CITY OF SEMINOLE

WATERSHED MANAGEMENT PLAN (Q163)

SUMMARY REPORT

JULY 2024

Prepared for:

Southwest Florida Water Management District

City of Seminole

Prepared by:

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1 INTRODUCTION

1.1 Authorization and Purpose

Applied Sciences Consulting, Inc. (CONSULTANT) has been tasked by the City of Seminole (City) under RFQ # 21-0409 with conducting a City-wide Watershed Management Plan (WMP) update. The approved Project Development Plan (PDP) outlines the approach for performing the Watershed Evaluation (1st Phase) as well as subsequent phases; including Model Parameterization, Model Development, Floodplain Analysis, Floodplain Level of Service (FPLOS), and Best Management Practices (BMPs). The City of Seminole WMP will reflect the watershed conditions as of March 17, 2021 (Data Cutoff Date).

1.2 Purpose and Objectives

The study is focused on flood control and water quality improvement projects. This WMP will be used as a tool in the planning, regulation, and management of stormwater for future development and for determining and prioritizing capital improvement projects. The following objectives will guide this project:

- Develop a digital terrain model for the watershed
- Develop an existing conditions watershed evaluation
- Develop an existing conditions hydrologic and hydraulic model and conduct a floodplain analysis
- Conduct a Flood Protection Level of Service (FPLOS) analysis for the watershed
- Conduct a Best Management Practices (BMP) analysis to address water quality and flooding concerns

The WMP update includes limited consideration to the previous 2007 WMP, as the product pre-dates SWFWMD Geographic Watershed Information System (GWIS) standards. A stormwater inventory effort was substantially completed in 2011. The 2011 stormwater inventory data will be utilized for this analysis.

1.3 Project Location and General Description

The City is generally located in the west-central region of Pinellas County with an area of approximately 5.7 square miles (**Exhibit 1**). There are 4 major waterbodies associated with the City watershed: Lake Seminole, Long Bayou, Cross Bayou, and Boca Ciega Bay that separate the watershed into three land areas. The City of Seminole watershed boundary is approximately 12.45 square miles and abuts six (6) other watersheds: McKay Creek to the west, Lake Seminole to the North, Starkey Road, Cross Bayou and Long Bayou to the east, and Coastal Zone 5 to the southwest (**Exhibit 2**).

2 WATERSHED INVENTORY

2.1 Characterization of the Watershed and Tributaries

Most of the City of Seminole watershed is urbanized development, where stormwater runoff is managed through traditional subsurface piping, stormwater management facilities (Detention and Retention ponds), and control structures.

The watershed boundary was developed using the previous 2007 watershed study, as well as District Planning Units, topographic information, aerial imagery, stormwater inventory, Environmental Resource Permits (ERPs), roadway plans, the City's corporate limits, and adjacent watershed studies.

Only two of the six adjacent watersheds have been studied and modeled (**Exhibit 3**), McKay Creek to the west and Starkey Road Basin to the east. To the north is an unstudied portion of the Lake Seminole Watershed and to the South is Boca Ciega Bay that is connected to the Gulf of Mexico. The northern portion of Lake Seminole was connected to the new City model during parameterization.

Topographically, most of the City drains to the City of Seminole watershed towards the large waterbodies, with a portion of the City sloping towards McKay Creek (**Exhibit 4**). The elevations range from sea level in the Bays to 72-feet to the northwestern watershed boundary, referenced to the North American Vertical Datum of 1988 (NAVD88). In the higher areas of the watershed there are a few locations that have been identified to experience percolation, whereas most of the watershed experiences a shallow groundwater table and manages stormwater through lakes, wet ponds, and stormwater conveyance out to Lake Seminole and into Boca Ciega Bay and the Gulf of Mexico.

In terms of water quality basins, the City of Seminole Watershed intersects nine (9) Water Body ID's located within the Springs Coast Group (Group 5), in the Anclote River / Coastal Pinellas County Planning Unit. These include 1618 Lake Seminole, 1618a Lake Seminole Outlet, 1618b Long Bayou Runoff, 1618c Long Bayou/Cross Bayou, 1618d Seminole Bypass Canal, 1633b McKay Creek, 1528b Direct Runoff to Intracoastal Waterway, 1641 Cross Canal (South), And 1694d Cross Bayou Drain (**Exhibit 5**). These WBIDs define the boundaries for state and federal water quality monitoring and assessment, which can lead to regulatory corrective action through the development of Total Maximum Daily Loads (TMDLs) and/or Basin Management Action Plans (BMAPs).

2.2 Digital Terrain Model Development

2.2.1 Topographic Data Source

The baseline LiDAR product selected for this project is the U.S. Geological Survey (USGS) 2018-19 LiDAR data set for Pinellas County. The product was prepared for USGS, performed by Dewberry and Dow Gallagher, and further reviewed and hydro enhanced by SWFWMD in January 2022. The Digital Elevation Model (DEM) meets QL1 standards (Vertical Accuracy RMSEz 10 cm, Nominal Pulse Spacing (NPS) < 0.35 m, NPS density ≥ 8 pts/m2, DEM cell size 0.5 m). It has been approved by SWFWMD for use in WMP and other planning projects. Review of the DEM and QC Ground Survey accuracy checks discussed in the LiDAR Report suggest that it is overall acceptable for modeling purposes in City of Seminole.

2.2.2 Horizontal and Vertical Datum

The vertical datum for all data is North American Vertical Datum of 1988 (NAVD88 (2012)) with 2012 adjustment and the horizontal datum is North American Datum of 1983 with the 2011 Adjustment (NAD 83 (2011)). The Coordinate System is FL State Plane Zone West (0902) in US Survey Feet NAVD88 High Accuracy Reference Network (HARN).

2.2.3 Topographic Errors and Voids

The DEM was reviewed against the Pinellas County 2021 Aerial Imagery and 2021 ERP locations for Topographic voids related to stale surface data compared to the Date Certain. It was determined that for the purposes of this study, one recent development resulted in a DEM adjustment based on topographic lines of the building plans (**Figure 1**). No voids were identified based on poor data collection and/or poor LiDAR Processing, as would be expected based on SWFWMD review and hydro-enhancement. **Exhibit 4** shows the enhanced DEM within the watershed boundary.

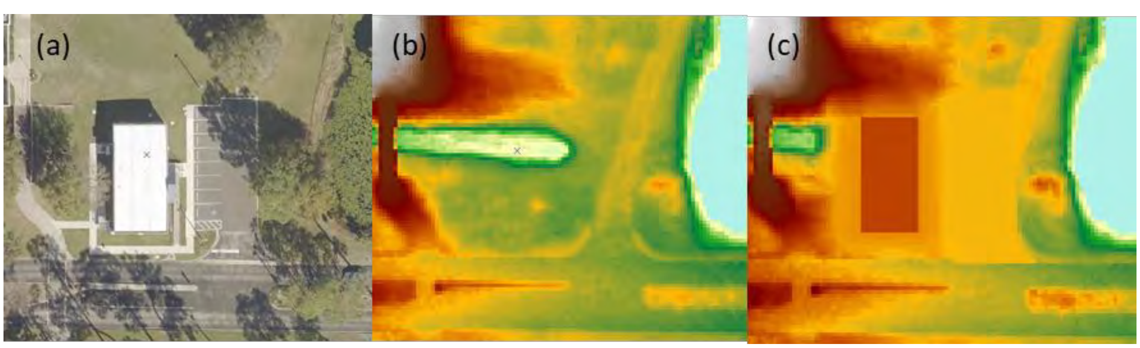

Figure 1 (a) Aerial of exemplary recent development, (b) original DEM, (c) adjusted DEM

2.3 Hydrologic Inventory

2.3.1 Watershed Boundary

The watershed boundary totals approximately 12.5 square miles, which was determined based on the previously established watershed boundary, the current terrain (DEM), and City stormwater inventory. The watershed contains the entire municipal area of the City of Seminole as well as contributing area from unincorporated Pinellas County. The northwest section of the watershed overlaps with McKay Creek WMP and the area east of Lake Seminole with Starkey Road Basin WMP. Boundary conditions will be set up to account for flow between the Seminole, McKay Creek, and Starkey Road Basin watersheds. The watershed boundary and the existing model boundaries of the two other WMPs are shown in **Exhibit 3**. During model parameterization, the watershed boundary was extended in some areas to address boundary conditions.

2.3.2 Catchment Delineation Process

Subbasin (catchment) delineation for the City of Seminole watershed was performed using Arc Hydro Tools version 10.6.0.83. Catchments were delineated for contributing areas to hydrologically significant private and public stormwater facilities, Drainage Retention Areas (DRA's), natural depressions, and the primary drainage systems (**Exhibit 6**). The delineation process was performed through manual sink selection using desktop review of the DEM, ERP's, stormwater inventory, aerial photography and Google Street View. The criteria for catchment delineation (size and depth) as documented in SWFWMD Guidelines and Specifications (SWFWMD 2020) were followed.

Select areas required conditioning of the DEM to represent the designed flow patterns. This is because the DEM does not recognize small curbs, subsurface drainage, or other small hydraulic features. In these cases, the DEM was conditioned by manually adding walls and burning pipes to aid the catchment delineation process.

During model parameterization, catchments were reviewed, and a few adjustments were made upon moving to the model scale. Although there are several small catchments (< 0.1 acre), these were deemed necessary to capture the level of detail required to model a highly urbanized system. Adjustments to the model simulation parameters (numerical modeling sensitivity parameters) were considered during model development. Considerations for model runtime, flow instabilities, and stage area extrapolations were addressed through adjustment of the model simulation parameters.

2.3.3 Sub-watersheds

The Seminole watershed was divided into four main sub-watersheds based on their drainage characteristics (**Exhibit 6**). These were labeled as sub-watersheds A through D. An additional area, north of the City, was added to the model and labeled as North. See **Section 3.4** for more information.

Sub-watershed A are the areas in the southeast that drain directly into Long Bayou and Cross Bayou, Sub-watershed B in the southwest drains into Boca Ciega Bay. A and B are subject to tidal changes. Sub-watershed C discharges to Lake Seminole, the catchments are mostly west of the Lake, as well as a few catchments on the northeast. Sub-watershed D in the northwest discharges to McKay Creek (see **Table 1** for characteristics of the sub-watersheds). In all four sub-watersheds the primary land use is high density residential.

Table 1 Sub-watersheds

Sub-Watershed	Total Acres	Number of Subbasins	Average Subbasin Size (ac)
A	2,056	500	4.11
B	532	139	3.83
C	3,429	494	6.94
D	1,285	273	4.71
North	689	7	98
Total	**7,991**	**1,413**	**5 ***

* Average excludes basins from the North region

2.3.4 Soils Characterization

The soil characteristics in the watershed were retrieved from the Natural Resources Conservation Service (NRCS) Web Soil Survey for City of Seminole (**Exhibit 7**). One third of the watershed is hydrologic soil group A, well-drained, which has low runoff potential and 6% hydrologic soil group B, moderately well-drained. The following table displays the distribution of soil hydrologic groups throughout the watershed. This table includes all land contributing to the watershed, including the northern Lake Seminole and Starkey Road areas.

Table 2 Soil Types in City of Seminole Watershed

Hydrologic Soil Group	Area (ac)	Percentage of Watershed
A	2524	31.58
A/D	4137	51.77
B	456	5.71
B/D	80	1.00
C/D	22	0.28
Water	772	9.66
Total	**7,991**	**100 %**

Approximately sixty percent inside the watershed are constituted of soil group A/D, B/D, and C/D. Soils with dual classification vary in their hydrologic response based on seasonality of the water table and/or man-made drainage improvements. For hydrologic modeling purposes, dual classification soils are conservatively associated with low drainage and high-water tables.

2.3.5 Land Use Characterization

The 2020 land use data was obtained from SWFWMD and reviewed to identify changes between then and the cut-off date of this study using the 2021 aerial imagery and ERP plans. As the watershed is already widely developed, the 2020 conditions generally reflect current conditions. A couple of roadways were updated as transportation. Additional updates may occur during the model verification and calibration process. The updated (2021) land use coverage is shown in **Exhibit 8**. A breakdown of land use coverage is listed in **Table 3** and summarized in **Table 4**. Over 80% of the watershed consists of urban land uses. More specifically, most of the developed areas consist of high and medium density residential areas (60%), Commercial and Services (8%), Institutional (5%), Recreational (4%), and Transportation (3%). Waterbodies make up almost 9%. The remaining 11% are a mix of other natural and developed land uses.

Table 3 Land Uses in City of Seminole Watershed

Top 5 Land Use Categories are Highlighted

FLUCCS	Land Use Description	Manning's Roughness	Area (ac)	Percentage of Watershed
1300	Residential High Density	0.15	4546.76	56.90
5200	Lakes	0.045	627.06	7.85
1400	Commercial And Services	0.2	537.34	6.72
1700	Institutional	0.11	385.93	4.83
1200	Residential Medium Density	0.11	328.17	4.11
1800	Recreational	0.045	270.94	3.39
5300	Reservoirs	0.045	254.63	3.19
8100	Transportation	0.2	250.91	3.14
1820	Golf Courses	0.045	101.76	1.27
1900	Open Land	0.045	97.81	1.22
1410	High Intensity Commercial	0.2	91.79	1.15
1100	Residential Low Density	0.09	86.82	1.09
4110	Pine Flatwoods	0.09	78.22	0.98
1500	Industrial	0.2	69.10	0.86
6410	Freshwater Marshes	0.045	63.21	0.79
6300	Wetland Forested Mixed	0.075	42.46	0.53
6440	Emergent Aquatic Vegetation	0.045	35.21	0.44
6400	Vegetated Non-Forested Wetlands	0.075	32.92	0.41
2500	Specialty Farms	0.045	26.73	0.33
6150	Stream And Lake Swamps (Bottomland)	0.045	13.48	0.17
7400	Disturbed	0.045	12.99	0.16
5100	Streams And Waterways	0.045	10.70	0.13
8300	Utilities	0.11	9.68	0.12
1350*	Historical Condominium	0.11	4.50	0.06
6120	Mangrove Swamps	0.075	3.66	0.05
6430	Wet Prairies	0.045	3.13	0.04
2400	Nurseries And Vineyards	0.045	1.99	0.02
4340	Upland Hardwood - Coniferous Mix	0.12	1.97	0.02
6530	Intermittent Ponds	0.045	0.80	0.01
3200	Shrub And Brushland	0.09	0.29	< 0.01
4300	Upland Hardwood Forests - Part 2	0.09	0.02	< 0.01
5400	Bays And Estuaries	0.045	0.01	< 0.01
	Total		**7,991**	**100.00%**

* Established new land use category for older condominium locations

Table 4 Land Use Summary

FLUCSS Series	Land Use Description	Area (ac)	Percentage of Watershed
1	Urban and Built-Up	6520.94	81.61
2	Agriculture	28.70	0.36
3	Rangeland	0.02	0.00
4	Upland Forests	80.50	1.01
5	Water	892.39	11.17
6	Wetlands	194.87	2.44
7	Barren Land	12.99	0.16
8	Transportation, Communication, Utilities	260.60	3.26
	TOTAL	**7,991**	**100.00**

2.3.6 Existing Floodplain Characterization

Approximately 28% of the Seminole watershed are located within FEMA effective Floodplains (AE). Zone AE is stretching from north to south along Lake Seminole and the Bayous including almost the entire area northeast of Lake Seminole and Long Bayou. These statistics were derived from the FEMA National Flood Hazard Layer (NFHL) with an effective date of October 7th, 2021. Based on our review, these floodplain areas are strictly based on coastal flood risk, and do not account for inland/precipitation-based flooding. A graphic of the FEMA floodplain is provided in **Exhibit 9**.

2.3.7 Historical Conditions

The Historical Water Levels (HWL) database has been obtained from the District and was saved in the geodatabase. Additional flood related data can be found in the Support folder. Additional highwater mark data was also included in this feature dataset.

Table 5 lists currently active monitoring stations in the watershed. The outflow of Lake Seminole at Park Boulevard is the only location within the City of Seminole watershed with historical water level measurements identified (USGS 02308889). In terms of water quality, Pinellas County has one current monitoring site (SB-A-03-01) in the watershed, in the South part of Lake Seminole. The NOAA Tidal station closest to City of Seminole is Clearwater Beach, FL - Station ID 8726724. It is in the Gulf of Mexico, which will support setting boundary conditions for the Calibration and Verification model simulations.

Table 5 Water Monitoring Stations

Station ID	Station Name	Data	Data Source	POR Dates
02308889	Seminole Lake Outlet Near Largo Fl	Gage height	USGS	10/01/2007-present
SB-A-03-01	Lake Seminole South	Water Quality parameters	WIN_21FLPDEM / Pinellas County	01/15/2003 - 05/16/2022
8726724	Clearwater Beach, FL	Tidal data	NOAA/NOS/CO-OPS	04/19/1973-present

2.3.8 Hydrologic Parameterization

The Interconnected Channel and Pond Routing (ICPR) version 4.07.08 software will be used to analyze the hydrology and hydraulics of the watershed. The Green-Ampt rainfall excess method will be used to determine infiltration and calculate runoff that will be hydraulically routed. Additional discussion regarding modeling parameterization is covered in **Section 4**.

Applied Sciences and the SWFWMD worked together to create the District's Soil Data Retrieval and Processing Excel Program (Yang 2019), which generates more accurate and consistent hydraulic soil parameters for ICPRv4 input. The soil characteristics originate from the 2018 Soil Survey Geographic Database (SSURGO) information from NRCS. They will be used to determine soil moisture content within the profile based on estimates to the depth of the water table. Soil parameters will be assigned through the SSURGO soil layer and the District Soil Data tool. The assigned depth to water table from the tool will be verified against site specific locations, if available. Additionally, site specific adjustments to the soils layer may occur when warranted, with proper justification and documentation provided. Final adjustments to soils may occur during model calibration.

2.3.9 QA /QC Process Description

In compliance with the SWFWMD G&S, a visual inspection of each basin delineation, soils classification, and land use classification has been performed. This process compares these data to the DEM and the aerial photographic, provided by the District to validate their reasonableness.

2.4 Hydraulic Feature Inventory

2.4.1 Hydraulic Feature Inventory Development

The current stormwater 2011 inventory from the City of Seminole was provided and served as a starting point to build the hydraulic feature inventory. The hydraulic structures recorded in the watershed were compiled and organized in a geodatabase labeled "Stormwater_Inventory" in the Support folder (**Exhibit 10**).

An ERP layer provided by the District was reviewed for recent developments within the watershed and used to assess, update, and extend the stormwater inventory database. Approximately 319 ERP permits were reviewed, out of which 272 were found to contain fully or limited relevant and legible data. In addition, data was extracted from several road plans provided with the 2011 Inventory data. Further, selected data from McKay Creek (2014), Seminole (2007), and Starkey Road Basin (2013) models were transferred into the inventory database. **Exhibit 11** shows the locations of utilized ERPs.

The desktop data collection efforts provided a complete stormwater feature inventory with almost 11,800 hydraulic features, within the watershed boundary. This stormwater inventory was then simplified into the model specific hydraulic inventory that only includes relevant, primary stormwater structures. For example, stormwater infrastructure that was removed from the inventory include hydraulic structures that are internal to a commercial development or neighborhood, stormwater laterals along a roadway, and other small pipes that may be internally drained within a delineated catchment.

There are approximately 1,800 stormwater pipes and 250 control structures (both structural weirs and drop structures) to be included in the hydraulic model. These are structures that have been deemed to be a critical conveyance feature. Only the structures to be represented within the watershed model without existing data have been considered for site survey. The precise feature counts may change upon further development and model refinement.

2.4.2 Summary of Conveyance Features

The primary conveyance in the watershed occurs through pipe and culvert systems, as well as overland flow, with around 20 channel sections requiring modeling. The Lake Seminole outfall structure is a major structure that connects the Lake Seminole drainage area to tidal systems. The other major conveyances systems are McKay Creek and the Lake Seminole Bypass Canal.

2.4.3 Summary of Water Body Features

A water body feature class was compiled as part of the LiDAR development project and saved in the GWIS geodatabase. 84 waterbodies were identified in this feature class, including Long/Cross Bayou (818 acres) and South Lake Seminole (402 acres). 51 of the other 82 waterbodies are larger than 1 acre, the remainder are below 1 acre. Through additional review of the watershed, additional "open water surface" features were identified and added to the GWIS_WATERBODY feature class. These features will help aid in setting initial stages during model development.

2.4.4 Field Reconnaissance and Drainage Verification

Field data acquisition needs were determined based on analysis of DEM topography, aerials and pre-field reconnaissance, and found necessary where data or drainage patterns required for modeling were missing or could not be verified from available plans. This resulted in 100 field reconnaissance points to be visited by ASCI staff. Tasks include clarifying drainage in specific areas and confirming or correcting anticipated stormwater routing, as well as collecting or verifying structure data other than invert elevations. If during the field reconnaissance critical structures are identified that miss invert elevations, they will be surveyed In House. For quality control, additional hydraulic structures may be visited to spot check and verify data from the inventory or building plans (**Exhibit 12**).

