peak Stage (ft, NAVD88)	Phase I PCM Peak Stage (ft, NAVD88)	Peak Stage Difference (ft)
NRU0750	W Fountain Blvd at Fountain Park, Parkland Estates	20.26	19.30	**-0.96**
NCL3510	W Cleveland St at S Habana Ave	20.28	20.11	**-0.17**
NCL3450	W Horatio St at S Habana Ave	20.27	19.46	**-0.81**
NCL3490	W Platt St at S Habana Ave	20.27	19.49	**-0.78**
NRU0790	W Swann Ave at S Audubon Ave (north side)	20.26	19.30	**-0.96**
NRU1050	W Platt St at S Armenia Ave	20.28	19.48	**-0.80**
NRU0960	W Azeele St at S Audubon Ave (south side)	20.27	19.48	**-0.79**
NRU1030	W Azeele St at S Armenia Ave (north side)	20.27	19.48	**-0.79**
NBW2090	W De Leon St at S Gomez Ave	20.26	19.36	**-0.90**
NCL3250	W Horatio St at S Gomez Ave	20.27	19.47	**-0.80**
NRU1010	W Horatio St at S Armenia Ave	20.27	19.47	**-0.80**
NRU0965	W Azeele St at S Audubon Ave (north side)	20.27	19.48	**-0.79**
NBW2110	W De Leon St at S Habana Ave	20.27	19.36	**-0.91**
NCL3470	W Azeele St at S Habana Ave	20.27	19.48	**-0.79**
NRU1040	W Azeele St at S Armenia Ave (south side)	20.27	19.48	**-0.79**
NRU1070	W Cleveland St at S Armenia Ave	20.27	19.58	**-0.69**
NRU1170	W Bristol Ave at S Lakeview Rd	20.26	19.30	**-0.96**
NCL3740	W Horatio St at S Arrawana Ave	20.27	19.46	**-0.81**
PondB	W Swann Ave at S Rome Ave (Swann Pond)	17.86	17.64	**-0.22**

6.2.4 Flooding Duration Reduction

Phase I alone cannot achieve the FPLOS goal in many locations without upsizing the secondary collection systems that drain roadway intersections several blocks away from the box culvert trunkline. However, roadways that still become inundated after the completion of Phase I due to undersized local stormwater infrastructure will drain much more quickly because of the new trunkline.

Figure 6-5 below shows a hydrograph of the most severe flooding expected in Palma Ceia Pines after Phase I is complete, at the low-lying portion of W Azeele St near S Habana Ave. While the roadway will still be temporarily impassable until a future phase project increases pipe sizes between this location and the AMI pond, the duration of flooding will be reduced from 6.7 to 2.4 hours.

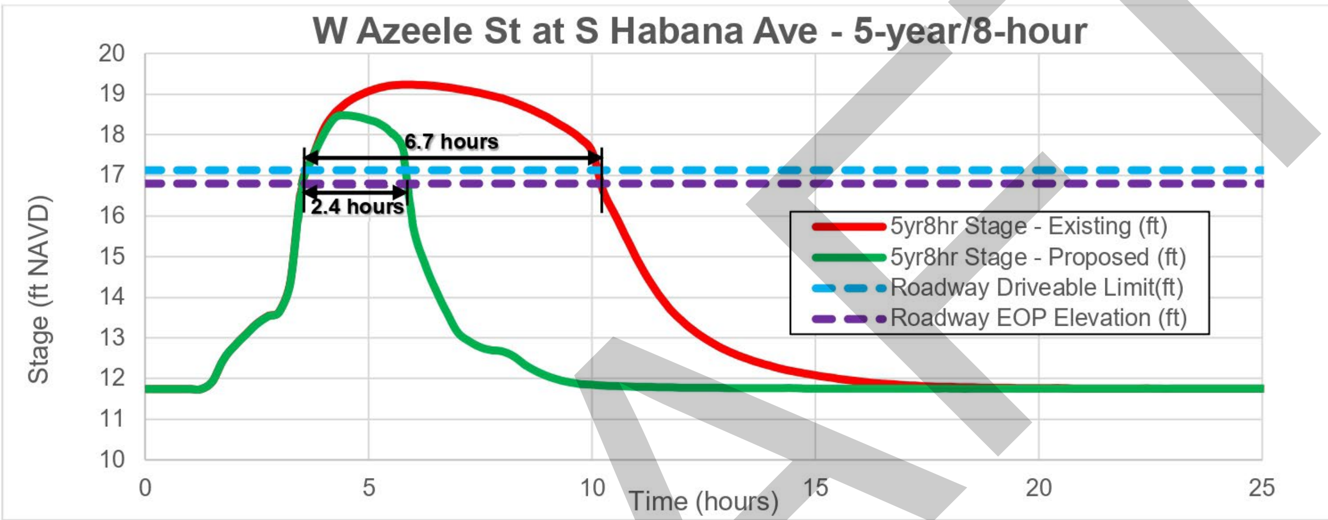

Figure 6-5 – Phase I – Reduction in Duration of Roadway Flooding, 5-year/8-hour Design Storm

The reduction in duration of flooding is perhaps even more significant for the larger events. The hydrograph comparison in **Figure 6-6** below shows the Phase I reduction in flooding duration predicted for W Kennedy Blvd near S Habana Ave for the 25-year/24-hour design storm event. Seven and a half hours of inundation in the existing condition is now reduced to 3.2 hours.

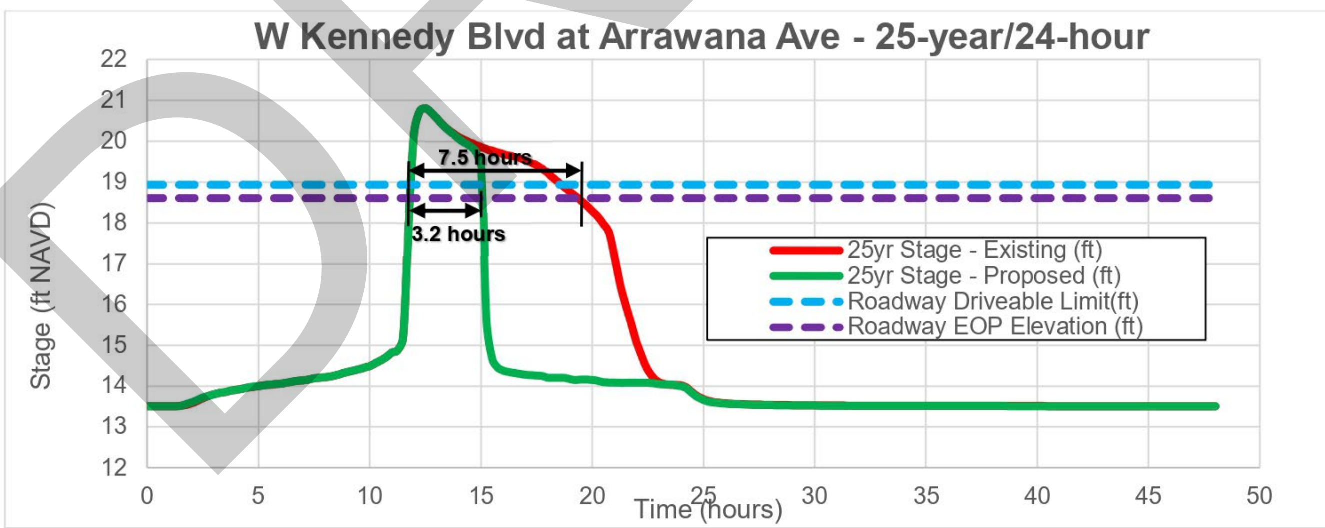

Figure 6-6 – Phase I – Reduction in Duration of Roadway Flooding, 25-year/24-hour Design Storm

6.2.5 Hurricane Milton Simulation

Hurricane Milton was a rainfall event of historic proportions, causing the inundation of over 300 homes and businesses within Parkland Estates and Palma Ceia Pines on October 9th, 2024. While designing stormwater infrastructure to handle extreme rainfall events like this one is generally not considered feasible, infrastructure designed for a more probable event like the 5-year/8-hour design storm can still provide a significant reduction in flooding during these anomalies.

To quantify the expected reduction in flooding if a storm similar to Hurricane Milton was to make landfall again, the simulation of this event, which was used to calibrate the RECM, was applied to the Phase I PCM and results were compared to show the significant benefit Phase I could provide for the community during another historic rainfall event.