2.4.5 Topographic Survey

Critical stormwater structures with missing or inconclusive invert elevations were identified for survey. Pipe related structures will be surveyed to determine dimensions, invert elevations, material, location and end treatments (headwalls, mitered, etc.). Weir structures will be surveyed for invert elevations, dimensions, shape and material. Photos will be taken for each surveyed structure and conditions limiting the function of the structure will be recorded.

210 structures were identified for In House survey and will be conducted by ASCI. In addition, swales or smaller channels may be surveyed if deemed necessary. In-house hydraulic feature data collection will be conducted using a Trimble Catalyst DA2 Receiver mounted on a 2-meter carbon fiber pole. If necessary, the pole can be equipped with an 18” horizontal offset to collect offset points within inlets or manholes. The receiver is paired with a Trimble TDC600 data collector using the Android operating system. Real time GNSS corrections are performed using the Trimble Corrections Hub (TCH) through a Trimble Catalyst 1 subscription. Depending on the collection location, TCH will determine the appropriate correction service - including Trimble VRS Now and Trimble RTX services. The Catalyst 1 subscription provides centimeter-level vertical accuracy down to 1 cm (0.032 ft or 0.39") providing that an adequate number of satellites are not obstructed by buildings or overhead foliage. The data collection software consists of ESRI Field Maps in conjunction with ArcGIS Online and the Trimble TerraFlex software. Using this software, field observations are collected and stored in a user defined schema on the cloud with the option of collecting a georeferenced photograph or video which is attached to the collected record.

58 structures were identified for professional survey by a sub-contractor, these included major conveyance features and structures in locations with heavy tree cover or difficult access. In addition, survey of cross-sections was requested for one channel section (Lake Seminole Bypass Canal) which is considered a major conveyance system. It will be

surveyed at a representative cross-section of the channel from at least 10 feet outside of the top-of-bank on both sides of the channel, and will include survey points at top-of-bank, toe of slope, other grade break points, water surface, and lowest invert.

Suncoast Land Surveying was contracted by Applied Sciences to perform this survey for the Seminole watershed field data collection effort. Horizontal and vertical hydraulic feature data will be acquired for pipes, control structures and channel cross sections.

All measurements will be in state-plane coordinates and reference North American Vertical Datum of 1988 (NAVD88). Surveyed elevations of structures are reported to 0.01 feet with a vertical accuracy certified to +/- 0.20 feet or better and cross sections will be reported to 0.01 feet with a vertical accuracy certified to +/- 0.25 feet or better.

The feature class associated with the survey request can be found in the Support Folder. AutoCAD Civil3D files and a spreadsheet will be prepared by the surveyor.

2.4.6 Hydro Network and HEP Network

Using the Arc Hydro tool process and the previously developed hydraulic feature (stormwater) inventory, the HydroNetwork (**Exhibit 13**) and HEP Network (**Exhibit 14**) were developed in accordance with the District Guidelines.

The HydroNetwork is used to establish connectivity between features to identify which direction water flows. The HydroNetwork is comprised of HydroEdge and HydroJunction feature classes, which are limited to modeled bridges, channel conveyances, and pipe and control structure conveyances. It also contains the Boundary Condition nodes.

The HEP Network is used to define sub elements (culverts, weirs, etc.) from the HydroNetwork, and to store specific structure data. The HEP Network is comprised of Hydraulic_Element_Point and HEP_Line feature classes, which are limited to modeled bridges, pipes, and control structure conveyances. The HEP features were created using the HydroNetwork, in a manner consistent with Appendix B4 of the District Guidelines and Specifications. A hyperlink to building plans providing respective structure data was added to the HEP_Line feature class.

Pipe Barrel and Weir tables in the GWIS geodatabase were populated with the stormwater inventory data and linked to HydroNetwork and HEP Network. Remaining data gaps such as pipe invert elevations will be filled with the data from the topographic survey (see section **2.4.5**).

The Hydronetwork was applied to develop the preferential flow links and nodes that will serve as the preliminary model network.

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3 PRELIMINARY MODEL FEATURES AND PARAMETERIZATION APPROACH

Preliminary model features were created from the Arc Hydro output, ERP's, and surveyed hydraulic structures. These features currently include approximately 1,403 basins, 2,057 nodes, 25 channel links, 192 drop structures (contain both structural weirs and pipes), 1,772 pipes, 33 structural weirs, 3897 irregular overland weirs and 40 percolation locations. These numbers could change pending comments from Peer Review and future public input/engagement.

The City of Seminole Watershed model parameterization approach follows the protocols and procedures contained within District WMP Guidance documents. See **Exhibit 16** for the overall model network and **Exhibit 17** for the 100-year, 24-hr model results.

3.1 Rainfall Excess

3.1.1 Time-of-Concentration (TC)

Arc Hydro was used to determine the travel time of a droplet of water based on the longest flow path generated. The time of concentration routine follows the TR-55 methodology provided by the NRCS. Since the D8 flow method is used to calculate the longest flow path, some straightening is required. Most of the catchments exhibit short time of concentrations due to their small size and high impervious coverage. The shortest TC will be limited to ten (10) minutes.

Several raster surfaces were generated to assist with the time of concentration calculations. The toolsets require a slope surface, derived from the DEM, and adjusted to represent length/length (ft/ft) units. Furthermore, a land use surface was developed based on the FLUCCSCODE designations throughout the watershed. A Manning's roughness value was then applied to each FLUCCSCODE based on engineering judgement and consultation with reference resources. For example, a heavily vegetated land use designation might be assigned a larger roughness coefficient compared to a less restrictive land use. Additionally, a paved versus unpaved surface was developed. Although an imperviousness coverage was not available for this watershed, one was constructed by combining a variety of sources. First, street polylines were reviewed, and variable buffer distances were established. For example, a local street might be assigned a buffer distance of 15 feet, while a larger collector road would have a buffer distance of 30 feet. Building footprints were added to this pseudo-impervious coverage dataset. A union step was performed to "fill in" the rest of the surface with unpaved areas. This paved/unpaved surface was used as input to the Arc Hydro time of concentration tools for the shallow concentrated flow regimes.

Finally, TC lines or longest flow path lines were clipped at open water bodies. The flow path tends to extend all the way to the storage node, but this would incorrectly increase the flow path length. Initial stage polygons and specific land use designations (reservoirs, wetlands, etc.) were used to assist with clipping the TC lines to shorter lengths when applicable. Some pipe and channel features were also added to the overall TC calculation. Pipes were assumed to flow at a specific velocity, while LiDAR derived cross sections were used to calculate channel geometries for velocity calculations. See the Watershed Evaluation support data folder for final TC calculations and GIS products.

3.1.2 Unit Hydrograph

The NRCS Unit Hydrograph Method was used to distribute runoff volume over the duration of the storm. Runoff rates and timing are controlled by the hydrograph shape factor and the TC. The standard peak factor of 256 recommended by SWFWMD has been determined to be appropriate for the City of Seminole watershed.

3.1.3 Design Storms

An initial model was developed, stabilized, and debugged using the no rainfall and 100-year 24-hour events. Once model verification and calibration are performed and validated, the 2.33-year, 5-year, 10-year 25-year, 50-year, and 100-year, 24-hour events will be modeled. The source for the rainfall depths is the National Oceanic and Atmospheric Administration (NOAA) Atlas-14 produced by National Weather Service (NWS). **Table 6** shows both NOAA and, as a comparison, SWFWMD rainfall depths for the mentioned rainfall return periods. The sources of the rainfall distributions are specified in the SWFWMD ERP Applicant's Handbook Volume II Design Requirements PART VI Section 6.3 Rainfall Distribution. These utilize the Florida Modified Type II distribution and are also included in Appendix A of the handbook (Project Design Aids). The Florida Modified Type II distribution is being applied per direction by the District on other recent Watershed Management Plans, consistent with understanding of recommendations from the Stormwater Rulemaking Technical Advisory Committee (TAC) in 2021. The 100-year, 5-day (120-hour) event will also be modeled using the NOAA Atlas-14 rainfall volumes with the rainfall distribution from the SWFWMD WMP Guidelines and Specifications Appendix E Rainfall and Distributions.

Areas where flood levels are sensitive to the peak rates of runoff, the 24-hour rainfall will be most critical due to the associated Florida Type II Modified Distribution for the event that generates rainfall intensities similar to a major short-term duration thunderstorm. The

120-hour rainfall will be critical in areas that have limited storage and no outfall resulting from the higher volume of rainfall.

Rainfall volumes for the 100-year 24-hour and 120-hour events are 13.4-inches and 18.73-inches respectively.

Table 6 Simulated Rainfall Events

Rainfall Event		Rainfall (Inches)		Distribution
Year	**Duration**	**NOAA**	**SWFWMD (Reference)**	
2.33	24-hour	4.75	4.5	Florida Modified Type II 24-Hour
5		5.96	6.0	
10		7.22	7.5	
25		9.32	9.0	
50		11.2	10.0	
100		13.4	11.5	
500		19.5	15.0	
100	5-day	18.73	19.2	SWFWMD 120 Hour

For the final deliverables, Applied Sciences simulated the SWFWMD rainfall volumes for the 25 and 100 Year, 24 Hour events for potential reference in the future. These specific storms are often related to current SWFWMD permitting requirements.

3.1.4 Calibration and Verification Storms

USGS Station 02308889 “Seminole Lake Outlet near Largo FL” and USGS 02308870 “Pinebrook Cn at Bryan Dairy Rd at Pinellas Park FL” as well as NEXRAD data were reviewed for the most recent storm events with high impact in Pinellas County, including the City of Seminole watershed. An unnamed storm event that occurred August 13 - 17, 2019 will be used as the calibration event for the model and Hurricane Hermine (August 31 - September 03, 2016) will serve for model verification. **Figure 2** shows total rainfall depths in the NEXRAD cells as well as precipitation measured at the closest USGS station during these events.

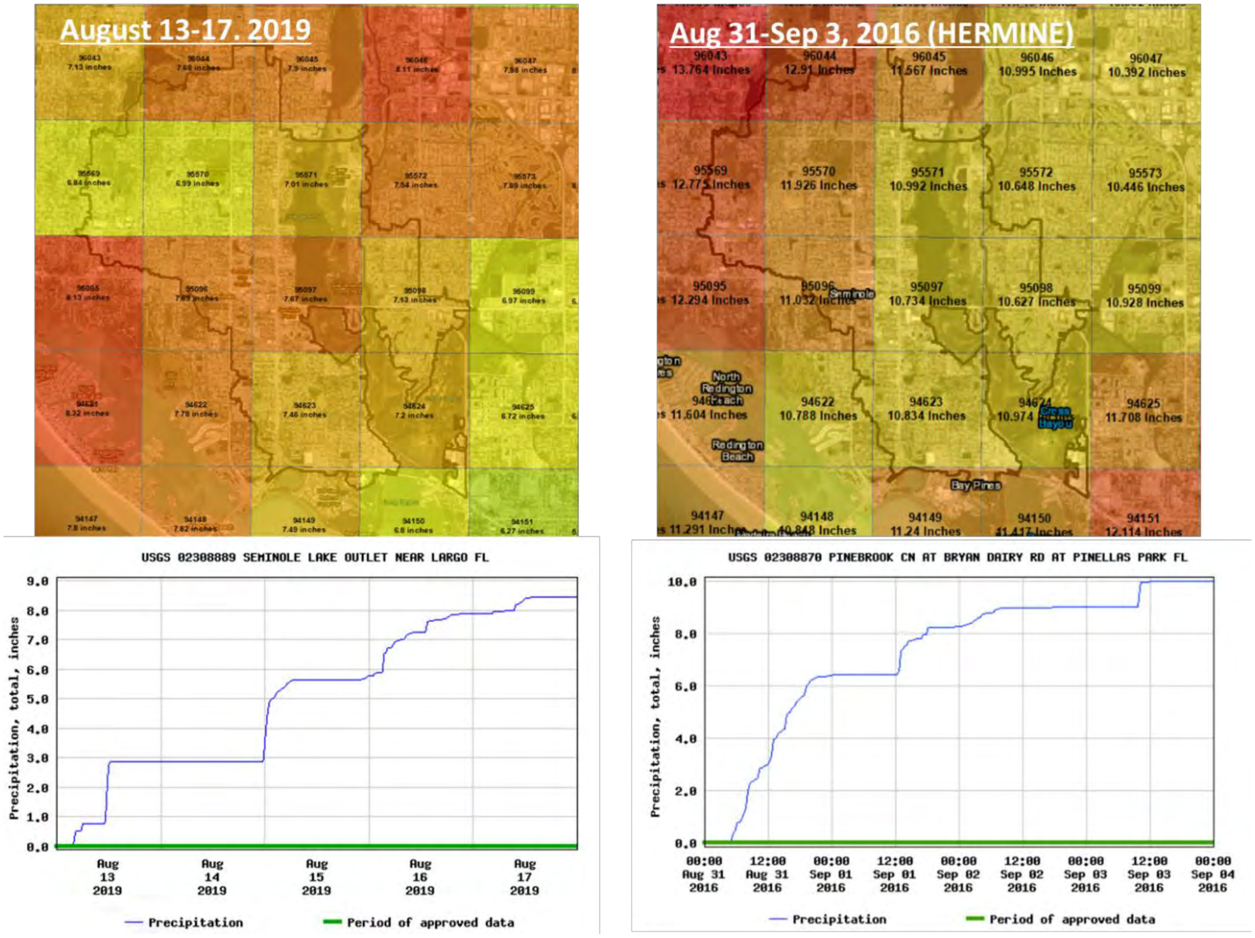


Figure 2 Calibration and Verification Storms

3.1.5 Lookup Tables

The land use lookup table is based on the Florida Land Use and Cover Classification System (FLUCCS, see **Table 7**). Typical values of Percent Impervious Area and Directly Connected Impervious Area (DCIA) for each land use in the region were reviewed and adapted to the specific characteristics within the Seminole watershed. During model parameterization, some small changes were made to the land use designations where appropriate. Mainly, reservoirs or open water surfaces were added. Table 7 represents the final lookup values used in the ICPR4 model.

Table 7 Impervious Sets (Land Use) Lookup Table

FLUCCS Code	Land Cover Type	% Impervi ous	% DCIA	% Direct	Initial Abstraction Impervious (In)	Initial Abstraction Pervious (In)
1100	Residential-Low Density	10	0	0	0.1	0.1
1200	Residential-Med Density	20	5	0	0.1	0.1
1300	Residential-High Density	65	50	0	0.1	0.1
1350	Historical Condominium	50	40	0	0.1	0.1
1400	Commercial	70	50	0	0.1	0.1
1410	High Intensity Commercial	95	90	0	0.1	0.1
1500	Industrial	70	68	0	0.1	0.1
1700	Institutional	65	55	0	0.1	0.1
1800	Recreational	35	25	0	0.1	0.1
1820	Golf Courses	5	2	0	0.1	0.1
1900	Open Lands	0	0	0	0.1	0.1
2400	Nurseries and Vineyards	10	5	0	0.1	0.1
2500	Specialty Farms	10	5	0	0.1	0.1
3200	Shrub And Brush Rangeland	0	0	0	0.1	0.1
4110	Pine Flatwoods	0	0	0	0.1	0.1
4300	Upland Hardwood Forests	0	0	0	0.1	0.1
4340	Upland Hardwood - Coniferous Mix	0	0	0	0.1	0.1
5100	Streams and Waterways	100	100	0	0.1	0.1
5200	Lakes	100	100	0	0.1	0.1
5300	Reservoirs	100	100	0	0.1	0.1
5400	Bays And Estuaries	100	100	0	0.1	0.1
6120	Mangrove Swamps	100	100	0	0.1	0.1
6150	Stream and Lake Swamps (Bottomland)	100	100	0	0.1	0.1
6300	Wetland Forested Mixed	100	100	0	0.1	0.1
6400	Vegetated Non-Forested Wetlands	100	100	0	0.1	0.1
6410	Freshwater Marshes	100	100	0	0.1	0.1
6430	Wet Prairies	100	100	0	0.1	0.1
6440	Emergent Aquatic Vegetation	100	100	0	0.1	0.1
6530	Intermittent Ponds	100	100	0	0.1	0.1
7400	Disturbed	0	0	0	0.1	0.1
8100	Transportation / Utilities	65	60	0	0.1	0.1
8300	Utilities	5	2	0	0.1	0.1

The Soil Lookup Table values are taken directly from the SWFWMD Soil Data Retrieval and Processing Tool (Version 2.0) which utilizes a combination of NRCS SSURGO and University of Florida/Institute of Food and Agricultural Sciences (UF/IFAS) soils information to establish the most representative parameterization to reflect infiltration and runoff potential (**Table 8**). The Map Unit Key (MUKEY) obtained from the NRCS soils layer is the input and one-tenth bar is used for field capacity estimation. When comparing the assigned vertical conductivity against the equivalent published SSURGO information, the assigned values are typically at or below the SSURGO established Representative Value (RV) for the same soil type. The conductivity values and other parameters may be adjusted during the calibration and verification process, as needed. Any adjustments during model calibration and verification will include supporting documentation before carrying forward with design storm event simulations. Soil adjustments will be geared towards achieving better model calibration to observed data. It is assumed that the soils parameters defined through the model calibration effort will be used in the final design storm simulations.

Applied Sciences further reviewed the recommended Green-Ampt soil parameter development workflow provided by the ICPR4 documentation. The workflow involves extracting data directly from the NRCS Web Soil Survey online resource. In general, the overall Green-Ampt parameters appear similar to that of the SWFWMD Soil Data Retrieval and Processing Tool; however, the approaches differ in one key aspect – Initial Moisture Content. The ICPR4 documentation recommends setting the initial moisture content to field capacity, while the SWFWMD Soil Data Retrieval tool calculates initial moisture content based on the depth to water table. The SWFWMD approach introduces the phenomenon of soil capillarity, where the water table influences the initial moisture content. As the depth-to-water-table decreases, the initial moisture content increases. As a result, the overall available soil storage at the time of model execution is much less than the ICPR4 approach. One can calculate a rough estimate for overall soil storage by subtracting the initial moisture content from saturated moisture content and multiplying by the depth-to-water-table. Applied Sciences compared these values in the table below:

ICPR4 Method (Soil Storage, inches)	SWFWMD (Soil Storage, inches)
156	67

It is important to note that these two approaches can serve as a starting point before model calibration and verification. Adjustments to initial moisture content and depth to water table during the calibration phase are often necessary to align with observed conditions.