Figure 6-7 and Figure 6-8 below show a significant reduction in both peak flood stage (and therefore the number of homes and vehicles damaged) and flood duration (and therefore the amount of time streets are inaccessible to emergency vehicles). The predicted peak stage reduction is between 15 and 17 inches throughout Parkland Estates and Palma Ceia Pines, and the duration of roadway flooding in Parkland Estates is reduced from 19 hours to less than 5 hours. **The model results predict that the Phase I improvements would have protected 225 of the 333 ground floor homes and businesses that flooded during Hurricane Milton if they had been in place prior to the 2024 hurricane season.**

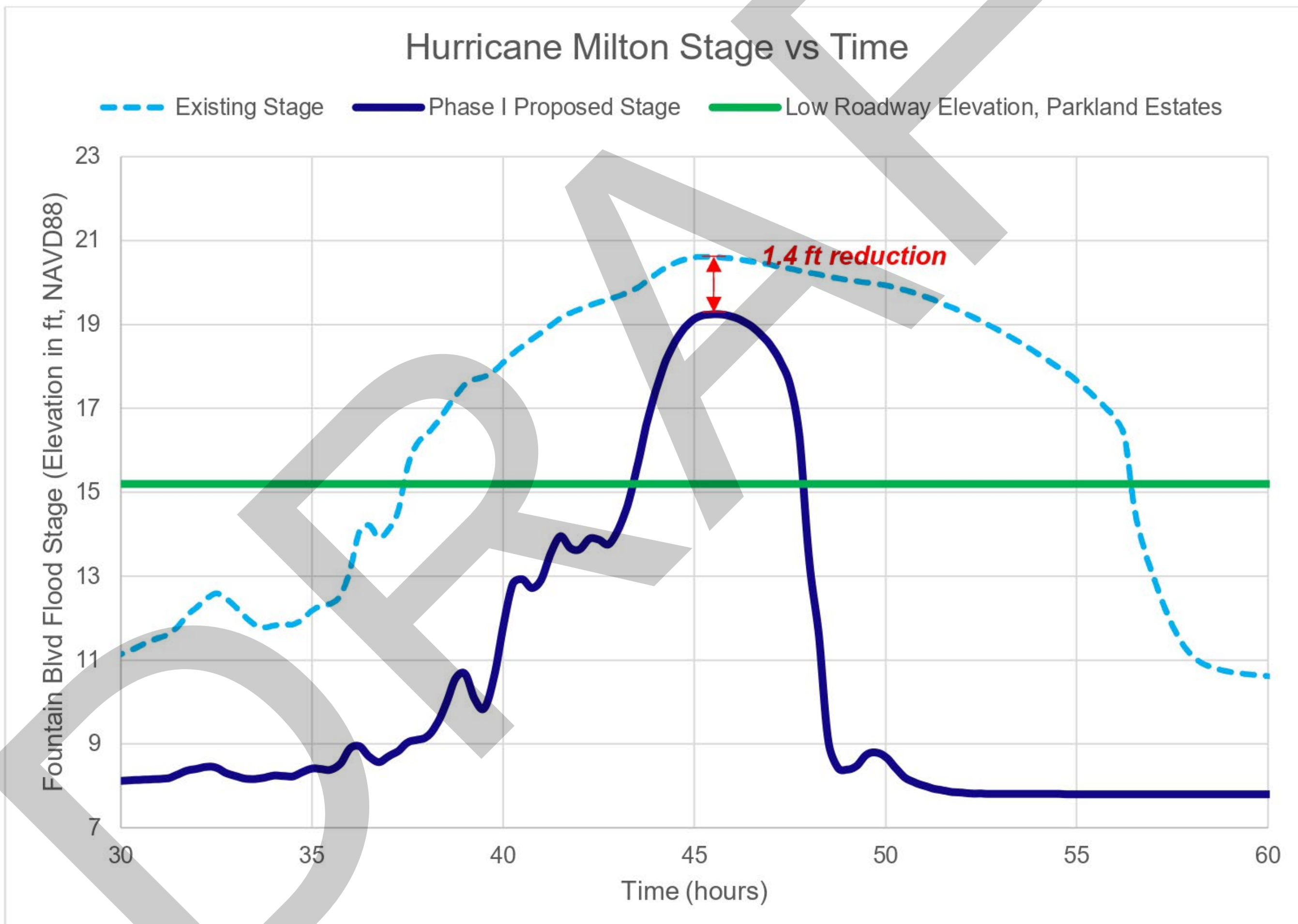

Figure 6-7 – Proposed Hurricane Milton Flood Reduction, Parkland Estates (Phase I only)

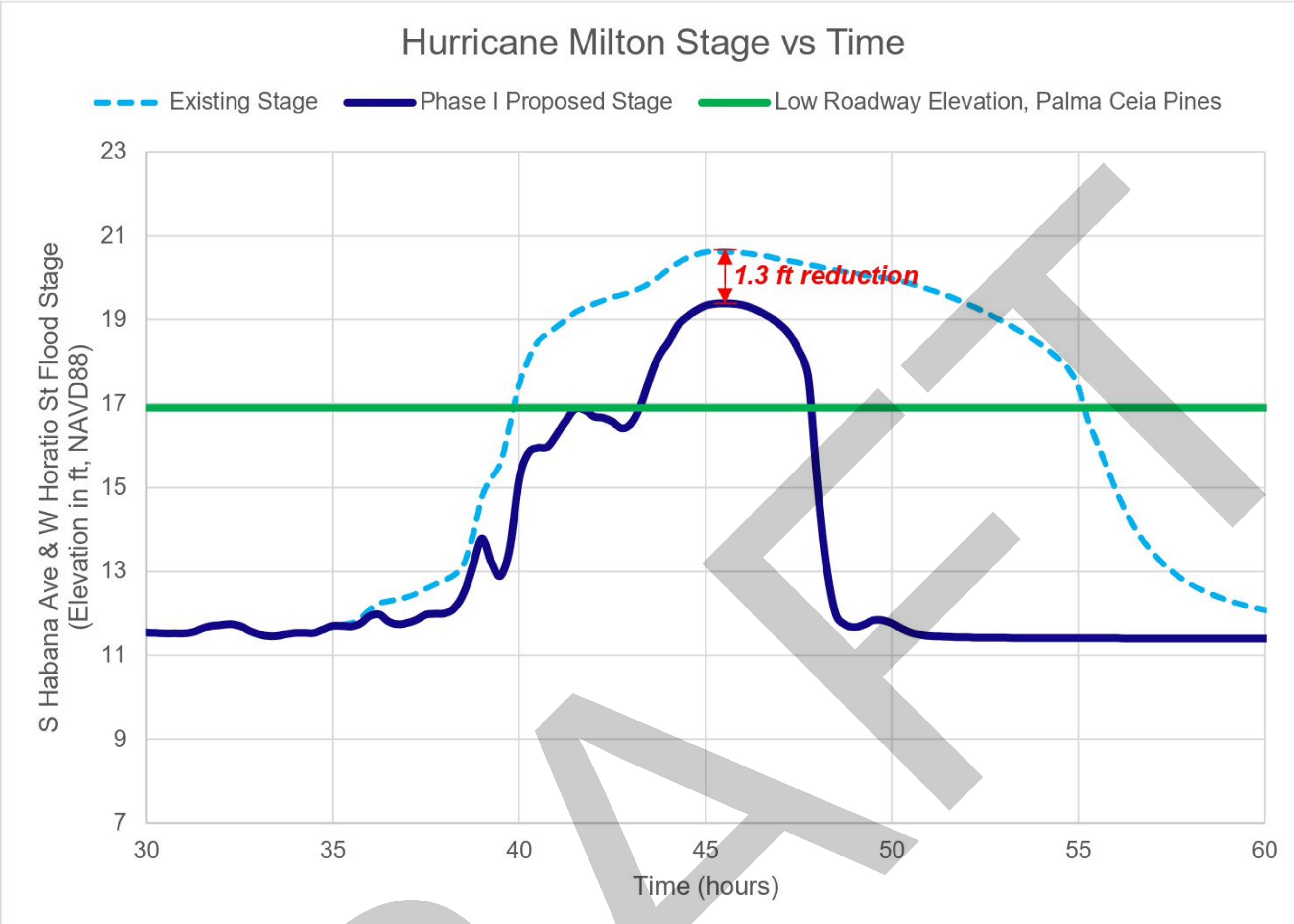

Figure 6-8 – Proposed Hurricane Milton Flood Reduction, Palma Ceia Pines (Phase I only)

A map showing the anticipated Phase I reduction in flood extents for the Hurricane Milton simulations can be found below in **Figure 6-9.**

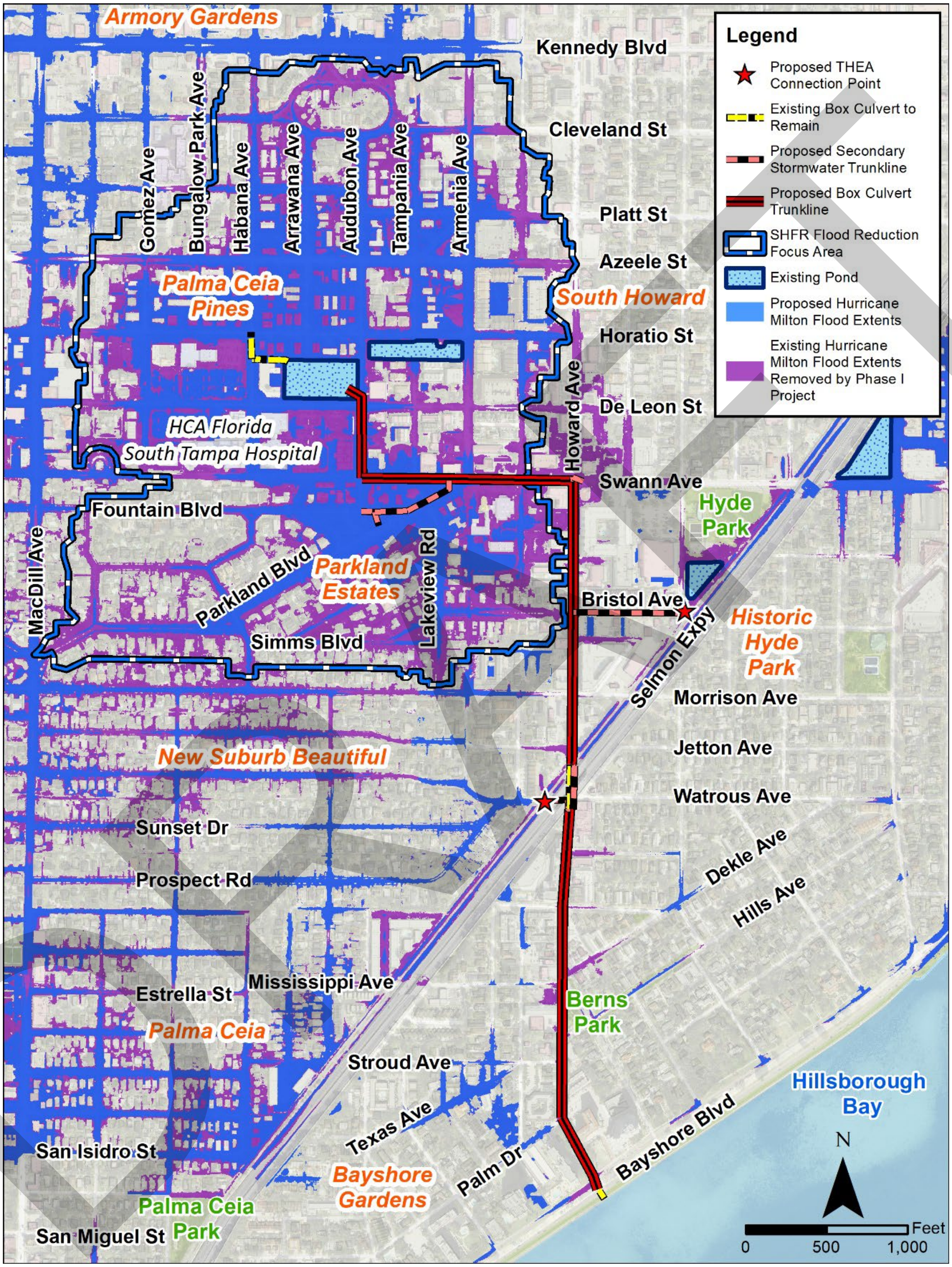

Figure 6-9 – Existing and Proposed (Phase I Only) Hurricane Milton Flood Extents Comparison

6.3 Future Phase Flood Reduction Benefits

This section focuses on the expected flood reduction benefits provided by the secondary stormwater collection systems to be constructed as part of future phase projects (discussed in **Section 5.1.3**), once the Phase I improvements outlined in **Section 5.1.2** are in place.

These collection systems are critical to achieving the FPLOS throughout the SHFR Flood Reduction Focus Area and at peripheral locations with FPLOS deficiencies, which are discussed in **Sections 4.8 and 5.1**. Much of the existing stormwater infrastructure that connects to the Phase I trunkline is undersized by City standards and unable to handle the amount of stormwater runoff expected in the 5-year/8-hour storm event.

Table 6-4 below provides a summary of benefits anticipated after the construction of **Phase I AND all recommended secondary stormwater collection systems discussed in Section 5.1.3.**

Table 6-4 – Summary of Proposed Future Phase Flood Reduction Benefits

Flood Impact/Reduction Benefit	2.33-year/ 24-hour Design Storm (4.5 inches)	5-year/ 8-hour Design Storm (5.3 inches)	10-year/ 24-hour Design Storm (7.0 inches)	25-year/ 24-hour Design Storm (8.0 inches)	50-year/ 24-hour Design Storm (10.0 inches)	100-year/ 24-hour Design Storm (11.0 inches)	Hurricane Milton (13-14.5 inches*)
Proposed **Reduction** of Roadway Inundation (miles)	6.0	8.1	5.0	4.6	3.9	3.3	4.6
Existing Duration of Roadway Flooding on W Swann Ave at S Audubon Ave (hours)	6	8	10	12	14	15	19
Proposed Duration of Roadway Flooding on W Swann Ave at S Audubon Ave (hours)	0	0	1	2	3	4	4
Existing Number of Homes/Businesses Inundated**	0	96	123	203	255	272	333
Proposed **Reduction** of Inundated Homes/Businesses**	N/A	96	123	198	197	164	235
% Reduction of Inundated Homes/Businesses**	N/A	100%	100%	98%	77%	60%	71%

*Hurricane Milton rainfall totals vary across the model's geographic limits, and were estimated by radar (source: NEXRAD)

**Includes predicted total number of ground floor dwellings, including single family homes, businesses, and individual apartment or townhome units, within the 206 specific buildings surveyed in 2025 by the design-build team.

Note: Benefits reflect all proposed improvements in **Figure 6-10** below. Additional future projects that reduce runoff to this area could further increase these benefits. All values in the table are predicted using H&H model results and have not been field verified after observed rainfall events.

6.3.1 Structure Flooding Reduction

Table 6-4 provides a summary of the predicted reduction in structure flooding for each event simulated.

The middle row shows how many of the structures that flood in the existing condition no longer flood during the same rainfall event, after all the recommended improvements are complete. The bottom row specifies what percentage of inundated structures will now be protected and no longer flood after the improvements are complete. This predicted reduction in structure flooding is tremendous and protects hundreds of vulnerable homes and businesses in a variety of heavy rainfall events.

6.3.2 Flooding Extents Reduction

Comparing **Table 6-4** back to **Table 6-1**, it is apparent that while the future phase improvements provide some additional relief to structure flooding, they significantly reduce the extent and depth of roadway flooding throughout Parkland Estates, Palma Ceia Pines, New Suburb Beautiful, Bayshore Gardens, and other neighborhoods.

Figure 6-10 shows the reduction in flood extents for the 5-year/8-hour design storm upon completion of **Phase I AND all recommended secondary stormwater collection systems.** The purple shading represents existing flooding extents predicted by the model that will be eliminated during the same storm event once the projects are complete.