Table 8 Green-Ampt Soil Parameters

MUKEY / Soil Zone	Soil Name	Kv Sat. ft/day	MC Sat.	MC Res.	MC Initial	MC Field	MC Wilting	Pore Size Index	Bubble Pressure	Allow Recharge	WT Initial
1017080	ADAMSVILLE SOILS AND URBAN LAND, 0 TO 5 PERCENT SLOPES	9.54	0.376	0.007	0.088	0.088	0.014	0.6	2.03	No	3.092
1017083	ANCLOTE FINE SAND, DEPRESSIONAL	6.04	0.421	0.018	0.162	0.162	0.036	0.52	1.67	No	0.033
1017085	PINEDA SOILS AND URBAN LAND	8.17	0.575	0.046	0.353	0.353	0.065	0.52	0.63	No	0.033
1017086	FELDA FINE SAND, DEPRESSIONAL	9.98	0.477	0.042	0.222	0.222	0.044	0.56	1.06	No	0.262
1017087	FELDA SOILS AND URBAN LAND	9.98	0.477	0.042	0.222	0.222	0.044	0.56	1.06	No	0.262
1017089	MANATEE LOAMY FINE SAND	41.93	0.712	0.06	0.404	0.404	0.147	0.32	0.67	No	0.262
1017090	MYAKKA SOILS AND URBAN LAND	10.67	0.401	0.017	0.116	0.116	0.033	0.58	1.64	No	2.581
1017092	EAUGALLIE SOILS AND URBAN LAND	5.42	0.44	0.021	0.21	0.21	0.038	0.56	1.59	No	1.181
1017093	SEFFNER SOILS AND URBAN LAND	10.93	0.394	0.015	0.119	0.119	0.029	0.58	1.67	No	2.362
1017094	MATLACHA AND ST. AUGUSTINE SOILS AND URBAN LAND	6.04	0.454	0.021	0.131	0.131	0.029	0.56	1.28	No	2.764
1017095	SAMSULA MUCK	3.08	0.755	0.027	0.548	0.548	0.147	0.67	0.6	No	0.262
1017096	PAOLA AND ST. LUCIE SOILS AND URBAN LAND	14.35	0.419	0.008	0.064	0.064	0.014	0.59	1.43	No	4.757
1017097	PINELLAS SOILS AND URBAN LAND	10.79	0.457	0.023	0.137	0.137	0.036	0.57	1.25	No	0.951
1017098	PLACID FINE SAND, DEPRESSIONAL	18.00	0.66	0.034	0.554	0.554	0.131	0.58	0.65	No	0.295
1017099	POMELLO SOILS AND URBAN LAND, 0 TO 5 PERCENT SLOPES	8.77	0.402	0.008	0.07	0.07	0.016	0.6	1.62	No	2.592

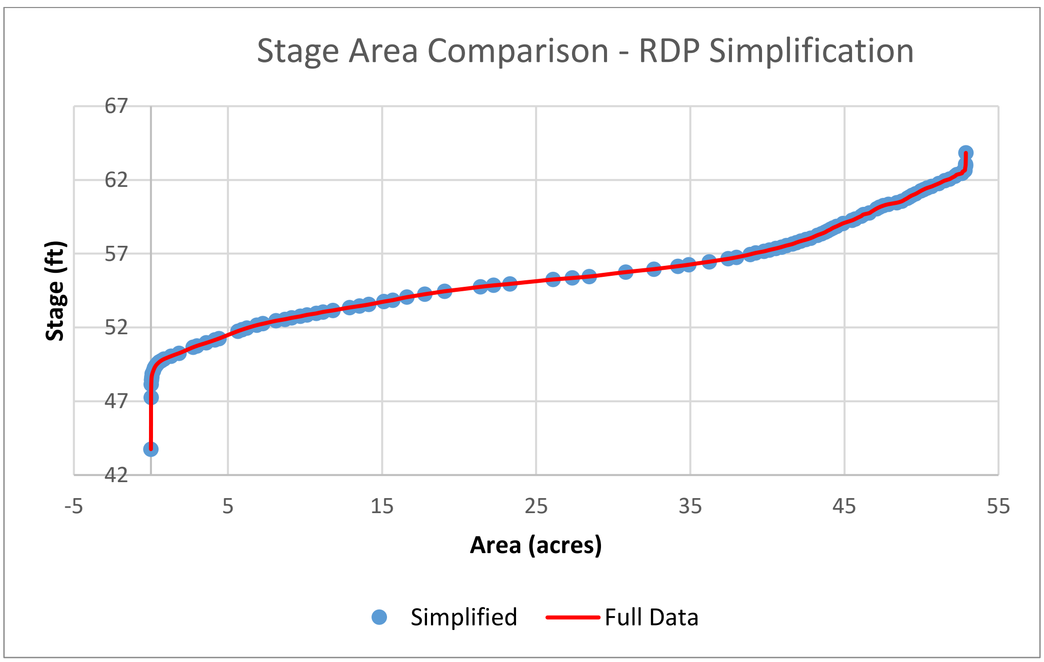
MUKEY / Soil Zone	Soil Name	Kv Sat. ft/day	MC Sat.	MC Res.	MC Initial	MC Field	MC Wilting	Pore Size Index	Bubble Pressure	Allow Recharge	WT Initial
1017104	KESSON FINE SAND, VERY FREQUENTLY FLOODED	10.87	0.526	0.035	0.191	0.191	0.053	0.58	0.87	No	0.033
1017105	URBAN LAND	6.09	0.454	0.021	0.13	0.13	0.029	0.57	1.28	No	2.231
1017106	ASTATULA SOILS AND URBAN LAND, 0 TO 5 PERCENT SLOPES	20.09	0.395	0.006	0.07	0.07	0.012	0.6	1.69	No	4.043
1017107	IMMOKALEE SOILS AND URBAN LAND	11.77	0.433	0.014	0.092	0.092	0.033	0.58	1.46	No	1.931
1017108	WABASSO SOILS AND URBAN LAND	11.39	0.481	0.024	0.164	0.164	0.047	0.57	1.28	No	1.181
1017109	WATER	1.09	0.526	0.035	0.191	0.191	0.053	0.58	0.87	No	0
1017110	PITS	7.74	0.467	0.017	0.117	0.117	0.027	0.58	1.2	No	1.247
3102917	WULFERT MUCK, TIDAL, 0 TO 1 PERCENT SLOPES	1.60	0.794	0.027	0.543	0.543	0.153	0.69	0.61	No	0
3102979	BASINGER FINE SAND-URBAN LAND COMPLEX, 0 TO 2 PERCENT SLOPES	10.67	0.401	0.017	0.116	0.116	0.033	0.58	1.64	No	1.181
3102987	TAVARES FINE SAND-URBAN LAND COMPLEX, 0 TO 5 PERCENT SLOPES	13.04	0.372	0.007	0.073	0.073	0.013	0.596	1.967	No	4.593

Note: A factor of safety of 2 was applied to default saturated vertical conductivity values. The values in this table represent the final design conditions.

3.2 Model Nodes and Stage Storage Relationships

Model nodes serve as storage features in the watershed, such as ponds, lakes, wetlands, and overbank areas. Also, nodes may serve as simple junctions to provide connectivity for the hydraulic network. Sub-basin runoff is assigned to nodes, as is sub-basin storage that is not already automatically accounted for in open channel conveyance. Percolation will be accounted for, where identified, as an outfall from nodes (surface storage areas), where the depth to water table is greater than three feet.

The catchment delineation process was based on the location of low points or drainage sinks that are considered pertinent to floodplain simulation. The Arc Hydro "Drainage Area Characterization" tool was used to develop stage/area consistent with District guidance and was collected at 0.1-foot intervals. Stage-area information was generated throughout the entire storage range (lowest to highest elevation within the model basin). To reduce the overall size of the stage-area dataset, a thinning routine was utilized. The Ramer-Douglas-Peucker (RDP) algorithm is a widely used algorithm for curve simplification or polyline simplification. It aims to reduce the number of points in a curve or polyline while preserving its shape and important features. In general, this algorithm was applied to all storage nodes and **reduced the overall number of data points by around 50%.** The following graphic displays the original raw data (Full Data) from the stage-area-characterization tools along with the simplified curve (Simplified) after utilizing the RDP algorithm:



Adjustments to the stage-area relationship were accounted for when connected to hydraulic features below ground surface. Care was taken to ensure these additional records did not result in inaccurate storage extrapolation. Manhole designated model nodes were not assigned any stage-area records and instead, a minimum area of 400 sq. ft. was set in the simulation manager of ICPR4.

Storage exclusion polygons were used to “mask out” channel geometry to ensure the overall storage for the basin was correct. Without the channel exclusion polygons, the channel geometry could be contributing twice to the basin storage.

3.3 Initial Stages

Consistent with SWFWMD G&S, initial conditions will be set based on tidal tailwater condition, outfall structure elevations, seasonal high-water levels, gage data, and/or permitted design levels. Tidal and boundary water levels were allowed to impact upstream nodes if no restrictions in the pipe systems were identified. For example, the tidal boundary condition of 1.5 NAVD88-ft could impact any pipe inverts lower than 1.5 feet. Similarly, for the northwestern boundary with McKay Creek, the initial stage of the boundary node was allowed to influence initial stages for any directly connected nodes. Boundary locations, Lake Seminole, and the tidal areas were reviewed, and initial stages adjusted where appropriate.

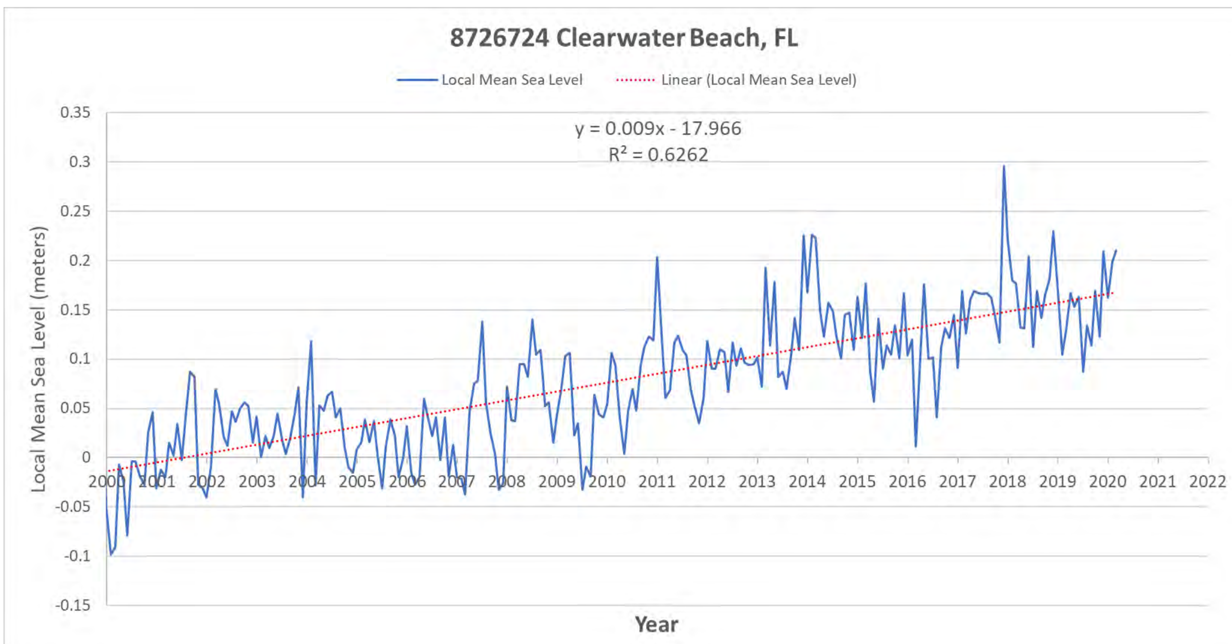
For model calibration and verification runs, the initial conditions will be generally based on observed antecedent conditions using rainfall and groundwater gage data where available. For design storm simulation the initial water level in wet detention ponds with an outfall structure was set to the lowest modeled invert elevation of the outfall structure. DRA’s will be assumed dry and set to the bottom elevation. For wetlands, the initial water level was set to the seasonal high-water level as determined by observed values or estimated based on no-rainfall equalized conditions. The no-rainfall condition was simulated to verify limited initial flows occurring in the watershed.

3.4 Boundary Conditions

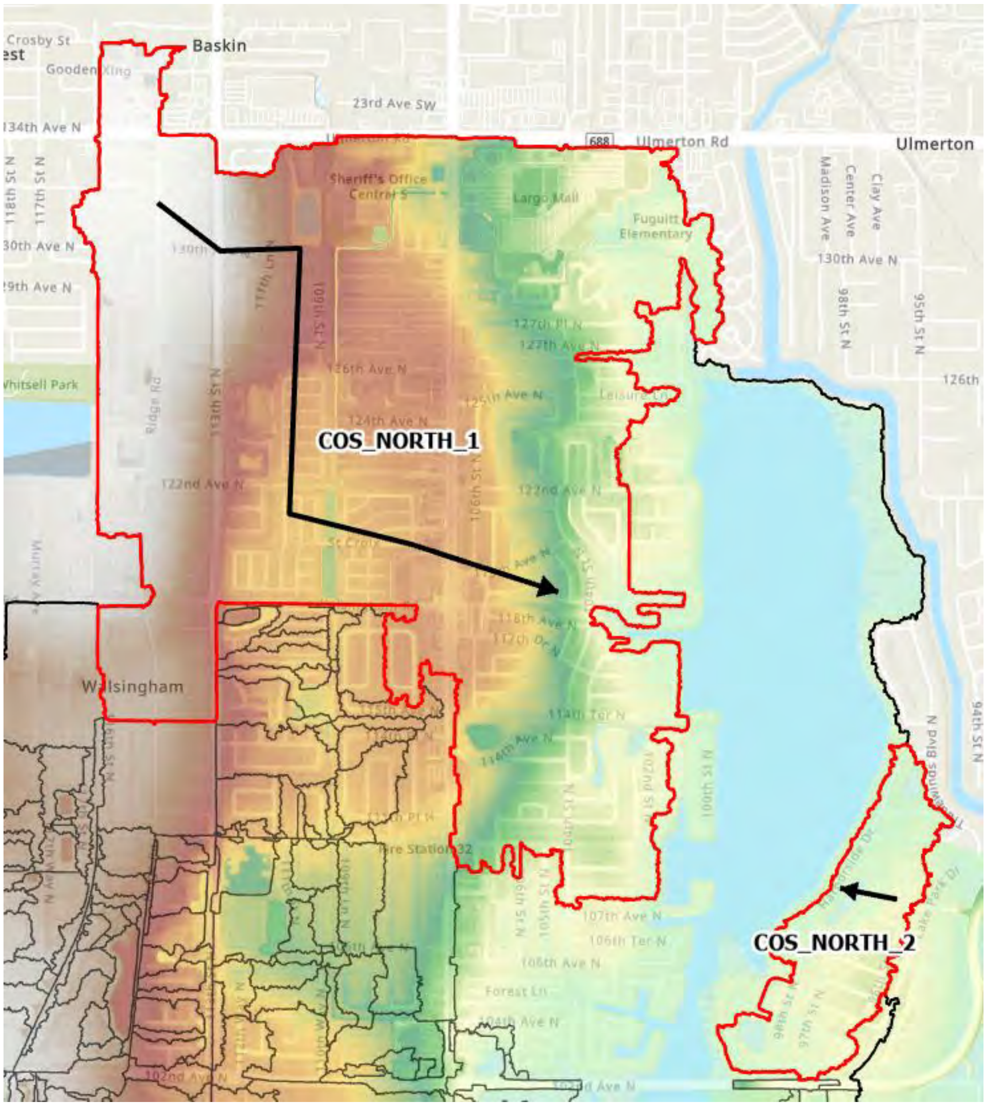
The City of Seminole watershed has four primary discharges. These are McKay Creek, Lake Seminole Outfall, Lake Seminole Bypass Canal, and direct discharge to tidal waters (Long Bayou and Boca Ciega Bay).

The preliminary delineation was updated to include (16) boundary conditions (time-stage and static stage/area nodes). Each time-stage node utilized the results from previously approved models, specifically McKay Creek and Starkey Road Basin models (**Exhibit 15**). The older Seminole model (from 2007) did not contain the same level of detail as the currently developed model and was not utilized for boundary conditions. For these areas, a fixed stage/area value was used to mainly allow overland weirs the ability to drain out of the watershed.

The tidal boundary conditions were determined using NOAA Tides & Currents data. A conservative but reasonable estimate to establish initial stages for tidal conditions (as well as the tidal boundary condition) is to use the Mean Higher High Water level (MHHW). The MHHW is the average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch. The nearest gage that provides an offset conversion to NAVD88 is the Clearwater Beach, FL gage (Station ID: 8726724). Based on the gage reference datum data it was determined that the MHHW for this gage is 0.95 ft NAVD88 for the 1983-2001 Epoch. This elevation will be offset to reflect the MHHW conditions at the year 2021 based on recent observed MHHW trends. Since 2000, the estimated linear increase in sea level at Clearwater Beach is 9 millimeters per year. This correlates to an increase of 0.59 feet since 2001 (end of the epoch). The observed MHHW over the last three years (2019-2021) is reported as 1.46 feet NAVD88. Therefore, the recommended tidal boundary condition is an average of those two values. The tailwater condition in tidal waters will be set at a fixed elevation equivalent to the current MHHW elevation of 1.50 feet NAVD88. This elevation will also be applied to establish a static water elevation for every hydraulic conveyance element with an invert below 1.50 ft NAVD88.

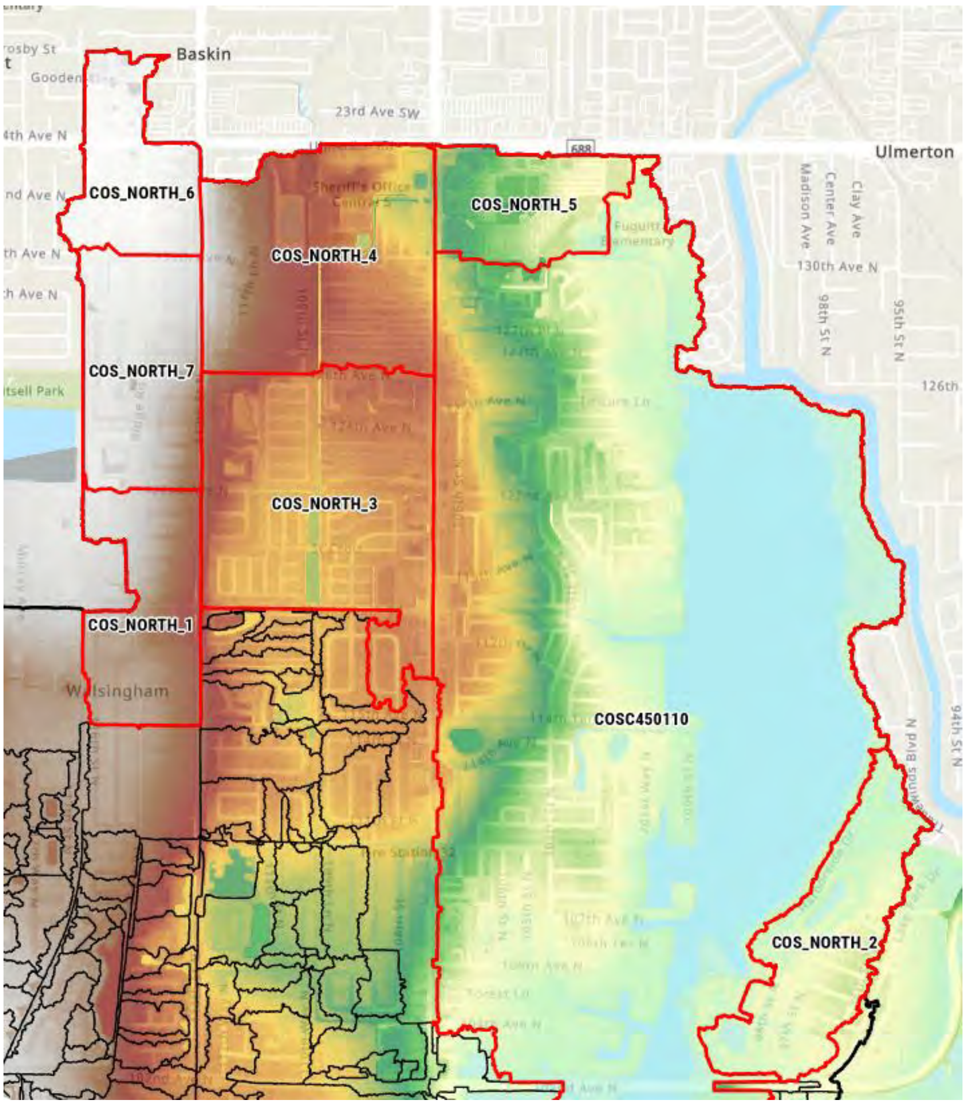


Upstream contributions from northern Lake Seminole, outside of the study area, were incorporated through two large hydrologic basins (approximately 1,076 acres total). These basins were independently developed through additional Arc Hydro processing. Similar hydrologic parameterization was completed and no additional unique land use or soil features were identified. Adjustments to Time of Concentration will be made during calibration and verification to match the Lake Seminole stages and time to peak. The following graphic displays the two large basins in the North sub-watershed. Both basins are currently modeled as contributing directly to the Lake Seminole basin (hydrologically only):

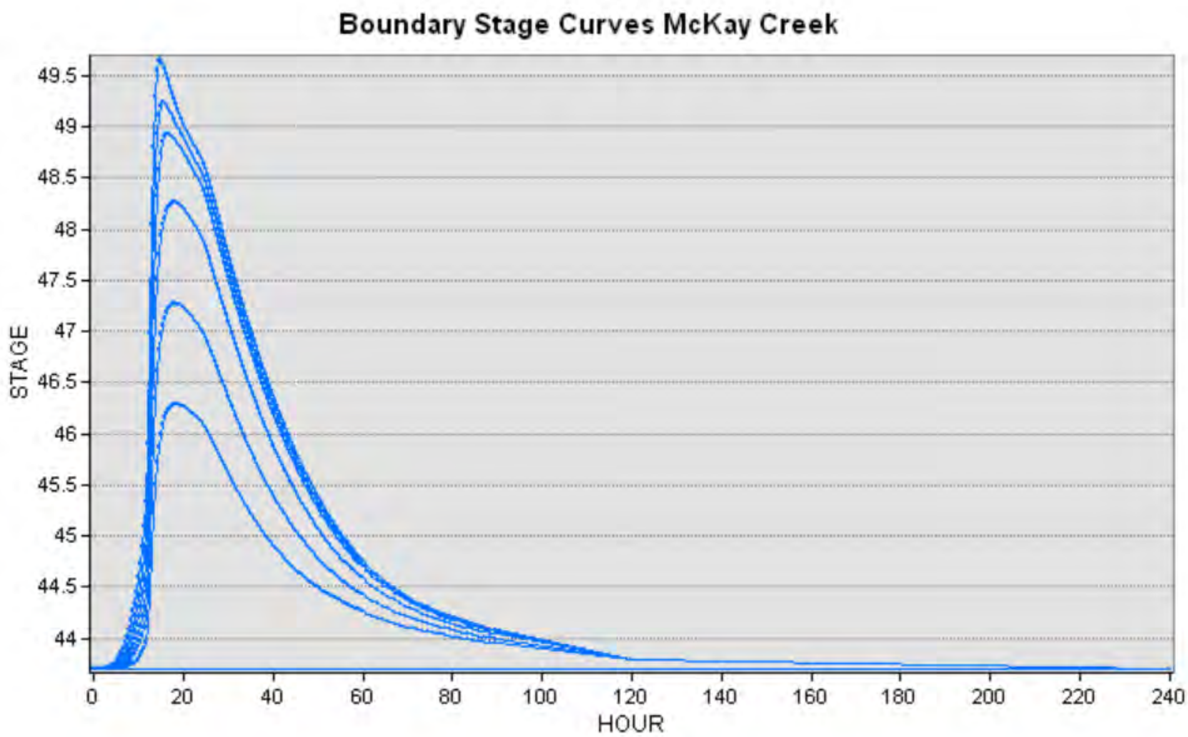


The Lake Seminole basin (COSC450110) north of the 102nd Ave bridge crossing was expanded to contain additional storage north of the bridge crossing. The bridge is assumed to have a minimal impact on the overall watershed modeling. The lake functions primarily as a level pool and there are no significant restrictions associated with the bridge, maybe a few pilons. The lake should be able to fluctuate like a level pool and now contains additional storage north of the 102nd Ave crossing.

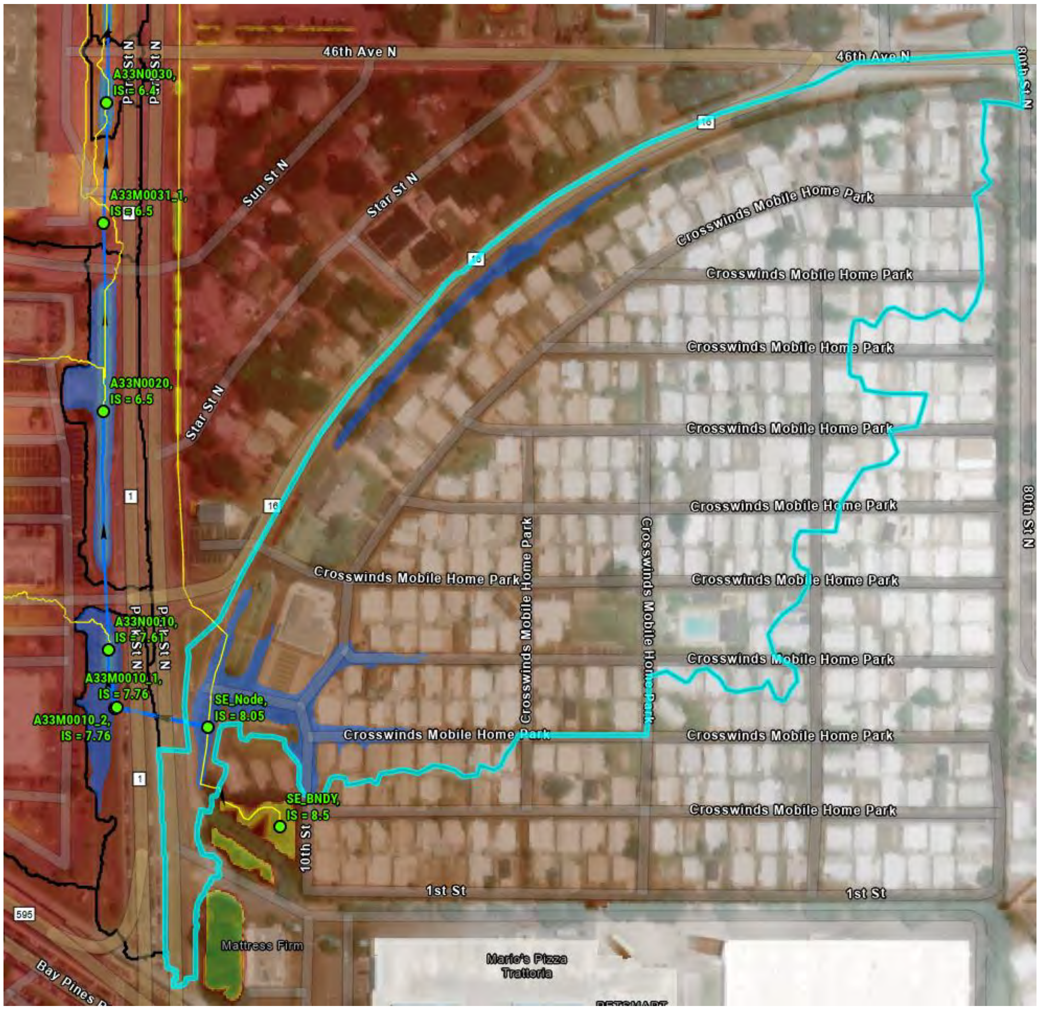
During model calibration, it was determined that introducing model features to COS_NORTH_1 could be beneficial. Applied Sciences developed several new model basins with unique stage-storage, land use, soils, and Time of Concentration. Major pipe features were extracted from ERP data and some channels were developed using the LiDAR DEM model. Through introduction of these new model features, runoff attenuation, timing, and flow dynamics to the lake were thought to be reflected more accurately. Additionally, these coarse model features may assist in future watershed studies that focus on the Pinellas County area related to Lake Seminole.



Previous modeled systems (McKay Creek and Starkey Road) were reviewed, and node time-series data extracted for the desirable storm events. Most of the needed design storm simulations were available; however, a few additional storm events were run to fill in the gaps. Additionally, the 5 year and 50 year events for both models were calculated by averaging the 2.33 year and 10 year and 25 year and 100 year events, respectively. The overall stage hydrographs appeared reasonable and assisted with assigning initial stages for any connected nodes. See an example below for McKay Creek, initial stages were set to 43.7 ft:



A final area in the southeast portion of the watershed was evaluated for a time-flow boundary condition; however, after further analysis, it was decided to add a new basin to the model and parameterize with soils/land use/stage-storage information (Basin Name, SoutheastBndy). The basin generates runoff to a dual, 24-inch pipe system that connects to portions of the City. The introduction of this model basin should more accurately represent the runoff contributions to the City while reducing the difficulty in managing time-flow boundary conditions across various design storms/calibration/verification events. The screenshot below displays the model configuration for this area:



3.5 Percolation Criteria

Percolation will be accounted for in the model using the “PercPack” approach originally developed in ICPR3 software, which has since been migrated into ICPR4. Depressional areas or DRA’s have been identified in well drained areas that have depths to the water table estimated to be greater than 3 feet. Three feet was chosen as a cutoff because most of the available soil storage within that range will be used up by precipitative infiltration negating the requirement for modeling percolation, as it will be accounted for in the model hydrologically. Additional criteria were specified to refine the location of percolation nodes. For example, any areas initially identified were removed if the non-percolation extent intersected any open water surface features (GWIS_WATERBODY). Final adjustments were made if the flooding extent was associated with greater than 50% impervious coverage. These areas are often related to observed flooding within streets. It is unlikely that percolation will occur under these highly impervious land use coverages.

The stair-step percolation approach was used to model percolation in the City of Seminole watershed. This methodology requires a hydrology only model run for percolation basins defined by the P1-Ring extent (100 Year, 24 Hour, non-percolation model results). The volume of infiltration determined from this model run was used to reduce the overall depth to water table or layer thickness of the percolation links. A stair-step increment of 0.2 feet was utilized for the City of Seminole study. **Horizontal flow** was restricted to the first (lowest) percolation link. The computational domain for the horizontal links were based on a P-Ring buffering technique. A buffer value of 50 ft and 150 ft were used for the P1 to P2 and P1 to P3 distances, respectively. Overlap of neighboring buffer rings was also handled through a GIS processing routine. Perimeter lengths were further adjusted to ensure increasing lengths, where P1 < P2 < P3, as required by ICPR4.

All additional vertical percolation links were set to constant areas based on the unique area assigned to each link (donut shaped area defined by subtracting the summation of areas below the current link area). The constant area approach allows ICPR4 to utilize the modified Green-Ampt model, incorporating effects of the advancing wetting front on percolation dynamics.

The percolation selection, P-Ring development, and generation of ICPR4 input parameters was captured programmatically using Python based GIS script tools. The outputs of the script tools were loaded directly into the ICPR_PERCOLATION table and a separate script converted these records into ICPR_LINK geometries with a length of 50 ft. All links were generated using the same coordinates (many overlapping lines represent multiple percolation links).

Hydrologic percolation parameters (conductivities, effective porosity, and layer thickness) were calculated from an area weighted average of the intersected soils for a given P-Ring extent:

- Vertical conductivity (Kv) values were taken directly from the model Green-Ampt look up tables (area weighted average), with no additional factor of safety applied.
- Horizontal conductivity (Kh) values were defined as 1.5 * Kv.
- Water table depth was defined as the lowest stage area record for the associated storage node minus the depth to water table (layer thickness).
- Aquifer base values were calculated as 10 feet lower than the water table elevation.

If an area floods beyond what is expected based on observed physical conditions and review of the percolation hydrographs, adjustments will be made to the parameters accordingly. Fine tuning of the percolation areas will be based on engineering judgment, verification storms, hydrograph review, high water marks, visual inspection of the percolation areas, etc. Utilities have been developed to assist in the percolation area parameterization.

3.6 Hydraulic Links

3.6.1 Control Structures

Control structure dimensions follow standard sizes, unless field review or supporting data indicate a non-standard size. ICPR drop structures are utilized where applicable to minimize the number of hydraulic links in the model. Most drop structures contain a single pipe and weir feature. Some contain multiple weirs (vertical slots, horizontal grates, etc.). There were a few drop structures that contained multiple pipes discharging from the "junction box". For these situations, ICPR4 allows one to increase the pipe count for the drop structure (if assumed identical). This process was done for a very limited number of hydraulic features throughout the watershed.

3.6.2 Pipes

Culverts, bridges, drop structures, etc., are structural conveyance features found in a typical watershed. Hydraulic characterization of structural features is based on geometric data, material properties, elevations, and other characteristics taken from ERP as-built drawings or collected field data. Hydraulic data contained in the project geodatabase include measured and/or observed data such as stage areas, lengths, diameters, end treatments, elevations, cross sections, digital photos, construction materials, etc. Hydraulic parameters consisting of roughness values, entrance and exit loss coefficients, conveyance way, and overbank identification, etc., are interpreted by the engineer from the data.

Manning's roughness coefficients are based on recognized sources (i.e., Ven Te Chow, 1959). Additional losses such as entrance, bend, and exit losses, were accounted for where applicable. Entrance losses were generally set to 0.5 for most pipe systems. Any pipes discharging to an open water body, the exit loss for these pipes was assigned a value of 1, indicating reduction of flow velocity.

The ICPR elliptical pipe tool is utilized to standardize any non-standard elliptical geometry surveyed or measured, as standardized elliptical geometry is required for ICPR4 modeling.

3.6.3 Weirs

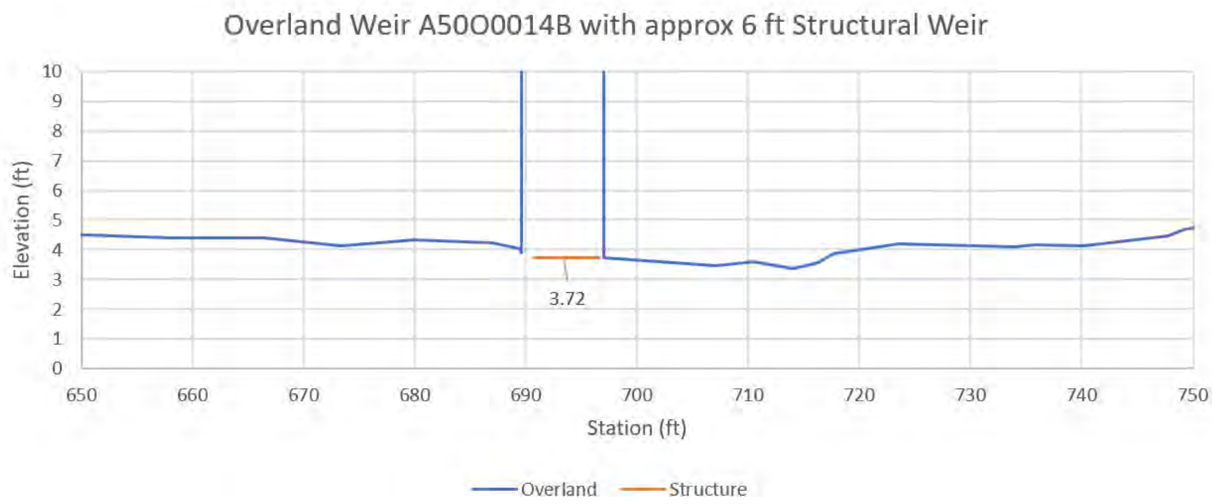
Structural and non-structural (overland) weirs have been accounted for in the preliminary watershed model development. The weir and orifice discharge coefficients follow standard values. Typically, the weir discharge coefficient ranges between 2.6 and 3.4 and the orifice discharge coefficient ranges between 0.5 and 0.7. Natural earthen overflows from depression areas were represented by broad crested irregular weirs that are equivalent to the overflow configuration (length and corresponding elevation of the saddle as practical) where applicable. A range of weir coefficients should be considered to best characterize the surface of the "saddle". Typically, a lower weir coefficient is used for forested or highly vegetated areas, and a higher weir coefficient is used for smoother areas.

Common weir coefficient values for natural earthen overflow weirs range from 1.8 to 2.8. The paved/unpaved surface, developed for TC calculations, was utilized again to gain a better understanding of the land use "underneath" the extent of the overland weir cross section. For example, if the cross section contained greater than 50% of paved land use, the weir coefficient was set to 2.6. If most of the land use was unpaved, a coefficient of 2.8 was used. These designations were manually reviewed and adjusted as necessary.

Overland weirs use an irregular cross-section with elevation data extracted from the DEM. Cross-sections cut from the DEM characterize the overland flow and will include the lowest overflow point elevation. Unless occurrence of flow can be ruled out completely, most overland weirs were included in the current model connectivity. No flow overland weirs may be removed from the model during the model refinement phase.

In order to accurately depict overland *structural* weirs, care was taken to manipulate the natural overland weir station/elevation data. This was accomplished through examination of the overland weir links that exist in parallel with a structural weir. The structural weir length or width was determined from review of inventory or ERP data. The natural overland weir cross section was visually examined to determine the appropriate location where the structural weir would exist. Using the structural weir length/width, any overlapping stations were adjusted so their corresponding elevations would not conflict with the structural weir dimensions. These elevations were set to a value of 999 and the natural weir invert was updated to a new minimum elevation from the remaining cross-sectional data. For a few instances, the weir invert of the structural weir was higher than some of the remaining cross-sectional elevations. This was assumed to be related to the minor inaccuracies that exist in the LiDAR. The overland weir invert was then updated to the invert of the structural weir. This ensures the overland weir does not start flowing prior to the structural weir.

In the example below, we can see a short, 6 ft structural weir embedded within the overland weir cross-section information. The invert of the structural weir is set to 3.72 ft.

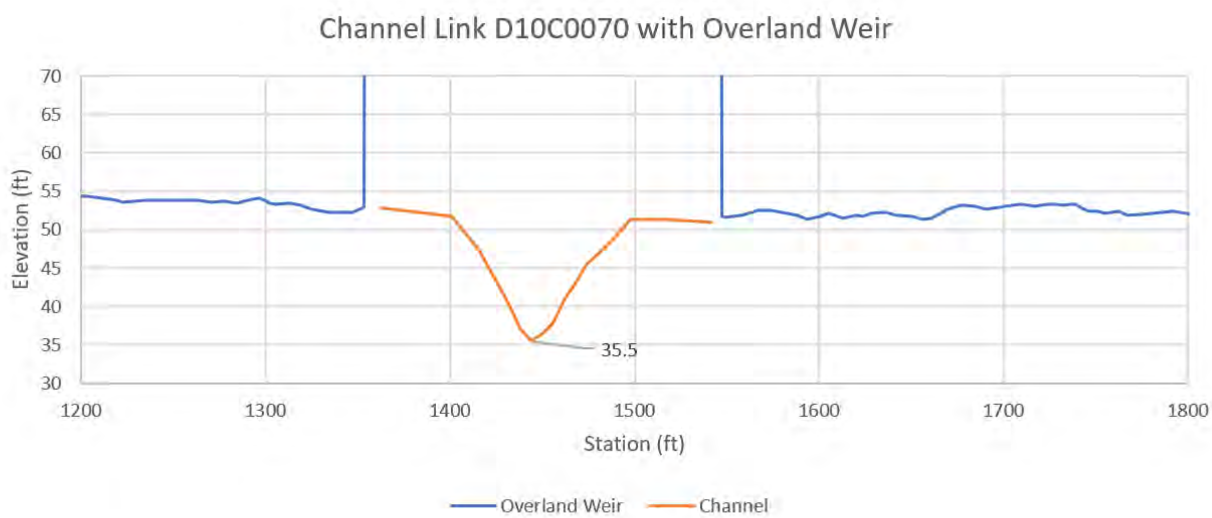


The elevation axis range was adjusted for visual demonstration purposes, but the overland weir elevations extend to a value of 999 ft within the window of the structural weir. This allows unique parameterization of the structural weir. Mostly, the discharge coefficient would change to something like 3.2 for sharp-crested structural weirs. A few dozen structural weirs were parameterized using the above methodology, throughout the watershed.

3.6.4 Channels

Rivers, streams, tributaries, man-made channels, creeks, ditches, etc. represent open conveyance systems or channels. Hydraulic characterization of a channel is based on a defined conveyance way. Conveyance and storage within the channel extents are represented by cross section information that terminates at the flow boundary of the conveyance way. Channel sections were defined primarily using field reconnaissance data and supplemented with DEM and building plan information. Several of the channels were parameterized through past survey information extracted from the McKay Creek and Starkey watershed models. Other, smaller channel systems were described through use of the underlying terrain. These cross sections were reviewed to ensure the LiDAR did not indicate a standing water surface elevation. Channel inverts were established based on upstream and downstream cross-sectional information. Storage beyond the effective conveyance is considered overbank storage that is assigned to a junction. Guidance for defining channel links within the node-link feature class and database are referenced directly from the SWFWMD G&S.

Like the structural weirs flowing in parallel with overland weirs, care was taken to ensure channel links did not flow in parallel with overland weirs. Overland weir links were initially turned off, if in parallel with channel flow. After initial model simulations, it was determined that some of the overland weirs were *required* to appropriately describe additional flows out-of-bank from the channel conveyance. For these instances, the overland weir cross section elevation data was reviewed and masked out (set to a value of 999 ft) for any stations in conflict with the described channel cross section. See an example below:



3.6.5 Rating Curves

Rating curves are used to model hydraulic features such as pump stations, complex bridges, and water control structures. Rating curves are generally accompanied by various types of operational tables. No rating curve relationships are expected to be incorporated in the watershed model at this time.

3.7 QA/QC, Calibration, and Verification

Quality Assurance (QA) is achieved through appropriate assignment of project tasks and responsibilities to team members, development of and adherence to protocols, compliance to the baseline schedule and budget, and daily task oversight.

Quality Control (QC) is being performed throughout the project according to well-designed protocols to check for errors and omissions, to verify that staff are using tools and following procedures correctly and effectively, and to fully understand why certain processes result in certain outcomes. QC protocols include those for raw data collection, data manipulation and calculations; parameter selection, processing and computations; reporting, mapping, and deliverables production. Additionally, under this TWA a formal QC is to be performed by a third-party consultant.

In terms of specific QC measures, verification of model input and outputs with collected data is necessary. Simulation of a watershed's response to rainfall is becoming more physically based and also provides opportunity for visual checks using GIS software. Detailed information is now available regarding the terrain, landscape, imperviousness, etc. Hydraulic characteristics of the surficial systems are less certain, but land cover data based on aerial photography can provide general information regarding soil infiltration capacity. Wetland areas suggest little infiltration is occurring; whereas, xeric landscapes tend to suggest significant infiltration and less runoff. Soil hydraulic properties should reflect these conditions.

Soil characteristics can be adjusted to match physical observations during calibration due to the associated uncertainty of the parameters. If an area appears to generate too much runoff, hydraulic properties that decrease runoff will be adjusted accordingly for percolation and soil infiltration. If an area is not generating enough runoff, the inverse will be implemented. Zero rainfall simulations will provide insight into possible initial condition issues. Other typical instability model checks include, but are not limited to, oscillations, continuity errors, max flow/stage change between time steps.