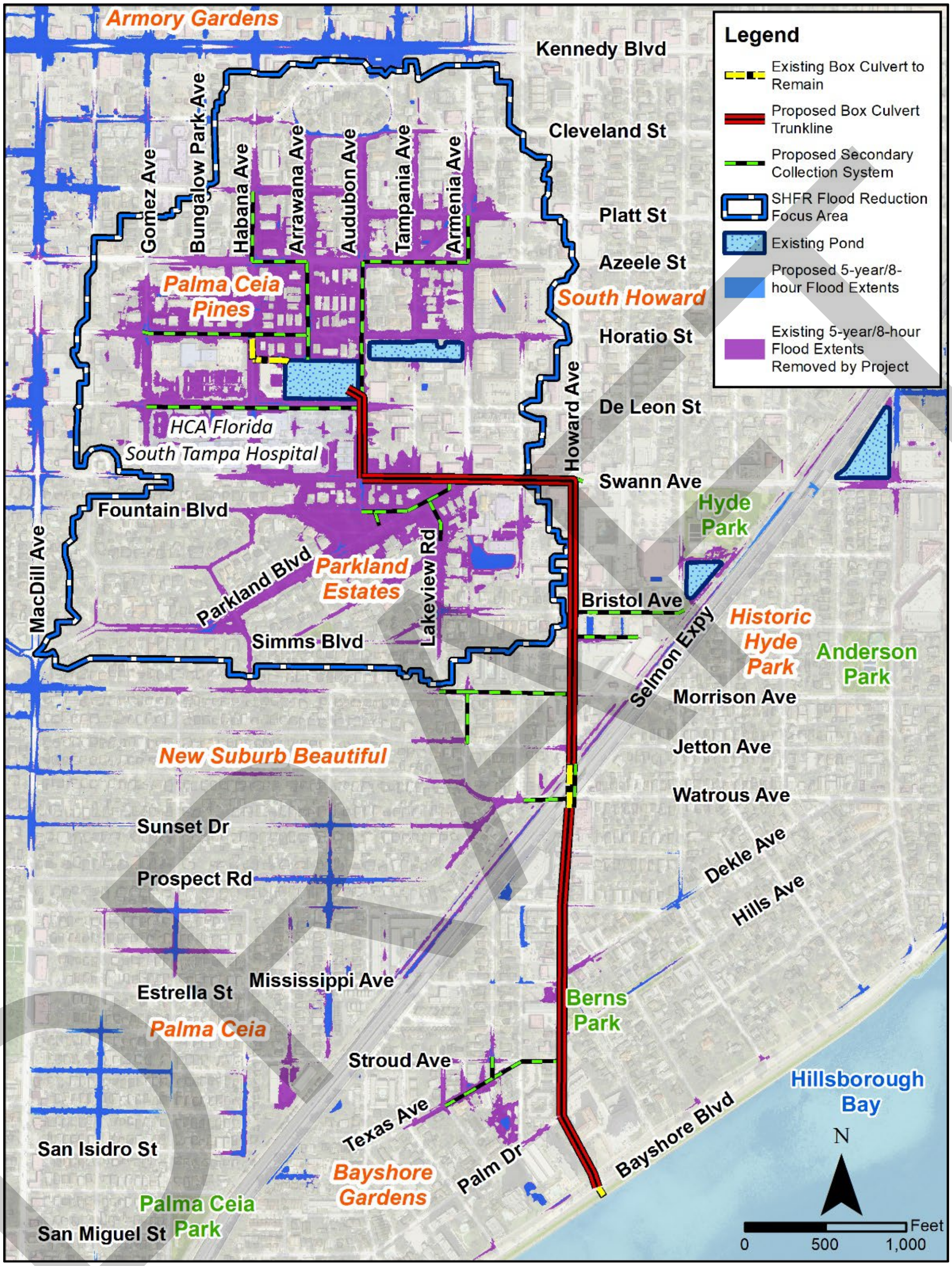

Figure 6-10 – Future Phase – 5-year/8-hour Proposed Flood Extents Reduction

6.3.3 Flooding Depth Reduction

Table 6-5 and Table 6-6 show the predicted reduction in peak stage for Phase I AND all recommended secondary stormwater collection systems, for the 5-year/8-hour and 100-year/24-hour design storm events, respectively.

Table 6-5 – Summary of 5-year/8-hour Flood Reduction and Proposed Flood Depths (Future Phase)

Node	Location	RECM Peak Stage (ft, NAVD88)	PCM Peak Stage (ft, NAVD88)	Peak Stage Difference (ft)	Low EOP Elevation (ft, NAVD88)	Proposed Flood Depth (ft)
NRU0750	W Fountain Blvd at Fountain Park, Parkland Estates	19.21	15.62	**-3.59**	15.2	0.42**
NCL3510	W Cleveland St at S Habana Ave	19.65	19.44	**-0.21**	19.1	0.34*
NCL3450	W Horatio St at S Habana Ave	19.23	16.6	**-2.63**	16.9	-0.30
NCL3490	W Platt St at S Habana Ave	19.23	17.72	**-1.51**	17.7	0.02
NRU0790	W Swann Ave at S Audubon Ave (north side)	19.22	15.59	**-3.63**	15.9	-0.31
NRU1050	W Platt St at S Armenia Ave	19.23	17.5	**-1.73**	17.3	0.20
NRU0960	W Azeele St at S Audubon Ave (south side)	19.23	17.04	**-2.19**	17.0	0.04
NRU1030	W Azeele St at S Armenia Ave (north side)	19.23	17.29	**-1.94**	17.4	-0.11
NBW2090	W De Leon St at S Gomez Ave	19.22	18.33	**-0.89**	18.0	0.33
NCL3250	W Horatio St at S Gomez Ave	19.22	17.36	**-1.86**	17.2	0.16
NRU1010	W Horatio St at S Armenia Ave	19.23	17.06	**-2.17**	18.2	-1.14
NRU0965	W Azeele St at S Audubon Ave (north side)	19.23	17.15	**-2.08**	16.9	0.25
NBW2110	W De Leon St at S Habana Ave	19.22	17.13	**-2.09**	17.3	-0.17
NCL3470	W Azeele St at S Habana Ave	19.23	16.98	**-2.25**	16.8	0.18
NRU1040	W Azeele St at S Armenia Ave (south side)	19.23	17.17	**-2.06**	17.2	-0.03
NRU1070	W Cleveland St at S Armenia Ave	19.24	17.75	**-1.49**	18.9	-1.15
NRU1170	W Bristol Ave at S Lakeview Rd	19.22	18.24	**-0.98**	18.0	0.24
NCL3740	W Horatio St at S Arrawana Ave	19.23	16.4	**-2.83**	17.1	-0.70
PondB	W Swann Ave at S Rome Ave (Swann Pond)	16.86	14.62	**-2.24**	15.2	-0.58

*Proposed flood depths in the table that are greater than 4 inches are highlighted in red. However, because the DEM was used to estimate the low edge of pavement elevations at this conceptual level of design, and there is often opportunity to elevate the low edge of pavement slightly during the final design phase, proposed peak stages within an inch of the FPLOS target are considered acceptable for this analysis.

**Based on the SHFR project's preliminary roadway design, which is at the 30 percent phase at the time of this report, it is likely that the lowest edge of pavement elevation along W Fountain Blvd will be elevated by several inches, which will reduce the anticipated flood depth here to less than four inches.

Table 6-6 – Summary of 100-year/24-hour Flood Reduction and Proposed Flood Depths (Future Phase)

Node	Location	RECM Peak Stage (ft, NAVD88)	Future Phase PCM Peak Stage (ft, NAVD88)	Peak Stage Difference (ft)
NRU0750	W Fountain Blvd at Fountain Park, Parkland Estates	20.26	19.25	**-1.01**
NCL3510	W Cleveland St at S Habana Ave	20.28	20.11	**-0.17**
NCL3450	W Horatio St at S Habana Ave	20.27	19.38	**-0.89**
NCL3490	W Platt St at S Habana Ave	20.27	19.41	**-0.86**
NRU0790	W Swann Ave at S Audubon Ave (north side)	20.26	19.25	**-1.01**
NRU1050	W Platt St at S Armenia Ave	20.28	19.40	**-0.88**
NRU0960	W Azeele St at S Audubon Ave (south side)	20.27	19.40	**-0.87**
NRU1030	W Azeele St at S Armenia Ave (north side)	20.27	19.40	**-0.87**
NBW2090	W De Leon St at S Gomez Ave	20.26	19.30	**-0.96**
NCL3250	W Horatio St at S Gomez Ave	20.27	19.39	**-0.88**
NRU1010	W Horatio St at S Armenia Ave	20.27	19.39	**-0.88**
NRU0965	W Azeele St at S Audubon Ave (north side)	20.27	19.40	**-0.87**
NBW2110	W De Leon St at S Habana Ave	20.27	19.30	**-0.97**
NCL3470	W Azeele St at S Habana Ave	20.27	19.40	**-0.87**
NRU1040	W Azeele St at S Armenia Ave (south side)	20.27	19.40	**-0.87**
NRU1070	W Cleveland St at S Armenia Ave	20.27	19.55	**-0.72**
NRU1170	W Bristol Ave at S Lakeview Rd	20.26	19.25	**-1.01**
NCL3740	W Horatio St at S Arrawana Ave	20.27	19.38	**-0.89**
PondB	W Swann Ave at S Rome Ave (Swann Pond)	17.86	17.63	**-0.23**

6.3.4 Flooding Duration Reduction

Once the secondary collection systems are in place, roadways outside of the SHFR Flood Reduction Focus Area that still flood due to undersized local stormwater infrastructure (S MacDill Ave for example) will drain more quickly because of the SHFR project's new stormwater infrastructure. Additionally, the roadways that achieve the FPLOS goal will see significant reduction in flood duration during events that are more severe than the 5-year/8-hour design storm.