The Seminole watershed is located in an area with very limited flood elevation data. Most areas that have chronic flooding are the result of coastal events, (e.g. tropical storms and hurricanes), or abnormal seasonal rainfall in locations. For calibration purposes, limited surface water gage data will need to be supplemented with any high-water marks from City or SWFWMD and/or information provided by residents and stakeholders.

4 MODEL CALIBRATION AND VERIFICATION

Applied Sciences calibrated and verified the City of Seminole Watershed model through comparison to several observed or established resources. The results demonstrate the detailed H&H model represents the watershed well and can reasonably predict observed data.

4.1 Calibration Data

Mainly, the USGS gage station (Seminole Lake Outlet Near Largo FL, 02308889) located near the outfall of Lake Seminole was used to compare observed lake levels to those from the watershed model. The gage station provided historical lake levels from 1950 to current. The extensive period of record allowed for statistical derivation of return period water levels for the typical design storm occurrences (5, 10, 25, 50, 100 Year water levels). The return period water levels were used to evaluate the peak stages from the final design storm models. Finally, floodplain extents were compared between the McKay Creek model and the City of Seminole model results for overlapping areas west of the City. General alignment between these two models is expected.

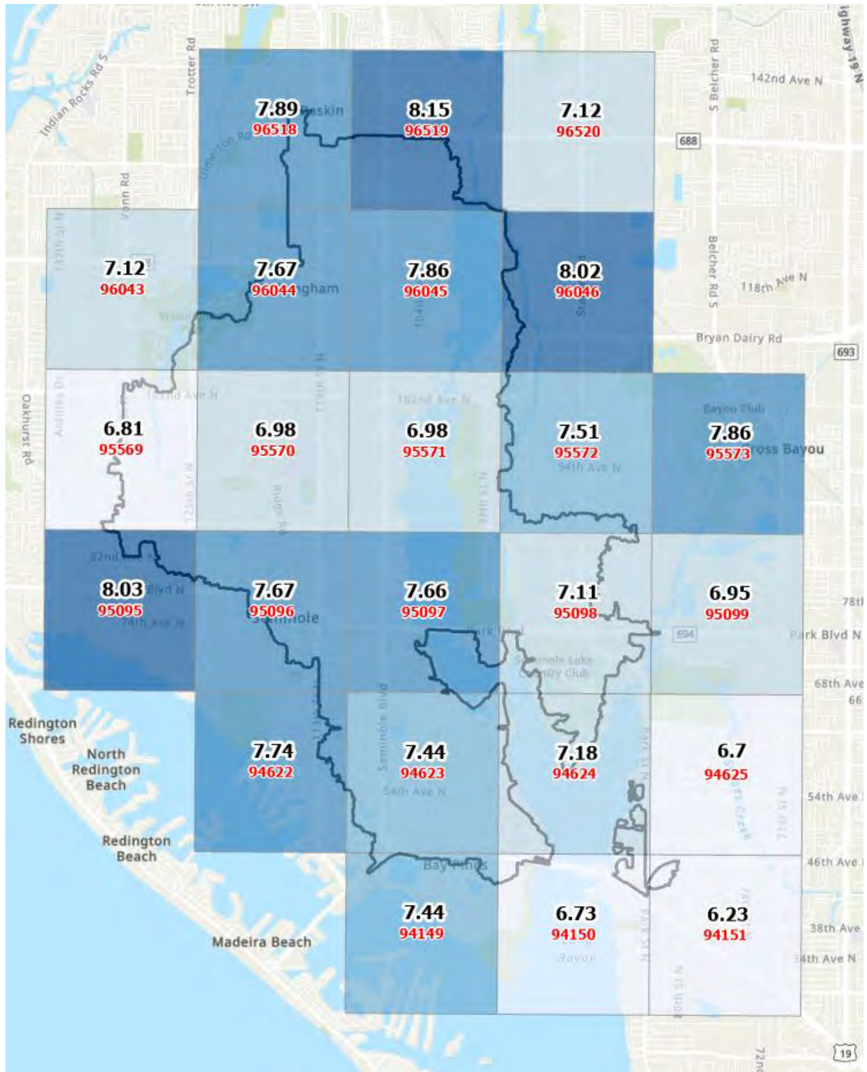
As previously mentioned, NEXRAD rainfall data were applied to the watershed model through direct intersection with the model basins. Rainfall distributions were extracted in 15-min increments and formatted for use in ICPR4.

4.2 Model Calibration

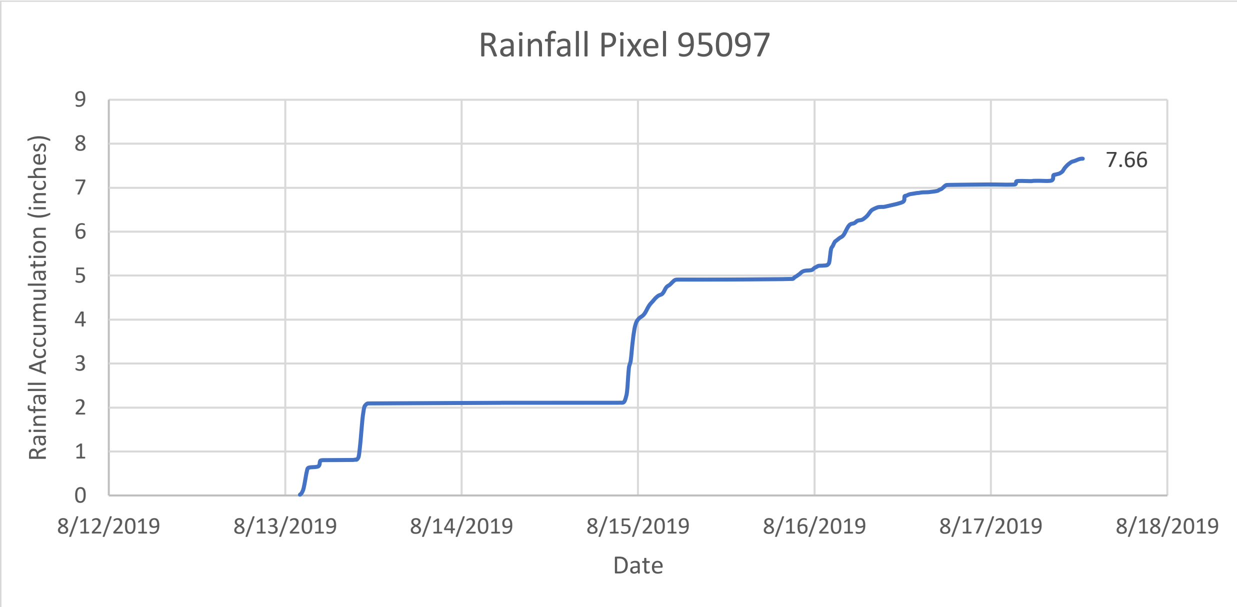
Applied Sciences calibrated the ICPR4 model using the recorded NEXRAD rainfall and Lake Seminole stages for an unnamed storm event that occurred August 13 - 17, 2019. The unnamed event was chosen for the model calibration due to the uniform distribution of rainfall across the watershed. NEXRAD rainfall volumes varied from 6.23 inches to 8.15 inches with a standard deviation of around 0.5 inches. The following table summarizes the total volume of rainfall for each pixel in the NEXRAD grid:

Table 9 Calibration Rainfall Volumes, NEXRAD Pixels

Pixel	Rainfall Total (inches)
94149	7.44
94150	6.73
94151	6.23
94622	7.74
94623	7.44
94624	7.18
94625	6.7
95095	8.03
95096	7.67
95097	7.66
95098	7.11
95099	6.95
95569	6.81
95570	6.98
95571	6.98
95572	7.51
95573	7.86
96043	7.12
96044	7.67
96045	7.86
96046	8.02
96518	7.89
96519	8.15
96520	7.12

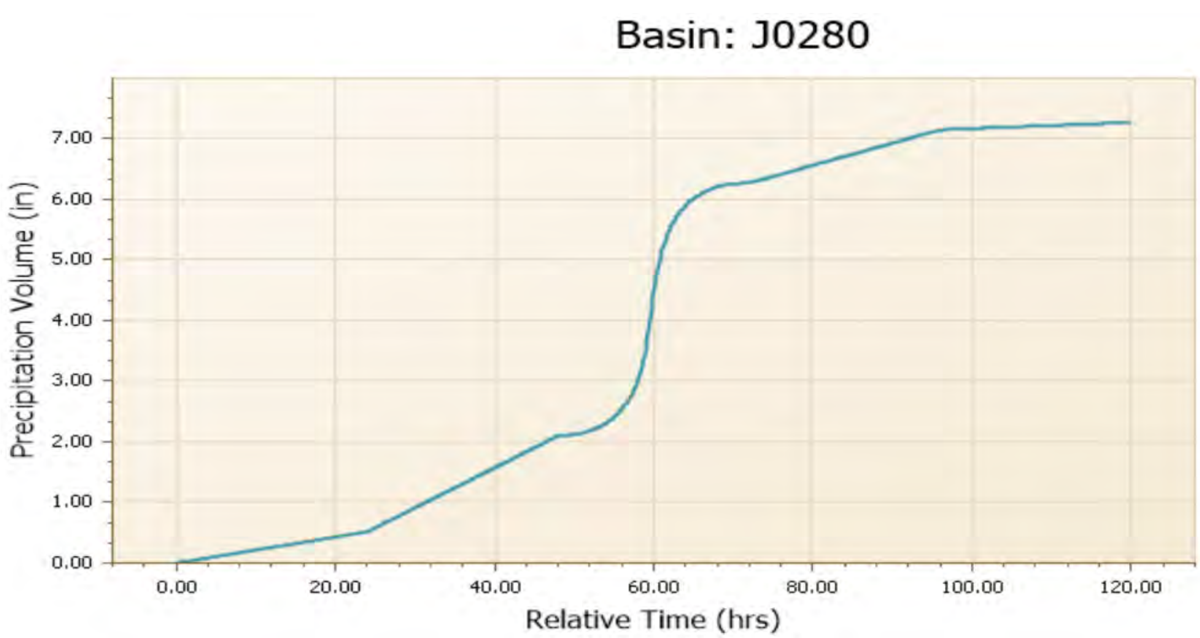


Applied Sciences defined the specific simulation duration from 8/13/2019 at 2 AM – 8/17/2019 at 3 PM. The event is approximately 4.5 days or about 109 hours of simulation time. This event is longer than the typical single event modeling, but we can compare the model results to a 5-day simulation with similar volumes (around 7 to 8 inches). Rainfall accumulation over time for a specific NEXRAD pixel displayed the following characteristics:



4.2.1 Boundary Conditions

Since the model calibration event approached the 5-day duration, neighboring watershed time-stage boundary nodes were established through simulating the 5-day, SWFWMD rainfall distribution with a rainfall volume approaching the average rainfall from the NEXRAD pixels. For example, the following chart displays the application of rainfall over time for a Starkey Road basin:



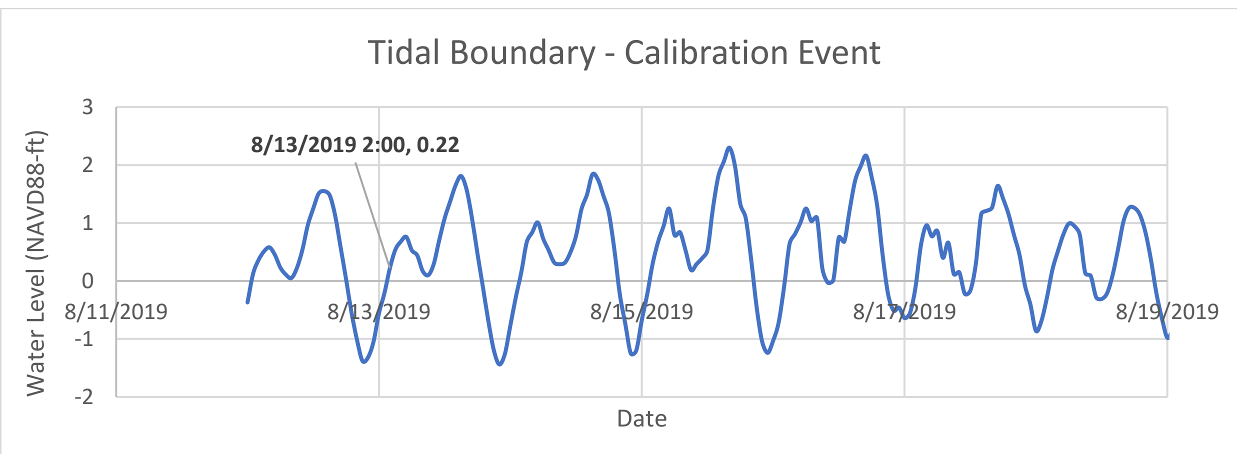
Although not an exact match between the observed NEXRAD rainfall and the SWFWMD design storm, the general shape, volume, and duration appear reasonable. This approach was completed for both the Starkey Road and McKay Creek models to establish calibration boundary conditions.

4.2.2 Soil Moisture

One can gain an understanding of initial soil moisture conditions through reviewing the rainfall accumulation prior to the model storm event. Applied Sciences referenced the local rainfall gage (Seminole Lake Outlet Near Largo FL, 02308889) that is supported by USGS. We typically look at the previous 14 days of rainfall and compare those to historical averages. This can provide an understanding of the degree of saturation expected in the watershed. Approximately 3.6 inches of rainfall was observed at the gage station for the 2-weeks prior to the unnamed August 2019 event. Based on this analysis, it is reasonable for the initial water table depth to be set to a seasonal high value. Prior to calibration changes, the initial moisture content was allowed to fluctuate based on the water table depth.

4.2.3 Tidal Boundary Conditions

Data from the NOAA tidal gage (8726724 Clearwater Beach, FL) was downloaded for the August 2019 timeframe. Hourly data for the tidal boundary were added to the model through the relevant time/stage boundary nodes (BNDY_0050, BNDY_0090, and BNDY_0030). The following chart displays the tidal fluctuations in NAVD88-ft for the calibration time frame.

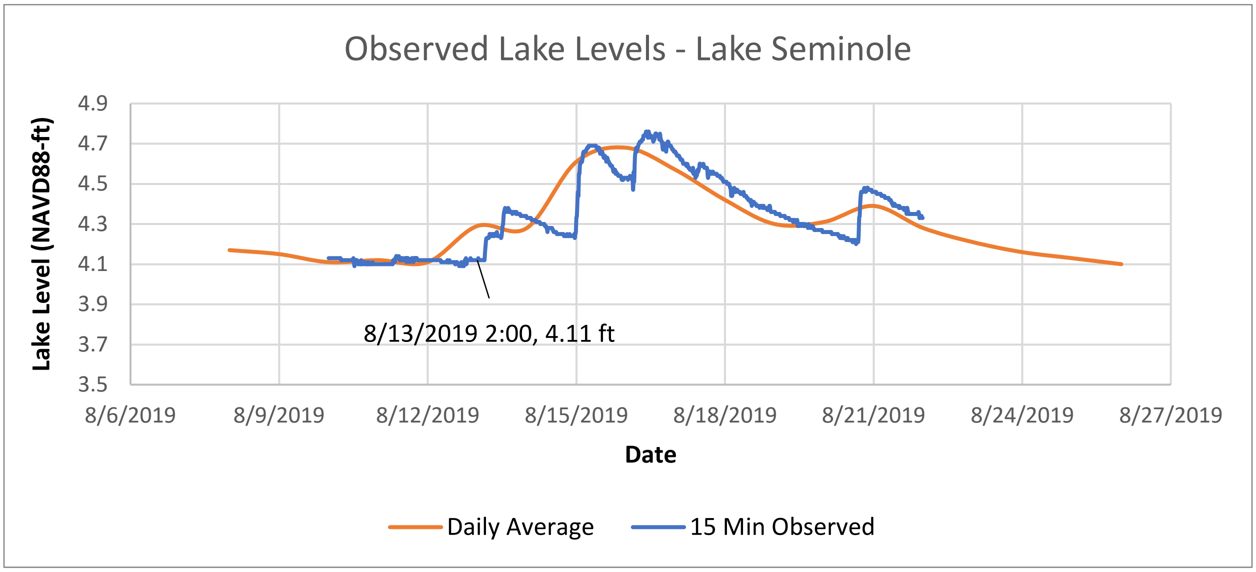


Tidal boundary nodes also influenced any hydraulically connected pipe/weir features. All connected and influenced nodes were updated with an initial stage of 0.22 feet.

4.2.4 Initial Stages

In addition to the tidal boundary conditions, the initial stage of Lake Seminole prior to the model simulation was defined from the USGS gage and applied to the node for the lake

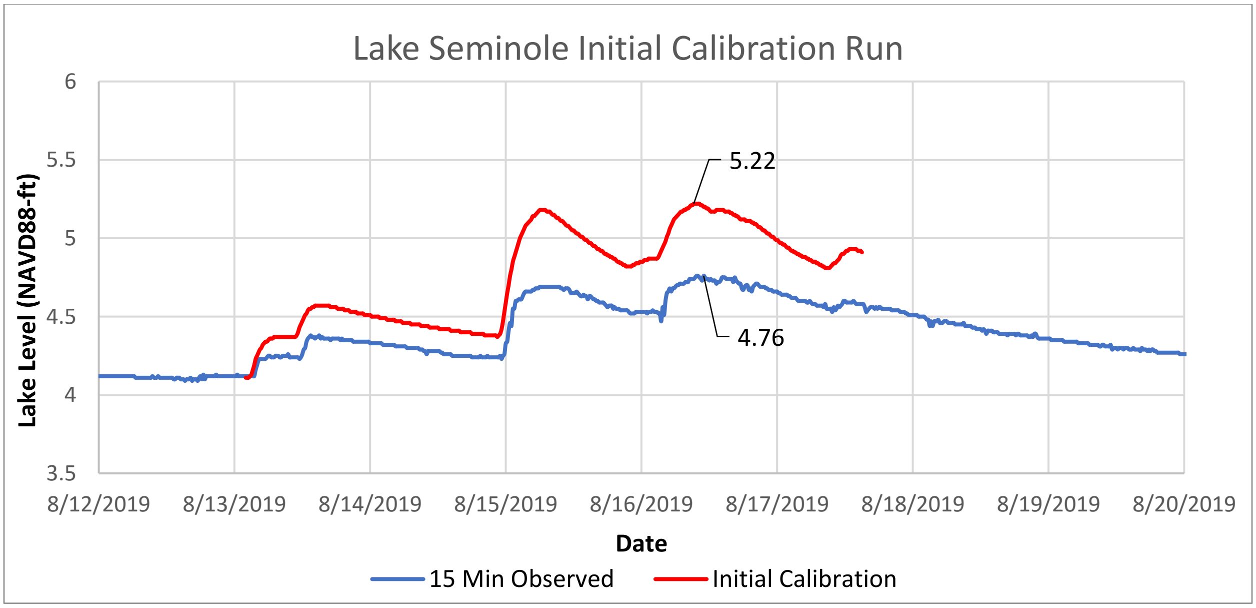
(C45N0110). The following chart displays the daily average and 15-min observed stage records for Lake Seminole:



Since the lake is controlled by a concrete overflow weir, it is common for the normal water level to be around the invert of the weir, approximately 4.13 NAVD88-ft.

4.2.5 Initial Comparison

The calibration model was initially run with standardized values for soils, land use, and Manning's roughness. The following plot displays the comparison between the initial model run and the observed lake levels for the calibration simulation period:



In general, the observed model results appear to reasonably capture the dynamics of the lake over time; however, the magnitude of the water levels in the initial calibration model run are slightly higher than observed. It appears that the model is generating more runoff than expected, with the modeled peak stage approximately 0.46 feet higher than observed.

4.2.6 Calibration Adjustments

Based on the initial calibration model runs, it was determined that adjustments to the model parameters were warranted. The most common calibration parameters are associated with specific definitions of soil storage and impervious percentages. Other considerations can be made to Time of Concentration, pipe roughness, and overland weir discharge coefficients.

Applied Sciences performed the following adjustments to the calibration model parameters to obtain a better fit to the observed data:

1. **Set MC Initial equal to MC Field (increase soil storage)**

   The standard Green-Ampt soil parameters, derived from the SWFWMD soil data retrieval tool, utilize the depth to water table to define initial moisture content. This approach assumes the water table can influence the initial moisture content of the soil due to capillary action. This methodology reduces the overall soil storage and thus infiltration potential. By decreasing the initial moisture content to field capacity, one can increase the available soil storage and increase soil infiltration. ICPR4 documentation recommends setting the initial moisture content to field capacity for normal antecedent conditions. By setting MC Initial to MC Field, calibration model results showed better agreement to observed lake levels on Lake Seminole.

2. **Increase WT Initial for select soil MUKEYs (max increase of 1 ft)**

   After globally adjusting the initial moisture content to field capacity, the model results were still higher than observed conditions. Another approach for reducing runoff in the watershed model was to focus on updating the depth to water table for specific soils. The GWIS_SOIL feature class was reviewed to identify specific soils, with large spatial coverage, that could be uniquely updated. Updates were limited to increasing the initial water table depth by a maximum of 1 ft. Since the ICPR4 model, as currently configured, is geared for event-based analysis; the available soil storage is fixed at model runtime. An approximation of soil storage can be calculated by taking the difference between saturated moisture content and initial moisture content and multiplying by the depth to water table. From this equation, we can see how *decreasing* the initial moisture content (see previous section) and *increasing* the depth to water table can increase the overall soil storage and infiltration capacity of the watershed. Calibration model results continued to improve with slight changes to depth to water parameters for specific soils.

3. **Imperviousness, slight decrease in % Impervious and DCIA**

After updating hydrology parameters related to soils, calibration model results still appeared higher than observed data. Another important component of runoff generation is related to the land use or imperviousness of the watershed. As previously noted, the hydrology development for ICPR4 requires a look up table where each land use category corresponds to a percent imperviousness and percent Directly Connected Impervious Area (DCIA). Often, these values are determined from previously defined references; however, during model calibration there is some flexibility to update impervious percentages to achieve better model results. For the City of Seminole, a large portion of the watershed is described as High Density Residential with a very high percent impervious value (near 75%). By reducing this value to around 65%, the simulated model results appeared to align more closely to the observed data on Lake Seminole.

4. **Increased TC times by 20% for basins with TC greater than 10 min (increase timing to arrive at lake)**

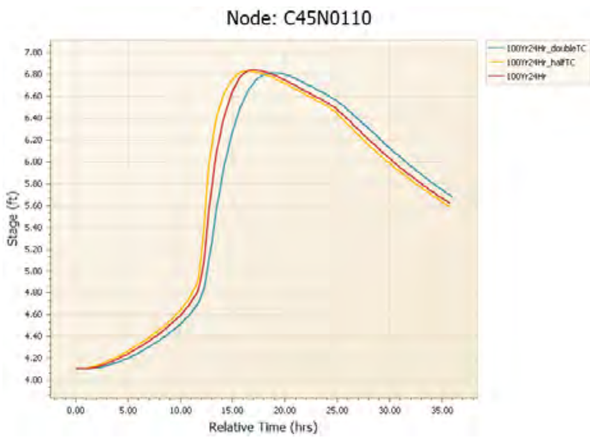
Additional considerations for better model calibration were focused on the Time of Concentration or TC parameter for hydrology definitions. The TC parameter typically represents the time required for water to travel from the hydraulically most distant point of the model basin to the outlet (storage node or waterbody). From the following equation, we can see the impact TC changes have on the peak discharge for a basin:

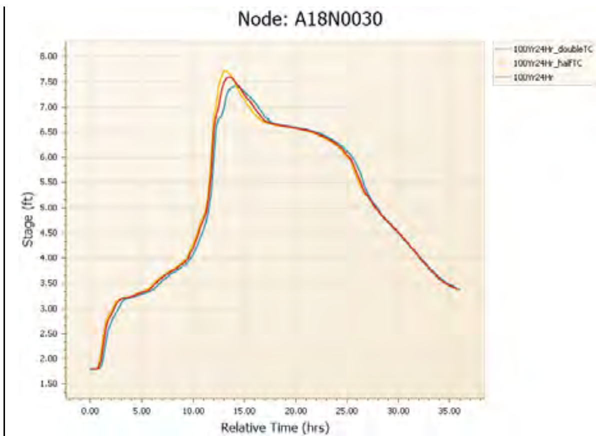
$$Q_p = \frac{(K)(A)(Q)}{\frac{2}{3}TC}$$

where,

Q_p	peak discharge
K	peak rate factor
A	drainage area
Q	direct runoff depth
TC	time of concentration

As one increases the value of TC, the overall peak discharge decreases. With lower TC values, the peak discharge will increase. By increasing the time for water to reach the outlet of a basin, the peak discharge will decrease and allow the connected systems to drain more easily. This impact appears relatively minor overall, but conceptually improves model performance. Applied Sciences further evaluated the impact of TC changes on the watershed. The following hydrographs represent the impact of increasing and reducing the TC value by 2:





We can see slight shift in peak stage timing for Lake Seminole (Node: C45N0110), along with slight changes to peak stage values/timing for an urbanized basin with around 8 acres of contributing area (Node: A18N0030). Overall impacts, even with doubling TC values, are small and was considered a minor adjustment for better model calibration performance.

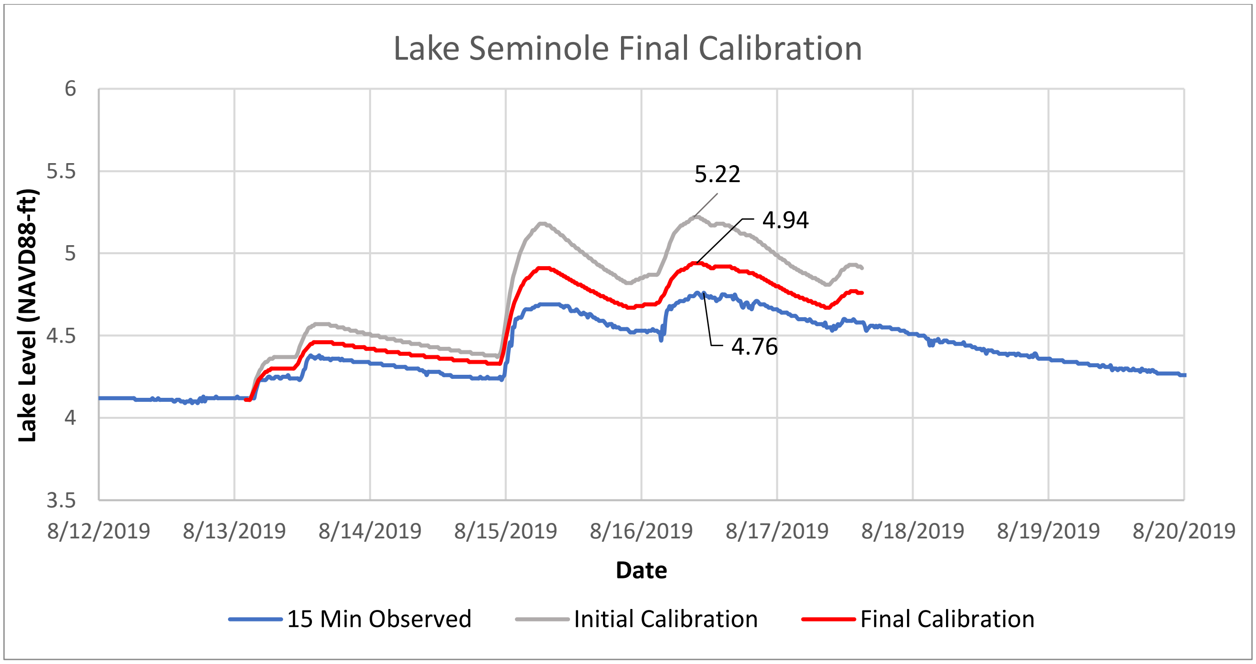
5. **Slight increase to Pipe Manning's roughness for main trunkline features (more resistance in the system)**

   Applied Sciences isolated the largest stormwater conveyance features from the watershed model and updated the Manning's roughness values. Roughness values were slightly increased for the major pipe systems to introduce more resistance in the stormwater system. Often these values were only increased a very small amount and within the normal range for concrete structures - standard concrete, n = 0.012 and updated values, n = 0.014. These changes are more related to practical ideas of modeling – not all stormwater systems will function as ideal systems with standard parameters. By introducing more resistance in the system feeding Lake Seminole, the outfall weir might be able to better drain the lake and slightly reduce the overall peak stage/timing during a stormwater runoff event.

6. **Slight decrease in weir coefficient for key overland weirs (more resistance in the system)**

   Similar to the previous section, Applied Sciences isolated overland weirs contributing flows to Lake Seminole. These weirs were evaluated for potential updates to the weir coefficient. Overland weirs in ICPR4 are parameterized with weir discharge coefficients that can impact the ability to flow. Increasing the weir discharge coefficient increases the flow rate. Standard values vary between 2.6 and 3.4. During initial parameterization, default values were defined for urbanized and vegetated cross-sections. During the calibration phase, Applied Sciences manually reviewed overland weirs to update the default parameterization. Mostly, discharge coefficients were slightly reduced, but were still within the recommended ranges. Conceptually, these changes represent better parameterization for overland weirs and provide additional consideration for local vegetation and cross-sectional properties.

The accumulation of the above model modifications produced the following calibration results:



The model updates produced a closer match to the observed data, with a difference in peak stage of 0.18 ft. It is believed that groundwater recharge components could be incorporated into the model for more accurate management of soil storage between rainfall events; however, this is not typical practice for the single event-based models. Currently, the model soil storage is fixed and cannot recover without a recharge mechanism.

4.3 Model Verification

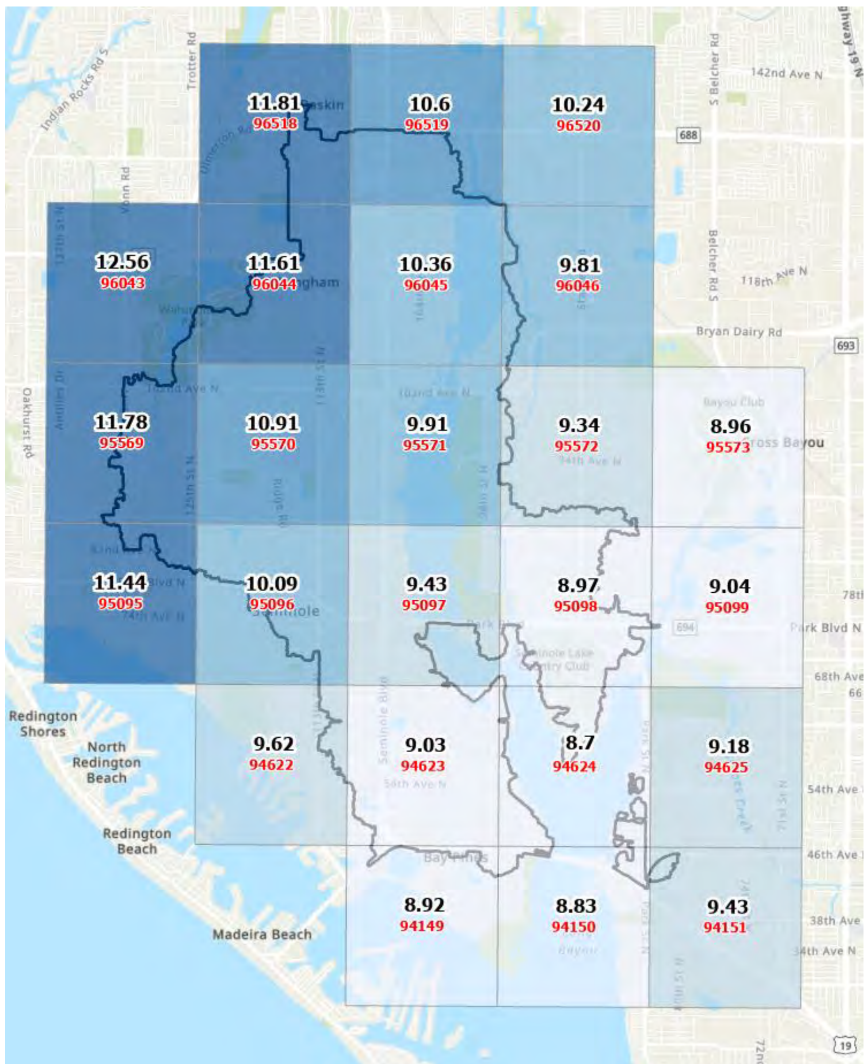
For model verification, Applied Sciences ran a second rainfall event with the adjusted model parameters from the calibration effort. The calibrated model parameters should translate well to the verification event. The main model input that changed was the NEXRAD derived rainfall. For the verification event, Applied Sciences simulated Hurricane Hermine. Hurricane Hermine produced heavy rainfall throughout the City and surrounding areas. The hurricane made landfall in the early morning of August 31, 2016.

The model simulation was executed from 8/31/2016 at 2:45 AM to 9/3/2016 at 8:30 AM, a total duration of around 3.24 days or 77.75 hours.

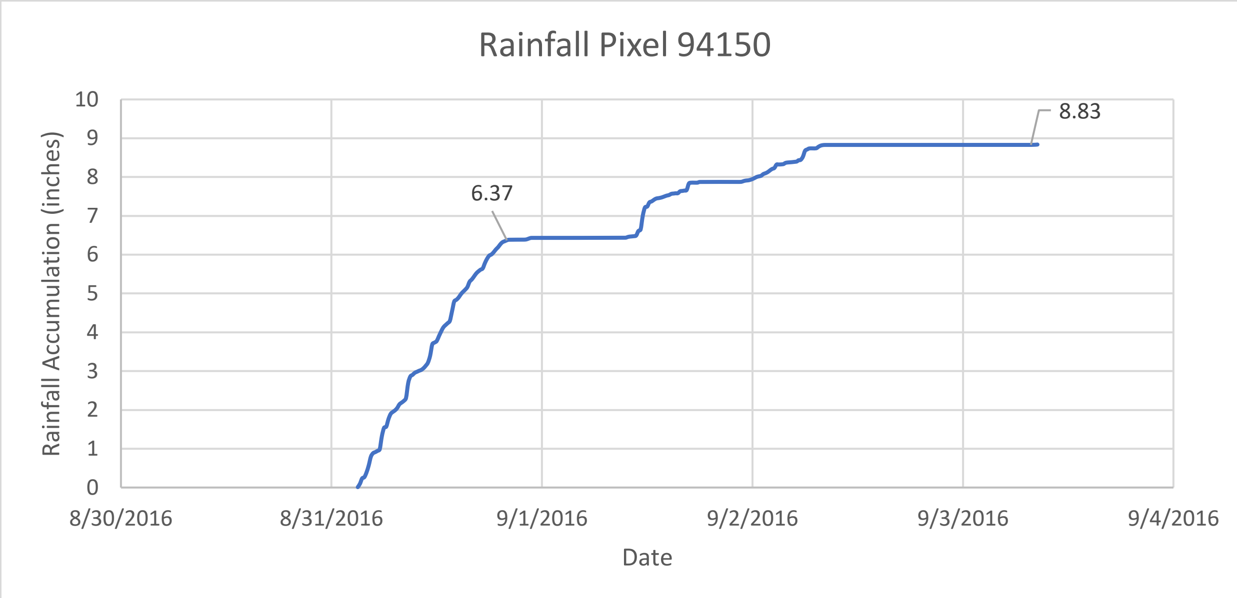
Hurricane Hermine produced an average of 10 inches of rainfall across the watershed. NEXRAD rainfall volumes varied from 8.7 inches to 12.56 inches with a standard deviation of around 1.12 inches. The following table summarizes the total volume of rainfall for each pixel in the NEXRAD grid:

Table 10 Verification Rainfall Volumes, NEXRAD Pixels

Pixel	Rainfall Total (inches)
94149	8.92
94150	8.83
94151	9.43
94622	9.62
94623	9.03
94624	8.7
94625	9.18
95095	11.44
95096	10.09
95097	9.43
95098	8.97
95099	9.04
95569	11.78
95570	10.91
95571	9.91
95572	9.34
95573	8.96
96043	12.56
96044	11.61
96045	10.36
96046	9.81
96518	11.81
96519	10.6
96520	10.24



Rainfall accumulation over the simulation time for a specific NEXRAD pixel is displayed the following characteristics:



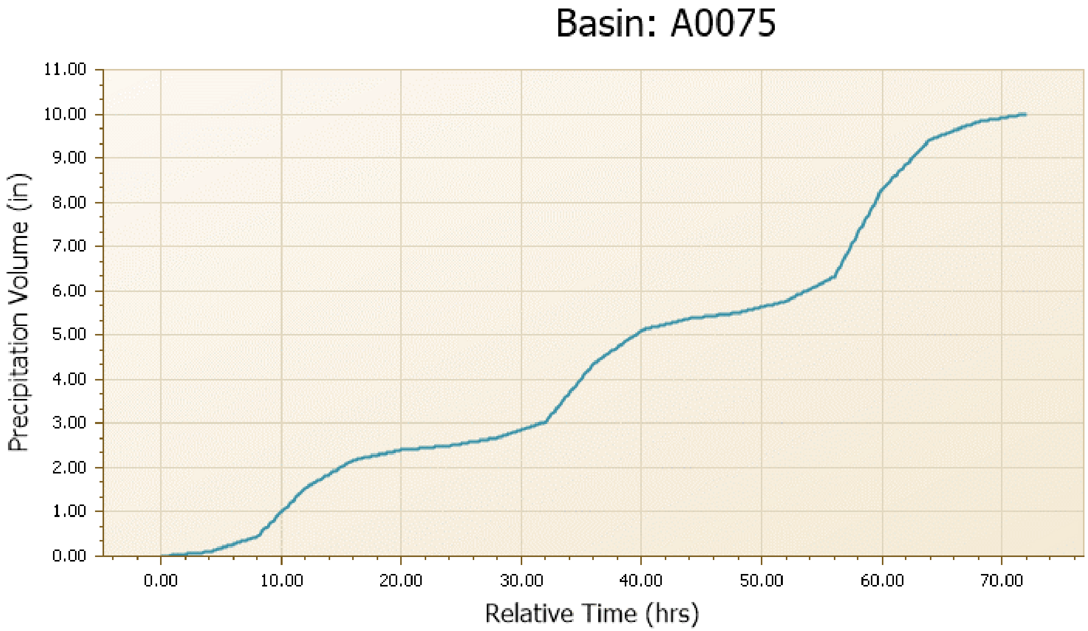
4.3.1 Boundary Conditions

Since the event is based on a three-day rainfall accumulation, we ran the neighboring watersheds for a similar 3-day (~72-hour) event with an average rainfall of 10.00 inches (the average accumulation across all pixels). We utilized the FDOT 3-day event with a volume of 10.00 inches. Each watershed (McKay Creek and Starkey Road) was run for the FDOT 3-day event and the corresponding time/stage data were extracted for the specific model nodes.

McKay Creek – BNDY_0040 and BNDY_0020 (McKay Creek mode nodes, NG0300 and NG0290, respectively)

Starkey Road – BNDY_0010 (Starkey Model Node NA1845).

The following rainfall accumulation curve for the FDOT design storm appears below:

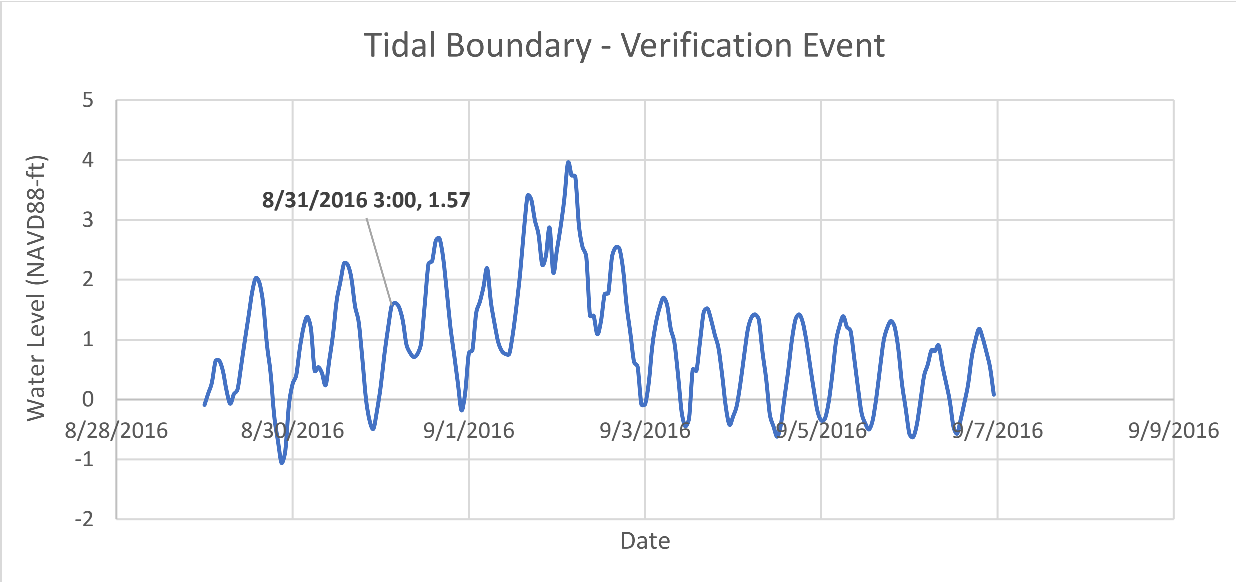


4.3.2 Soil Moisture

From the calibration effort, it was determined soil moisture properties with MC Initial set to MC Field provided the most accurate results. This approach was also applied to the verification model.