The hydrograph in **Figure 6-11** below shows the reduction in flooding duration expected on S MacDill Ave near W De Leon St once the recommended pipe is installed along W De Leon St between S Audubon Ave and S Gomez Ave. The duration of flooding will be reduced from 5.0 to 2.5 hours. The depth of this flooding can be further reduced by extending the new pipe connection to S MacDill Ave, as discussed in **Section 5.1.4.3.**

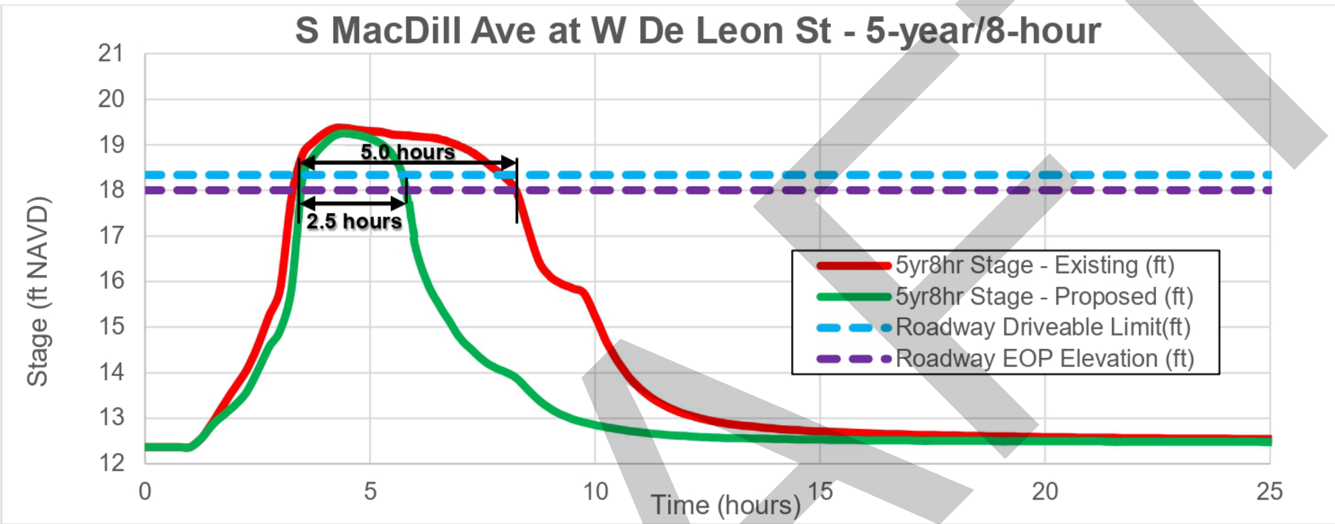

Figure 6-11 – Future Phase – Reduction in Duration of Roadway Flooding, 5-year/24-hour Design Storm

The hydrograph comparison in **Figure 6-12** below shows the predicted reduction in flooding duration at the same location for the 25-year/24-hour design storm event, once the secondary collection systems are installed in Palma Ceia Pines. Six and a half hours of roadway inundation in the existing condition will be reduced to 3.0.

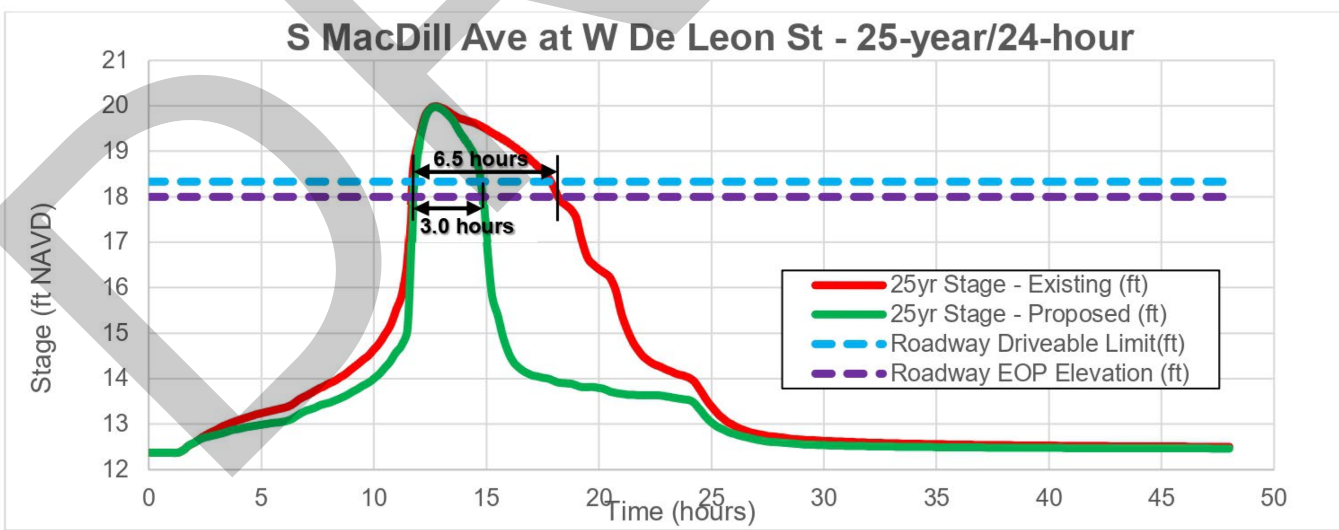

Figure 6-12 – Future Phase – Reduction in Duration of Roadway Flooding, 25-year/24-hour Design Storm

6.3.5 Hurricane Milton Simulation

To quantify the expected reduction in flooding if a storm of similar magnitude to Hurricane Milton were to make landfall again after the full project is complete, the simulation of Hurricane Milton was applied to the PCM, and results were compared to show the significant benefit this project could provide for the community during another historic rainfall event. The comparison shows a similar reduction in peak flood stage between Phase I and the future phase improvements, with the future phase collection systems providing a slight additional benefit.

Figure 6-13 and Figure 6-14 below show a significant reduction in both peak flood stage (and therefore the number of homes and vehicles damaged) and flood duration (and therefore the amount of time streets are inaccessible to emergency vehicles). The Phase I hydrographs were plotted in gray for reference. The predicted peak stage reduction is between 16 and 18 inches throughout Parkland Estates and Palma Ceia Pines. **Model results predict that the future phase collection systems would have protected an additional 10 homes and businesses – now 235 of the 333 ground floor homes and businesses that flooded during Hurricane Milton if they had been in place prior to the 2024 hurricane season.**

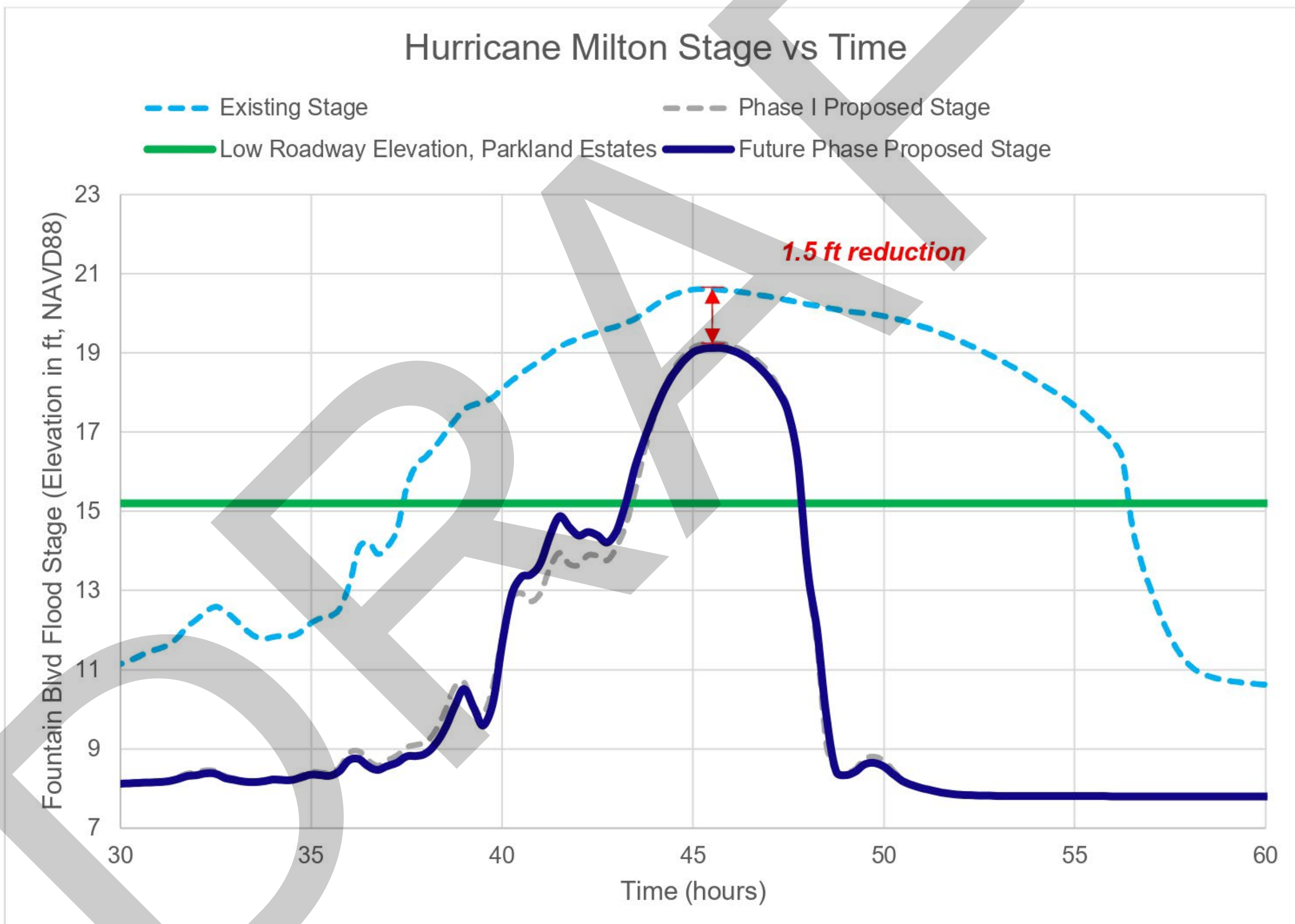

Figure 6-13 – Proposed Hurricane Milton Flood Reduction, Parkland Estates (Future Phase)