4.3.3 Tidal Boundary Conditions

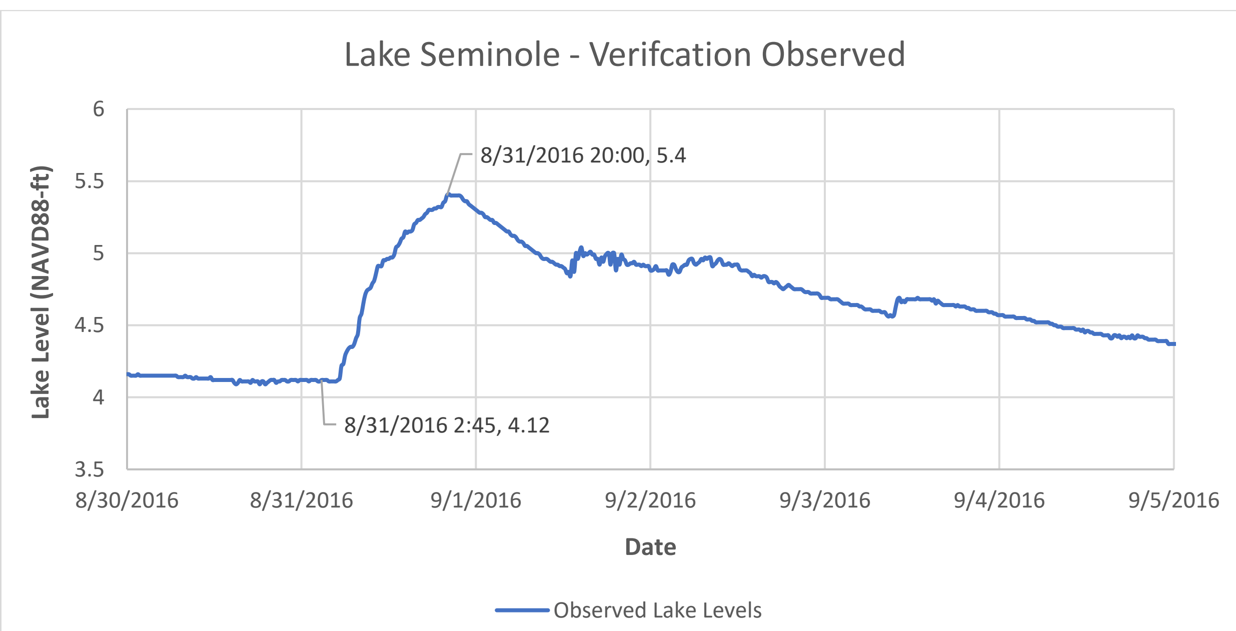
Data from the NOAA tidal gage (8726724 Clearwater Beach, FL) was downloaded for the August-September 2016 timeframe. Hourly data for the tidal boundary were added to the model through the time/stage boundary nodes (BNDY_0050, BNDY_0090, and BNDY_0030). The following chart displays the tidal fluctuations in NAVD88-ft for the verification time frame.



4.3.4 Initial Stages

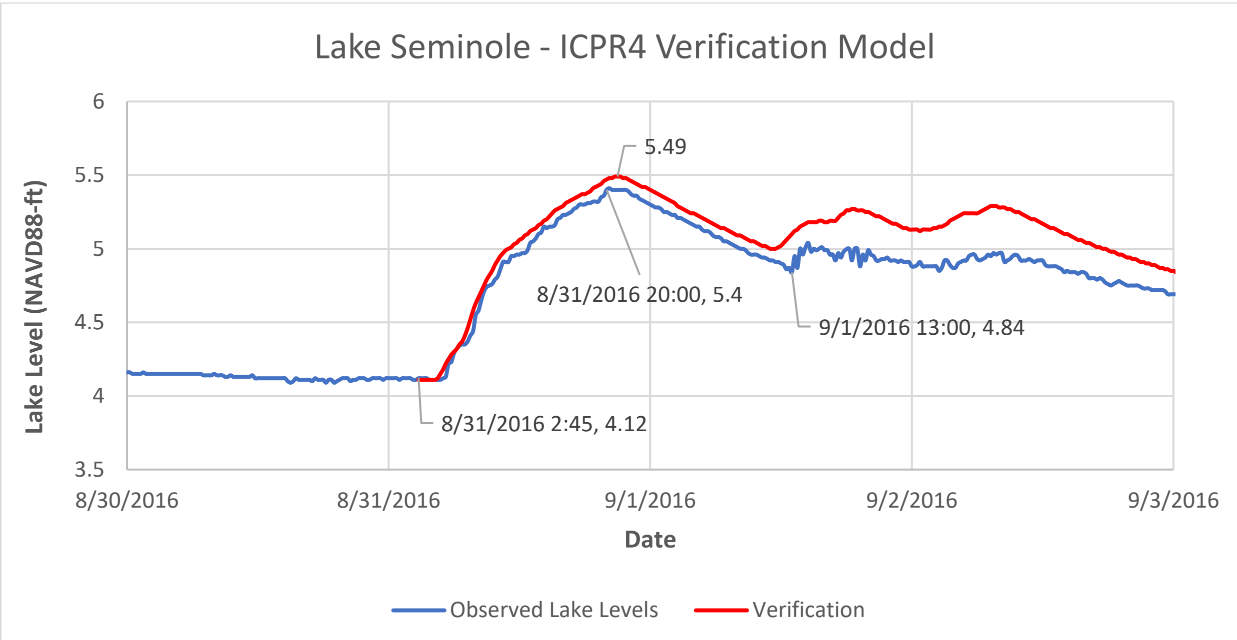
Initial conditions were adjusted based on the tidal influence at the start of the simulation. At the southern portion of the watershed, there are many tidally influenced nodes. These are often connected to outfall pipe systems. It is important to adjust the initial stages for these nodes to align with the tidal time series. All relevant tidally influenced nodes were updated with an initial stage of approximately 1.5 NAVD88-ft. This value also aligns with the design storm modeling.

The following chart displays the observed timeseries for Lake Seminole during the verification event:



4.3.5 Verification Results

The verification model appears to align well with the observed lake levels. The following chart displays the verification model run along with the observed lake levels for the Hurricane Hermine event:



The peak stage is within 0.1 feet and the overall behavior of the curves appears reasonable. Similar to the calibration model, the intent of the model is to simulate single events. The model deviates from the observed conditions at around 9/1/2016 13:00. This is understandable based on the implementation of hydrology within the model. The Green-Ampt soils do not have the ability to recover any soil storage – the soil storage is fixed during the initial model execution. As infiltration occurs, the soil storage is filled and there are no recharge mechanisms implemented. This is common practice for these types of models, and this could explain the deviation after the main application of rainfall. To capture the lake level dynamics more accurately for multiple events, a recharge or groundwater model component would be required. This was outside the scope of this project but could be considered in future studies.

5 KNOWN FLOODING LOCATIONS

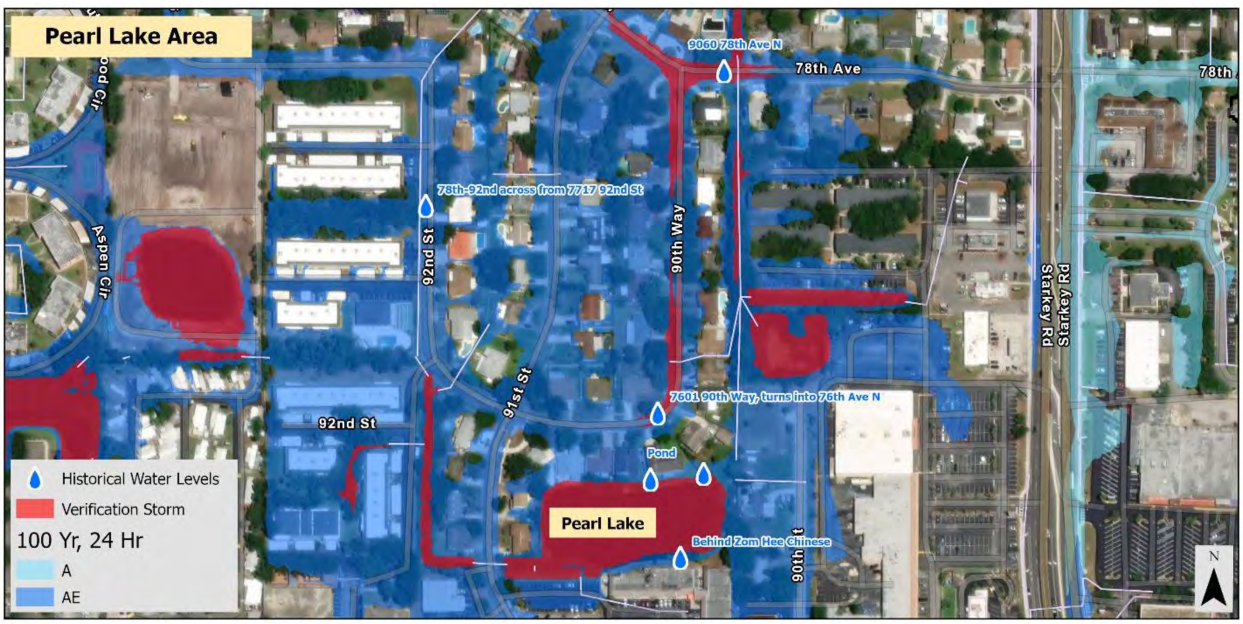
Through communications with the City, Applied Sciences identified three known flooding locations. The City provided qualitative descriptions regarding past flooding issues along with various flood photos from recent events. The known flooding conditions were reviewed and compared to the design 100 Year, 24 Hour event along with the Calibration and Verification events. The flowing section presents each location and describes the existing flooding conditions along with comparisons to the model results.

Location 1 – Pearl Lake

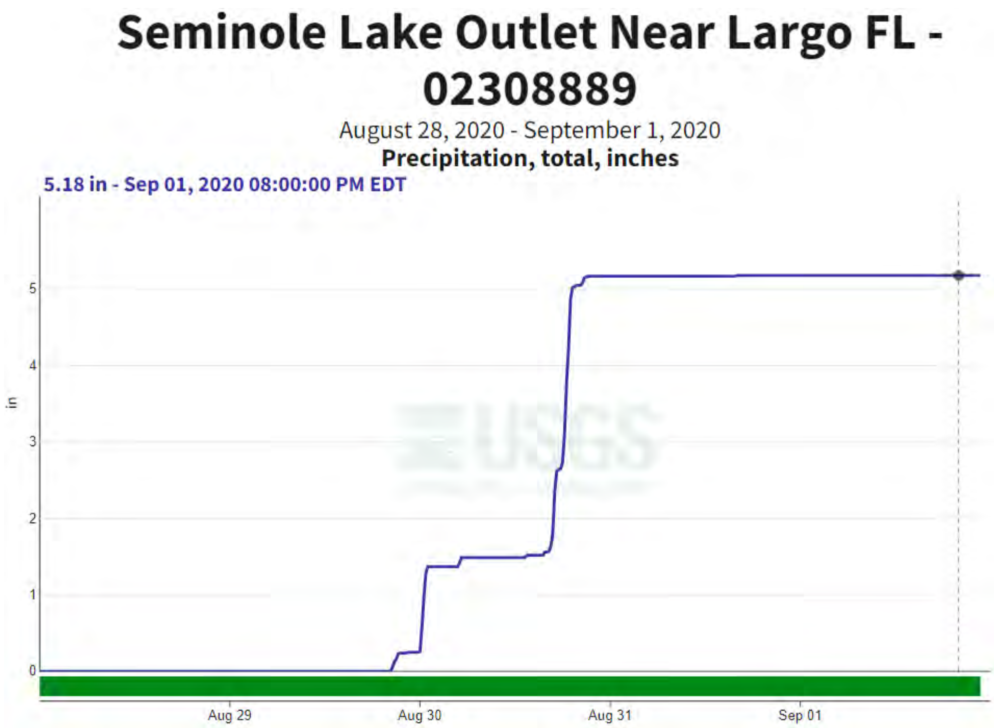
The City provided the following description for a recent flooding event that occurred in August 2022:

> *On August 8, 2022, the City had a 2-to-3-inch flooding rain in the evening. Several areas in the city experienced street and yard flooding. The Pearl Lake area was one of the worst. 79th Ave N, 92nd St and 78th Ave N, 90th Way and 78th Ave N had 2 to 2 ½ feet of water in the street. On the west side the water passed the sidewalk. Pearl Lake exceeded its banks flooding backyards along 76th Ave N.*

The City provided several flooding photos, most from the event described above. This area experiences repetitive nuisance flooding. Runoff is conveyed through open ditch systems, culverts, and stormwater ponds. Water flows south to Pearl Lake and then west to the Lake Seminole Bypass canal. Flooding is most likely the result of low-lying terrain and limited storage in Pearl Lake. The following graphic shows several point locations along with a few flood photos.



Although not directly modeled, the flood photos align with the Calibration and Verification events – we would expect to see street flooding along 78th Ave N and 90th Way. Applied Sciences extracted the observed rainfall from the two storm events described in the photos above – August 30, 2020, and August 8, 2022. The August 30, 2020, event produced around 5.18 inches of rain within a 24-hour period. The following rainfall accumulation graph was extracted from the USGS Lake Seminole gage station, see below:



The simulated Verification event showed around 6.37 inches of rainfall in 24-hours and produced a flooding response that appears to align well with the flood photos from August 2020. The following graphic displays a comparison between the provided flood photo and the Verification floodplain results. Red arrows were added to show estimated peak stages between the flood photo and the simulated Verification event.

9060 78th Ave N, Looking NE

Photo conditions from August 30, 2020

Verification Model Results

The August 8, 2022, event produced slightly less rainfall than the August 2020 event and may align better with the Calibration model. The USGS Lake Seminole gage station reported the following accumulated rainfall during this time, around 4.17 inches within a 24-hour period. A large portion of the rainfall (3 inches) was observed within a short period of time, indicative of an intense thunderstorm.

Peak stages between the Calibration and Verification events were within 0.25 feet in this area. The simulated Verification and Calibration events appear to align well with the observed flood photos, while the 100 Year, 24 Hour design storm modeling results appear to represent a much more significant flooding issue in this area. This area will likely be considered for the future BMP Alternative Analysis.

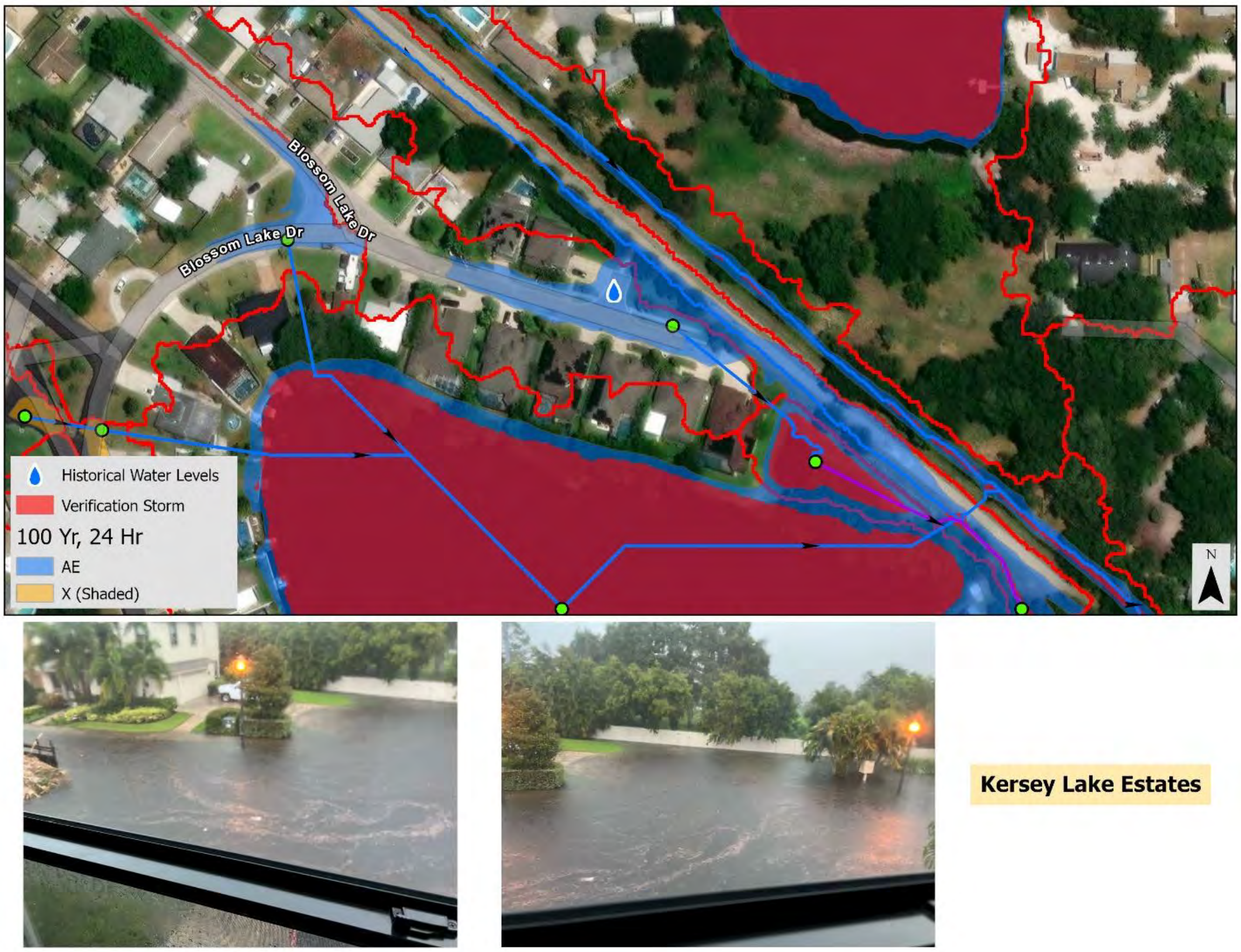
Location 2 – Grove Terrace and Oakdale Terrace

This area of the City is located between Seminole Blvd and 113th St, just east of the Seminole Garden Apartments. Grove Ter has swale/ditch/driveway culvert systems on both sides, while Oakdale Ter has a small outlet pipe draining north to a large 72-inch pipe system. The 72-inch pipe eventually discharges into Lake Seminole. The City notes that the western portion of Grove Terrace floods annually, including the roads and yards. The following graphic shows two locations along with a few flood photos from an unnamed rainfall event on November 10, 2022.

Observed flooding in these areas is mostly contained to the roadway and ditch systems. These flooding events are quite frequent and the 100 Year, 24 Hour event shows much greater inundation. The simulated Verification event shows some standing water in the ditch systems at the very westerly end of Grove Ter. Flooding is mainly related to low-lying terrain and the lack of traditional stormwater infrastructure. This area appears to be a good candidate for BMP Alternative Analysis in future tasks.

Location 3 – Kersey Lake Estates

The final location was identified as Kersey Lake Estates on Blossom Lake Trail. Kersey Lake Estates is a private community at the end of Blossom Lake Dr that receives most of the drainage from Blossom Lake Dr. Recent, high-intensity rainfall resulted in overtopping of the small stormwater pond at the very end of Blossom Lake Dr. The following graphic displays the location of the flooding and supporting flood photos from August 8, 2022.