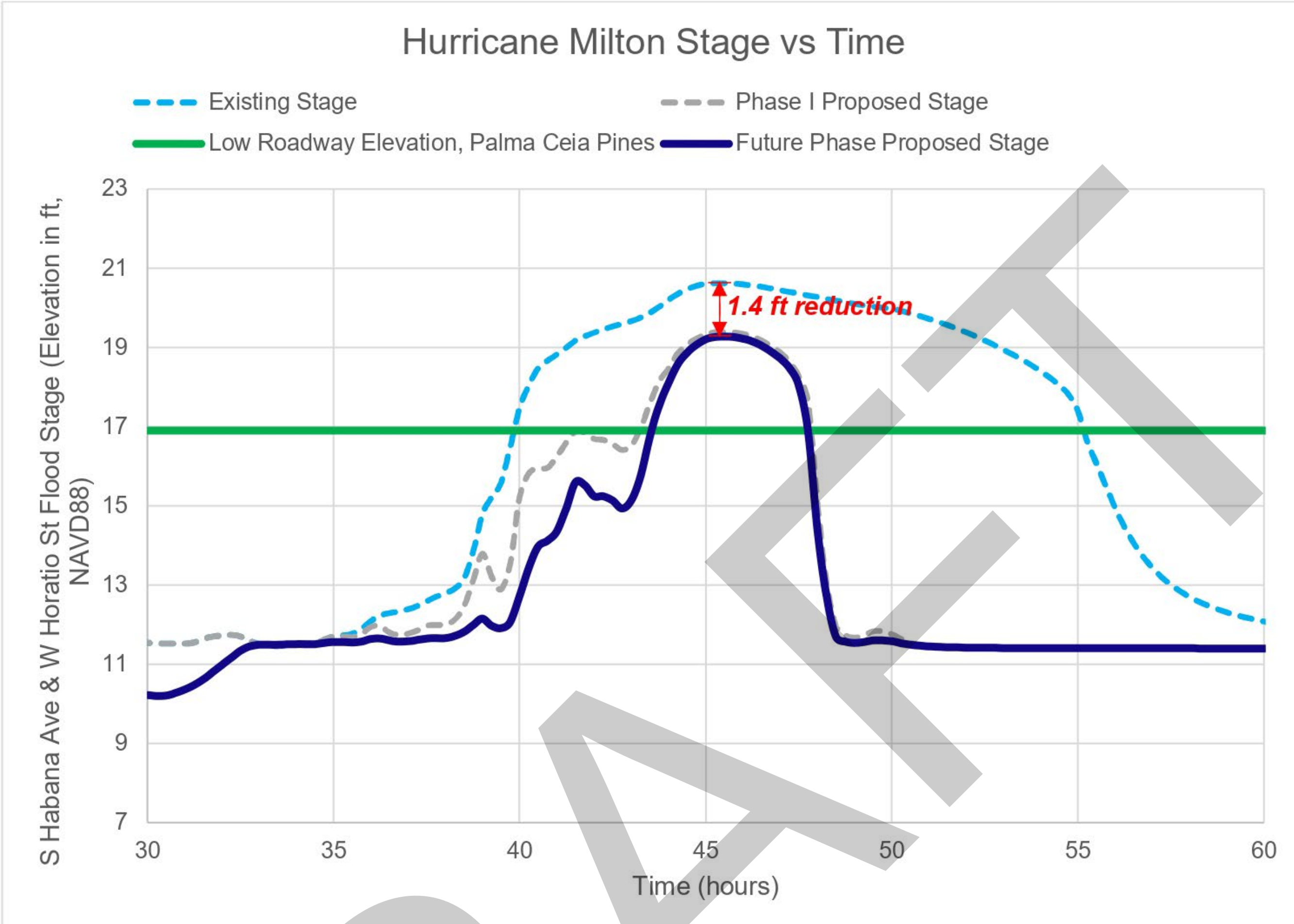

Figure 6-14 – Proposed Hurricane Milton Flood Reduction, Palma Ceia Pines (Future Phase)

A map showing the anticipated Phase I AND future phase reduction in flood extents for the Hurricane Milton simulations can be found below in **Figure 6-15.**

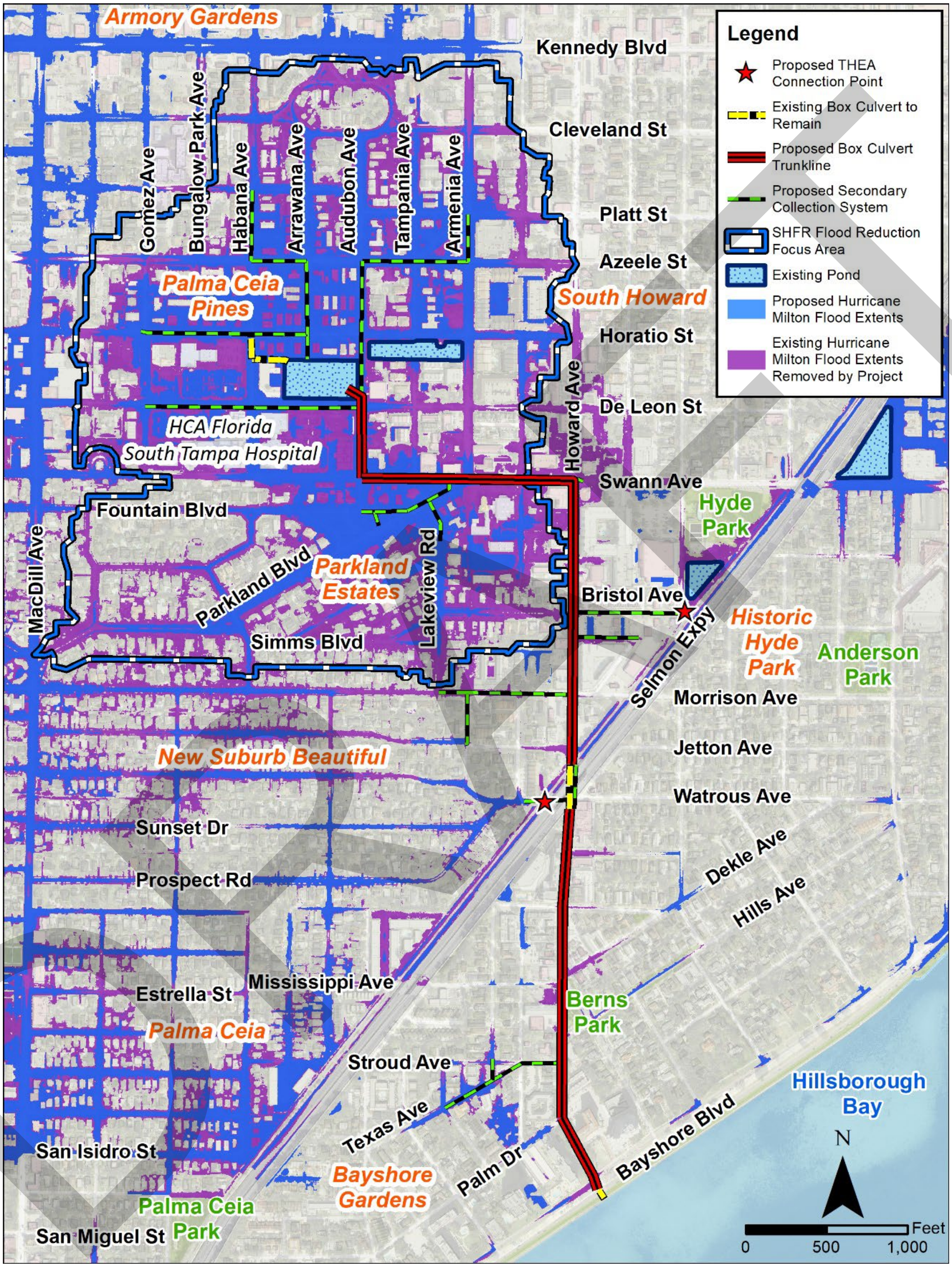

Figure 6-15 – Existing and Proposed (Future Phase) Hurricane Milton Flood Extents Comparison

6.4 Benefit-Cost Analysis

SWFWMD developed a Benefit-Cost Analysis (BCA) tool, in the form of detailed Excel workbook, for use in evaluating stormwater improvement and flood protection projects. The tool requires manual input of data including predicted lengths of roadway inundation, roadway classification and traffic data, estimated (or surveyed, in this case) finished floor elevations, and existing and proposed H&H model results. The tool uses the input data to quantify a dollar amount of predicted damages over the life cycle of the project for both existing and proposed conditions, based on assumptions documented in the tool and the project's H&H modeling results for six 24-hour design storm events. The recurrence interval is used to factor in the annual probability for each storm event and calculate an expected annual dollar value of damages, which is then applied to the service life of the project. **The tool calculates a benefit-cost ratio (BCR) by dividing the total present value of future benefits by the estimated total project cost.**

The tool provides an objective way to compare the monetary benefits of one project versus another. It only considers flood reduction benefits and does not consider other benefits such as water quality and/or socio-economic impacts. The flood reduction metrics used to calculate the project's benefits include:

- Reduction of property damage due to inundation (structures and vehicles)
- Reduction of roadway replacement cost due to repetitive inundation
- Reduction in loss of service cost associated with duration of impassable roadway flooding

This tool was used to complete a phased BCA of the entire selected alternative (W Swann Ave to S Howard Ave), which includes Phase I and the future phase collection systems as two individual BCAs, and then together for one combined BCA.

A detailed estimate of the Phase I construction cost can be found in **Appendix L** and is based on the 30% design. Because the conceptual design of the future phase improvements is subject to change, a formal cost estimate of future phase projects has not been developed for this report, and the estimated range of those projects' costs used was provided by the City. **Estimated project costs shown in each table include construction costs as well as engineering and permitting fees.**

It is important to note that the estimated costs are preliminary, based on present-day economic conditions when this document was written, and are subject to change. It is also important to remember that the future phases include Palma Ceia Pines, as well as other secondary stormwater collection systems that extend beyond the Phase I project corridor (see **Figure 6-1**), and they are subject to change.

The calculated benefits are confined to the model update area, which does not extend far west of S MacDill Ave. The SHFR project will certainly provide benefit to the west of this area, especially along the Cleveland Street Outfall system's primary trunkline, but it is not calculated as part of this exercise. For example, Henderson Blvd between W Horatio St and W De Leon St can expect to see a noticeable reduction in roadway flooding, but it was not included in this analysis. The BCR associated with the project is likely higher than what is quantified in this report, which can be thought of as the lower end of a range of benefits.

A summary of the three separate BCAs performed for the recommended project is shown in **Table 6-7, Table 6-8, and Table 6-9** below.

Table 6-7 – Benefit-Cost Analysis – Phase I only

Expected Annual Damage Without Project	$21,040,904
Expected Annual Damage with Project	$12,496,761
Expected Annual Damage Benefit	$8,544,143
Discount Rate	7.0%
Project Useful Life (# years)	50
Total Present Value of Future Benefits	$117,915,552
Total Project Cost	$99.8M
Benefit/Cost Ratio	**1.2**

Table 6-8 – Benefit-Cost Analysis – Future phases only, with Phase I already complete

Expected Annual Damage Without Project	$12,496,761
Expected Annual Damage with Project	$7,276,528
Expected Annual Damage Benefit	$5,220,233
Discount Rate	7.0%
Project Useful Life (# years)	50
Total Present Value of Future Benefits	$72,043,108
Total Project Cost	$32M to $50M*
Benefit/Cost Ratio	**1.4 to 2.2**

*Future phase project cost estimate range was provided by the City, and is based on present day dollars

Table 6-9 – Benefit-Cost Analysis – Total Project (Phase I and Future Phases)

Expected Annual Damage Without Project	$21,040,904
Expected Annual Damage with Project	$7,276,528
Expected Annual Damage Benefit	$13,764,376
Discount Rate	7.0%
Project Useful Life (# years)	50
Total Present Value of Future Benefits	$189,958,660
Total Project Cost	$132M to $150M*
Benefit/Cost Ratio	**1.3 to 1.4**

*Future phase project cost estimate range was provided by the City, and is based on present day dollars

The phased benefit-cost analysis shows that the majority of structure flooding reduction occurs with Phase I and is more beneficial than the reduction in roadway-associated damages. The future phase benefits rely heavily on reduction of roadway flooding and loss of service due to impassable roadways. For meaningful flood relief for the roadways in Palma Ceia Pines to occur, a new outfall to the bay must be constructed as part of Phase I.

Generally, for larger projects of this size, a BCR greater than 1 provides meaningful justification for implementation. While this project's cost is indeed significant, so are the much-needed flood reduction benefits.

6.5 Streetscape Design

As part of the reconstruction of S Howard Ave, the design-build team is developing a comprehensive streetscape and aesthetics package that enhances full corridor functionality while introducing context-sensitive upgrades suitable for this urban area of significance. The streetscape plan assembles a cohesive set of elements incorporating Complete Streets principles to improve mobility, safety, and overall corridor character. Design development is prioritizing increased walkability, neighborhood enhancement, recognition of the historic district, and the support and promotion of local businesses. The streetscape will be crafted to elevate quality of life and reinforce a strong sense of place for residents and visitors, while integrating safety, sustainability, and long-term maintainability.

The streetscape design approach is unifying all street elements into a coordinated corridor-specific vision. Key components include sidewalk organization, pedestrian circulation systems, enhanced pavement materials, and aesthetic crosswalk treatments. Pedestrian zones incorporate transit stop improvements, potential street furnishings, and integrated signage and lighting systems. Additional features include traffic-calming strategies and enhanced pedestrian safety measures to foster a safer and more comfortable walking environment.

Street tree plantings will be incorporated to provide shade, enhance corridor identity, and support traffic calming. Tree system design considerations include irrigation infrastructure and root-cell technologies to ensure the long-term health and sustainability of urban canopy.

All streetscape elements will follow a unified theme that establishes S Howard Ave as a specific district within Tampa's urban fabric. Paving materials, furnishings, lighting, and all other streetscape components are being selected to reinforce this cohesive identity.

Many of these goals were further refined based on public input received during a formal public meeting held in June 2025. At that meeting, conceptual layouts of proposed streetscape elements were presented along with several potential unifying design styles. The most popular design feature identified by participants was the inclusion of wider sidewalks to enhance the pedestrian experience, while the least favored feature was the addition of on-street parking.

Of the design styles presented, two emerged as preferred options, each suited to different segments of the corridor. The project area is divided by the Selmon Expressway, with the southern portion influenced more heavily by the Hyde Park Historic District and the northern portion characterized by a slightly more urban context. Most participants selected a modern "Industrial Chic" style for the northern section, and a historic "Craftsman" style for the southern section—consistent with the predominant architectural character of the Hyde Park Historic District.

Streetscape development will be fully coordinated with City's Mobility Department and Transportation and Stormwater Operations Division to ensure all proposed improvements meet City requirements and procedures. Coordination will also include reviewing existing and proposed utilities to avoid conflicts. Additionally, streetscape development will be coordinated with HART (Hillsborough Area Regional Transit) regarding any transit stop enhancements.

All streetscape design efforts will follow applicable guidelines from AASHTO and the FDOT Design Manual.

7. Environmental Impacts

The project consists of new underground stormwater infrastructure within a largely developed and urbanized part of South Tampa. Most of the runoff within the project's drainage area is currently discharged to either Old Tampa Bay or Hillsborough Bay with minimal to no treatment. The SHFR project intends to preserve existing stormwater treatment within detention ponds (see **Figure 7-1**), to the extent possible, and intends to provide a net reduction in pollutant loading by introducing green infrastructure solutions. These will be included in the 60 percent design plans and documentation and could include a variety of options such as increased treatment volume within existing ponds, bioretention swales, nutrient separating baffle boxes (NSBB) with filtration media, and permeable pavers as part of the project's streetscape design.

No impacts to wetlands, mangroves, or sea grasses are expected because of the project. The permits necessary to secure project approval from local, state, and federal government will be applied for and navigated by the design-build team during and after the 60 percent design phase.

7.1 Environmental Permitting Requirements

The permitting effort for this project is considered standard and will require coordination with SWFWMD for Statewide Environmental Resource Permitting (ERP), which primarily regulates stormwater management (water quality, water quantity), floodplain impacts, and impacts to wetlands and other surface waters. Most of the permitting requirements for the alternatives proposed are typical in terms of conducting H&H analysis, demonstrating no adverse flood impacts, and quantifying wetland impacts. No freshwater-wetland impacts are anticipated as part of this project.

The project's design will require coordination with SWFWMD regarding previously issued permits associated with the AMI pond and Swann Pond. The SHFR project intends to construct a new outfall for the AMI pond, while preserving its existing treatment function by constructing a weir that matches the existing weir as part of the new outfall. **While the new weir and box culvert outfall from the pond will provide significant capacity for relief during severe rainfall events, it will not change the treatment provided by the pond.**

A virtual pre-application meeting was held with SWFWMD on July 24, 2025 at 11:00 a.m. to get an understanding of anticipated permitting requirements specific to this project. The meeting allowed the opportunity to provide SWFWMD staff with an overview of the project and to discuss applicable permitting considerations and requirements. The proposed improvements will require an ERP Individual Permit.

Because of the anticipated velocity of runoff entering Hillsborough Bay through the existing box culverts beneath Bayshore Blvd, it's recommended that revetment is installed within the bay to prevent scour that will undermine the structural integrity of the existing seawall along Bayshore Blvd. This will most likely consist of rip rap – a layer of large rocks sized to handle the force of wave action and the velocity of stormwater leaving the system during significant rainfall events like the 100-year/24-hour design storm. Any work within the limits of Hillsborough Bay will require a permit from the United States Army Corps of Engineers (USACE), along with a minor work permit from the Hillsborough County Environmental Protection Commission (HCEPC). No impacts to mangroves or sea grasses are expected during the installation of revetment.

Project will need to obtain a Section 404 Clean Water Act permit from the U.S. Army Corps of Engineers (USACE). This will likely be accomplished through verification under Nationwide Permit (NWP) 7 for outfalls and associated intake structures. The Nationwide Permit Program is designed to streamline approvals for certain minor activities. While some NWPs, including NWP 7, require pre-construction notification and verification, this process is expedited and typically completed within three months. Once issued by SWFWMD, the ERP will satisfy Section 401 Water Quality Certification (WQC) under the Clean Water Act. A WQC is required before the USACE will issue a Section 404 permit. Minutes from the pre-application meeting and information relevant to key permits like the AMI Pond and Swann Pond ERPs can be found in **Appendix P.**

Figure 7-1 below provides a conceptual illustration of the proposed culvert's connection to the AMI pond, which will maintain the pond's stormwater treatment capacity and will eliminate the need for the existing pump station that currently recovers the pond's treatment volume.

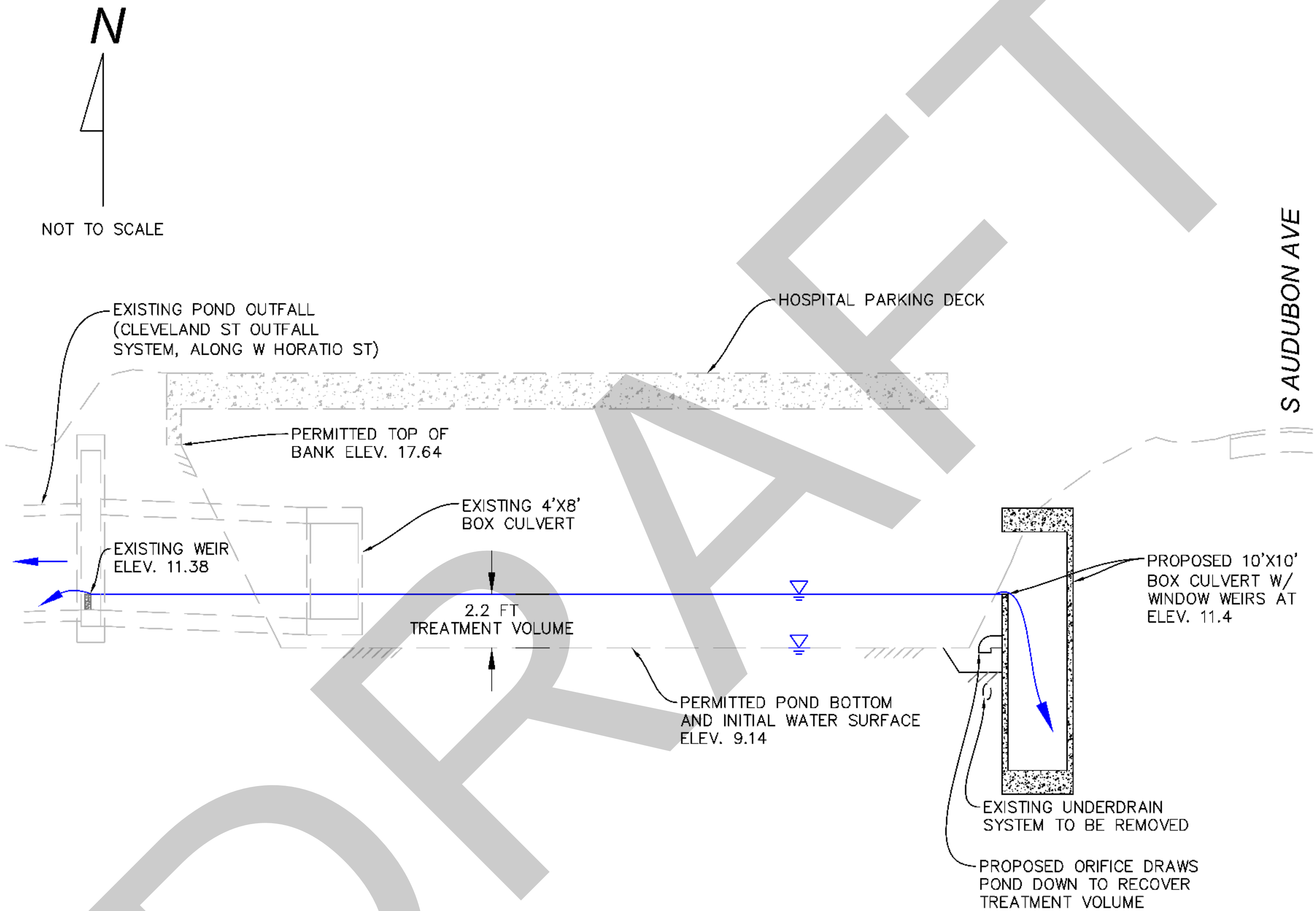

Figure 7-1 – Conceptual Proposed Box Culvert Connection to AMI Pond

7.2 Water Quality Impacts and Green Infrastructure Improvements

Much of the stormwater runoff generated in South Tampa currently discharges straight into the surrounding bays without treatment. The overall water quality goal of the SHFR project is to provide a net reduction in nutrients and other pollutants currently being discharged into Old Tampa Bay and Hillsborough Bay.

The SHFR project has been conceptually designed to preserve existing stormwater treatment to the extent possible without sacrificing the project's flood reduction goal. In instances where preservation of existing stormwater treatment is not realistic, compensatory treatment will be required by SWFWMD to issue an ERP for the project.

This need for compensatory treatment will apply to the portion of S Howard Ave to the south of W Swann Ave that currently drains into Swann Pond, but that will be redirected into the new 10'x10' box culvert after construction of the project. It is important to note, however, that some of the private development within this area already provides permitted stormwater treatment of their own runoff, and that Swann Pond's treatment capacity is limited in comparison to its large drainage area. The amount of compensatory treatment needed will be determined and provided as part of the project's 60 percent design submittal. Design features currently being evaluated **to help preserve existing treatment** include:

- Phase I - A parallel 18-inch diameter pipe system along the north side of W Swann Ave between S Armenia Ave and S Howard Ave, which continues to send stormwater runoff from north of W Swann Ave into Swann Pond during low-flow conditions (when most pollutants are flushed into the storm sewer system)
- Phase I - New weir structures incorporated into the walls of the new 10'x10' box culvert alongside the eastern slope of the AMI Pond that maintains the pond's existing treatment volume. This is illustrated in **Figure 7-1** and was discussed previously in **Section 7.1.**
- Phase I – ZOM Pond's outfall and stormwater treatment function are left alone
- Future Phase – An internal weir structure can be installed underground at the intersection of W Azeele St and S Armenia Ave to preserve treatment of stormwater runoff generated to the south of W Azeele St, provided by ZOM Pond.

Compensatory treatment will be provided by green infrastructure solutions constructed as part of the project, or by increasing treatment capacity within existing ponds by modifying the existing outfall control structures. This is a real possibility for the AMI Pond, whose existing weir controls water surface elevations within the pond approximately 6 feet below the adjacent roadways. Design features currently being evaluated **to provide new stormwater treatment** include:

- Phase I - Nutrient Separating Baffle Boxes (NSBB) – these have been successfully incorporated into several City stormwater projects in recent years. They filter stormwater runoff using a series of screens, baffles, sediment chambers and floating skimmers, all within a single compact structure. One location being evaluated for construction of a NSBB is S Habana Ave at W San Isidro St, as part of the existing 60-inch stormwater trunkline that currently drains Parkland Estates.
- Phase I - Bioretention swale within the open space between W Fountain Blvd and W Parkland Blvd
- Phase I - Permeable pavers that absorb stormwater runoff, as part of the S Howard Ave streetscape design. One potential location for these will be the loading zones dedicated to deliveries to businesses.
- Phase I - There is potential to slightly elevate the existing and proposed weirs that will control water levels in the AMI Pond to increase treatment volume within the pond while maintaining the flood reduction needed to meet the project's goals. This is being evaluated further as part of the 60 percent design, which is typically used to apply for an ERP.

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