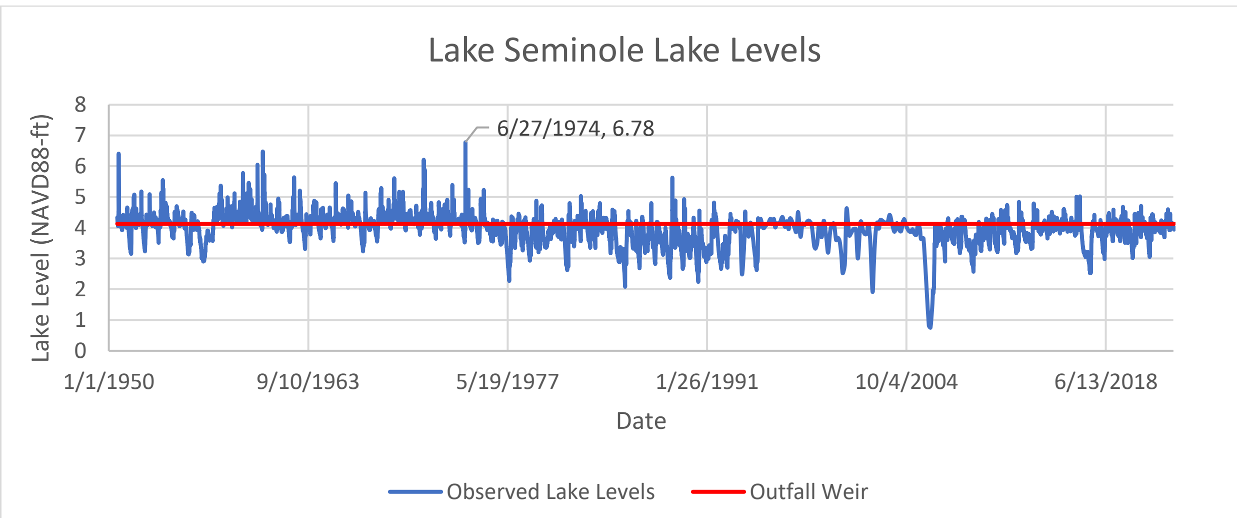
It is believed that high intensity rainfall can overwhelm the existing stormwater system, and downstream conditions along the Pinellas Trail do not allow for quick enough drainage. Additionally, a large amount of stormwater runoff is directed to this area from the northwest (along Blossom Lake Dr). The Verification model results do not show flooding in this area, most likely due to lower rainfall intensities as compared to the various design storms. This area is considered a local drainage issue and most likely will not be incorporated into the BMP Alternative Analysis.

6 FLOODPLAIN ANALYSIS

This section of the report further describes additional considerations related to the evaluation of the design condition watershed model. For this analysis, we evaluated the historical lake levels associated with Lake Seminole, compared model results from past studies, and evaluated the impacts of multi-day events. These comparisons provide confidence in the proposed floodplains and offer additional justification for the model performance and floodplain delineation.

6.1 Historical Lake Levels

Historical lake levels for Lake Seminole were downloaded from the USGS gage station (Seminole Lake Outlet Near Largo FL, 02308889) and the historic gage (USGS 02308888 SEMINOLE LAKE NEAR LARGO FL, 02308888). Data from both gage stations was aggregated with a total period of record from 1950 to current. The historic data was reported in NGDV29-ft and was converted to NAVD88-ft with the model wide conversion factor of -0.87 feet. The following figure displays the historic lake levels over time:



The above figure also displays the invert elevation of the fixed outfall weir on the downstream end of Lake Seminole. Fluctuations above and below the weir invert indicate wet season and dry season periods, respectively.

Through statistical analysis of the yearly max stages for the lake, we were able to approximate return period water levels corresponding to the same return periods of the design storm models – 2.33, 5, 10, 25-, 50-, 100-, and 500-year events. The following table displays the estimated return period stages and design storm modeling results:

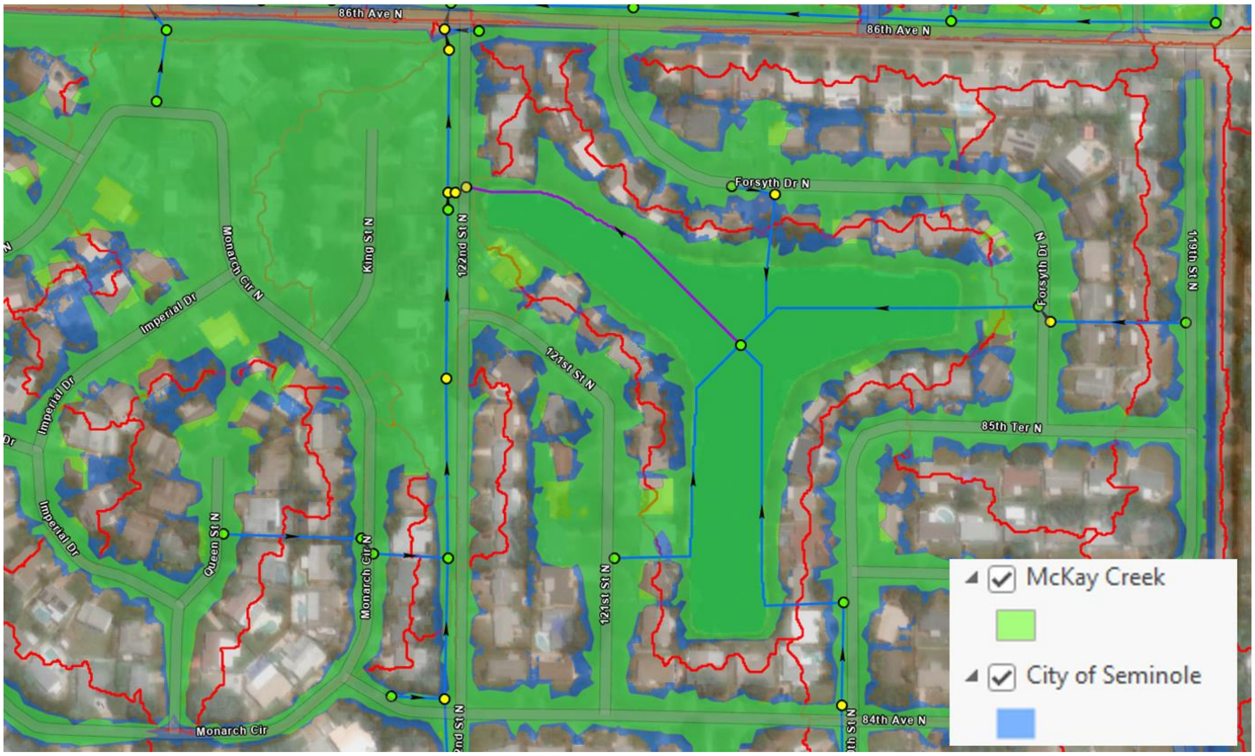
Return Period	Rainfall (inches)	Predicted (NAVD88-ft)	Design Model (NAVD88-ft)	Difference (ft)
2.33-Year	4.75	4.76	5.05	0.29
5-Year	5.96	5.2	5.28	0.08
10-Year	7.22	5.6	5.52	-0.08
25-Year	9.32	6.14	5.98	-0.16
50-Year	11.2	6.57	6.41	-0.16
100-Year	13.4	7.02	6.84	-0.18
500-Year	19.5	8.15	7.78	-0.37

In general, the statistical lake data and the observed modeling data appear to align well. Some deviations are noted for the smallest storm and the more significant events. We can compare the modeled Verification event to the 5-Year and 10-Year design storm events due to similar rainfall volume volumes. During the initial portion of the Verification storm (8/31/2016), around 6.37 inches of rainfall was observed. Lake Seminole responded with a peak stage around 5.4 NAVD88-ft. This Verification event appears to align well with the design storm simulations. The observed lake level and observed rainfall falls between the design storm peak stage and rainfall volume, further supporting the reasonableness of the model.

The larger events (like the 500-year storm) might not be reflected in the underlying dataset and could be related to the inherent properties of the lake/outfall system. There could be a type of limit to how high the lake would get when the lake elevations start entering the 7.5 to 8.0 ft level. This analysis provides *some* understanding for the model performance related to the various statistical rainfall events.

6.2 Past Studies – McKay Creek

The McKay Creek watershed model was developed in 2013 by Jones Edmunds and Associates (JEA). The model overlaps a portion of the City of Seminole in the northwest portion of the watershed (see Exhibit 2 in the Appendix). Many of the overlapping model features were extracted from the McKay Creek model for use in the City of Seminole model. It is expected that the overall floodplain extent would be similar for both models for the overlapping areas. The following figure demonstrates similar floodplain extents between the two models:



The McKay creek model simulated the 100 Year, 24 Hour event with 12.0 inches of rainfall, compared to the 13.4 inches used for the City of Seminole. Because of this, we would expect the City of Seminole model results to be *slightly* higher than the McKay Creek study. Although qualitative, the comparison of the 100 Year, 24 Hour floodplains between the two models provides confidence in the performance/reasonableness of the new City of Seminole model.

6.3 Multi-day Events

It is important to determine the impact of a multi-day storm on the performance of a watershed model. Applied Sciences ran equivalent return period events (100 Year) with a 24 hour and 120-hour (5-day) duration. For this watershed, it is anticipated that the single day event would, in general, produce higher peak stages across the watershed. This phenomenon is often related to the influence of the application of rainfall over time. For the 24-hour design storm, the intensity of rainfall is quite high and drives runoff response in the watershed more dramatically. The following figure demonstrates most nodes in the watershed were shown to have a higher peak stage in the 24-hour event as compared to the 120-hour simulation:

Simulation	Node Count, Higher Peak Stage
100 Yr, 24 Hr	1,737
100 Yr, 120 Hr	338

Since most nodes responded higher in the 24-hour event, Applied Sciences recommends using the 100-Yr, 24-Hr simulation to represent model floodplains.

6.4 Floodplain Open House Meeting

After the development of the initial City of Seminole watershed model, Applied Sciences, the City of Seminole, and SWFWMD hosted an in person public meeting to present floodplains and model results to residents. Applied Sciences developed detailed maps for the watershed and the City assisted with printing needs. See **Exhibit 20** for the overall watershed index map. Additionally, a web-based map viewer was created for residents to digitally view the floodplain model results and provide spatially referenced comments. Finally, the City mailed around 6,000 letters to potentially impacted residents.

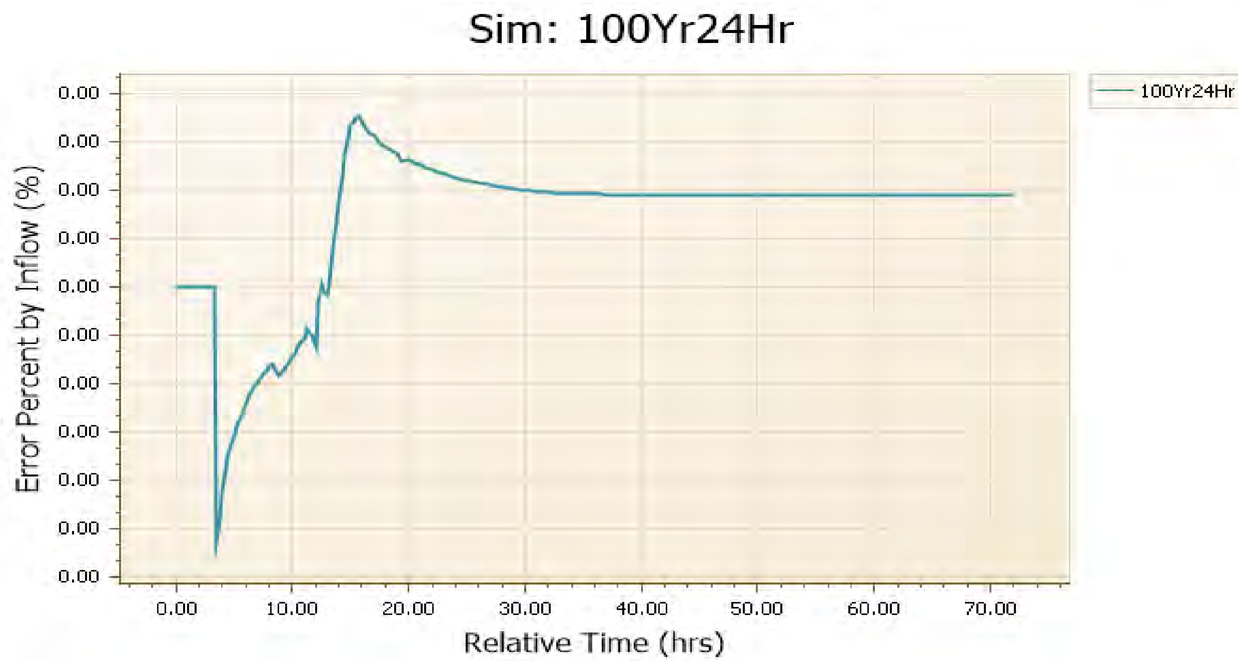
The meeting was originally scheduled for 8/29/2023 but was rescheduled to the following week due to Hurricane Idalia. The open house meeting was officially completed on 9/5/2023 at the Seminole Recreation Center. Residents were invited to provide feedback on the model results, talk with City/District/Consultant staff, and view detailed information on accompanying laptops – see the following photos from the event.

Around 45 people attended the in-person meeting, and overall Applied Sciences received and reviewed around 88 comment cards. See **Exhibit 21** for a summary of the received comment locations. These comments were organized in a file geodatabase and maps were developed for residents upon request. The maps were designed to show a comparison between the preliminary model results and the effective FEMA data. During the review of the public comments, Applied Sciences identified several areas requiring additional fieldwork and model updates. Over the next few months, Applied Sciences completed model revisions and updates to reflect a more accurate watershed model. Additional pipes were surveyed and added to the model, while existing pipes were field verified for connectivity, correct dimensions, and inverts.

6.5 Hydraulic Stability, Continuity and Model Performance

Instabilities in the model were reviewed and addressed in several ways to ensure that peak flood stage results were reasonable:

- A spatial review of the plotted floodplains from the 100-Yr, 24-Hr design storm was conducted to identify glass wall situations. These were remedied by the addition of overland weirs.
- Model hydrographs were reviewed to identify any situations where flow occurred at time zero. These instances were remedied by investigating and revising initial stages. Some minor initial flows can be expected in a detailed watershed model like that of the City of Seminole due to the complexity of hydraulic connectivity. These minor flows should be considered insignificant and do not impact the reasonableness of model results.
- Link flow hydrographs were reviewed to identify links which contained excessive flow or instabilities.
- Simulations were run free of Error and Warnings.
- Mass balance report in ICPR4 indicates a very small routing error of nearly 0%, see screenshot below:



6.6 Floodplain Delineation

Applied Sciences utilized Arc Hydro tools to delineate floodplains for the 100-Yr, 24-Hr design storm, Calibration, and Verification events. Node peak stages were exported from ICPR4 reporting functions and joined to the appropriate tables in the GWIS geodatabase. The GeoICPR tool requires the population of the ICPR_NODE_RESULTS and the VariableDefinition tables. Additional inputs include the ICPR_NODE, ICPR_BASIN, and DEM features. All model simulation results were populated in the ICPR_NODE_RESULTS table (500, 100, 50, 25, 10, 5, 2.33, Verification, and Calibration), but floodplain maps were only generated for the 100-Yr, 24-Hr, Calibration, and Verification event, see **Exhibit 17**, **18**, and **19**, respectively.

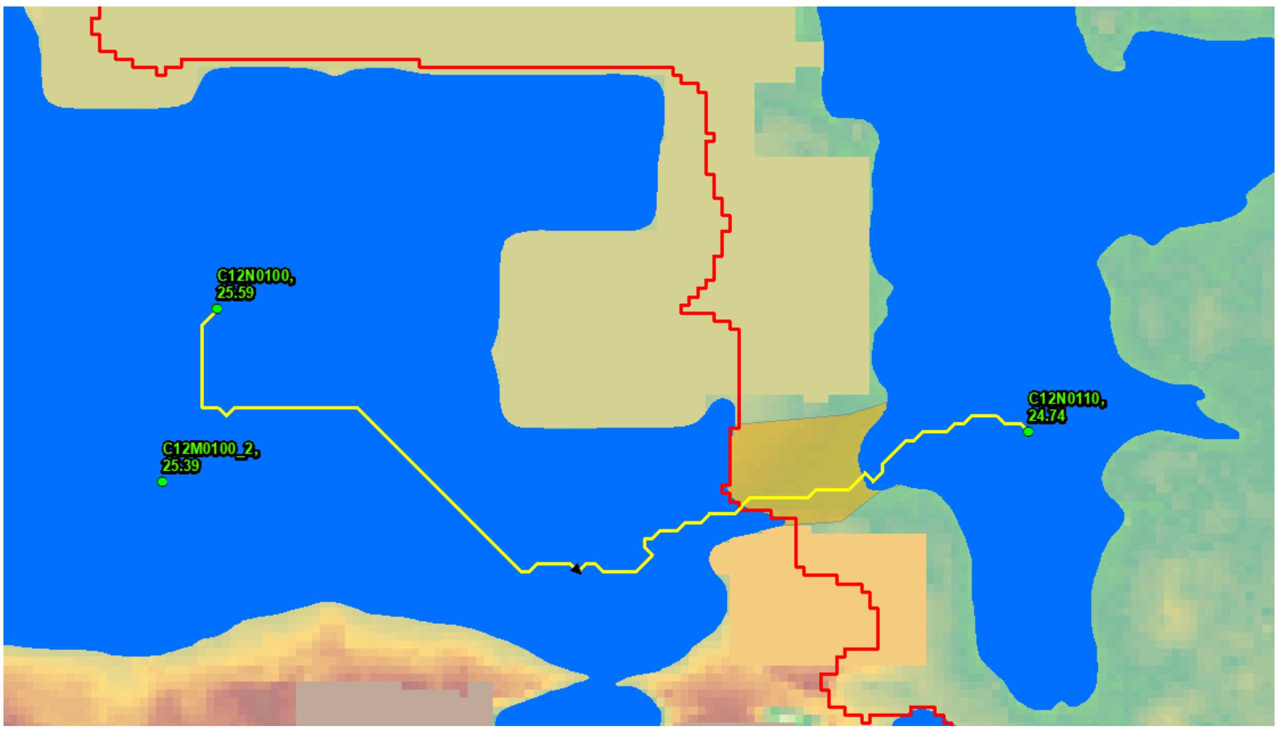
The tool was executed to include disconnected polygons, a configuration that may result in floodplains developing away from the storage node. Any resulting floodplain features less than 2,500 square feet were removed from the polygon feature classes. The results of the GeoICPR tools were further refined using the eliminate and smoothing tools. A sliver/hole area of 2,500 square feet and a smoothing length of 20 ft were used to parameterize these tools.

6.7 Transition Zones

After a brief review of the delineated floodplains, several locations were identified for the development of transition zones. These floodplain features often represent locations where overland weirs overtop the cross section with a certain depth and flowrate. For the City of Seminole watershed study, the following criteria were generally followed:

- Overland weirs with depth at the invert greater than 0.5 feet and a max flow rate greater than or equal to 10 cfs
- No transition zones developed for:
    - o Overland weir links with long physical distances between from and to nodes
    - o Connections that flow over Hydrologic Group Type A soils with flow paths greater than 500 ft

The delineation of transition zones is a subjective process, where the floodplain feature is manually delineated based on the connectivity, terrain, and other notable features. The following figures demonstrates an example of a transition zone (delineated in orange):



6.8 FEMA Naming Conventions

Most of the delineated floodplains were classified as AE zones. These features contain model derived Base Flood Elevation (BFE) values. Additionally, each model basin should have a unique floodplain feature, see GWIS_FLOOD feature class in the Watershed feature dataset of the geodatabase deliverable. Any floodplains that were disconnected from the storage node were assigned as A zones.

The total number of flood zone features and types of floodplains are described below:

- 1,359 Total Features
  - 1,170 AE Zones
  - 189 A Zones
    - 91 Transition Zones (labeled as FEMA_ZONE A)

6.9 Floodplain Area – City of Seminole

The processed, level pool floodplains were clipped to the City municipal boundary to determine the total area of flooding impact. Based on this analysis, approximately 22% of the City area is impacted during the 100 Year, 24 Hour event. This analysis does not account for typically inundated areas like open water surface ponds or wetlands. Applied Sciences further expanded this analysis by utilizing the initial stage polygons or the GWIS Waterbody feature class from the project deliverables. The following table displays these results:

Metric	City Boundary	100 Year, 24 Hr	Open Water Surfaces
Area, Acres	3,630	807	355
% Area	-	22	10

By taking into account the typically inundated areas (wet ponds, wetlands, etc.) the overall impact to the City reduces to around 12%.

Note: Only level pool floodplains were generated for the City of Seminole watershed. The city lacks traditional creek/channelized flow systems. Instead, large, concrete stormwater features like pipes and box culverts are used to transport stormwater/runoff.

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8 EXHIBITS

Exhibit 1 City of Seminole Watershed Boundary

Exhibit 2 SWFWMD defined Watershed Boundaries

Exhibit 3 Watershed Models

Exhibit 4 DEM

Exhibit 5 WBIDs

Exhibit 6 Sub-watersheds

Exhibit 7 Soils

Exhibit 8 LULC

Exhibit 9 FEMA

Exhibit 10 Stormwater Inventory

Exhibit 11 ERPs

Exhibit 12 Field Data Acquisition

Exhibit 13 Hydro Network

Exhibit 14 HEP Network

Exhibit 15 Boundary Conditions

Exhibit 16 Model Network

Exhibit 17 Design Floodplains, 100 Year

Exhibit 18 Calibration Floodplains

Exhibit 19 Verification Floodplains

Exhibit 20 Public Meeting Index Map

Exhibit 21 Public Meeting Comment Summary

Exhibit 1 City of Seminole Watershed Boundary

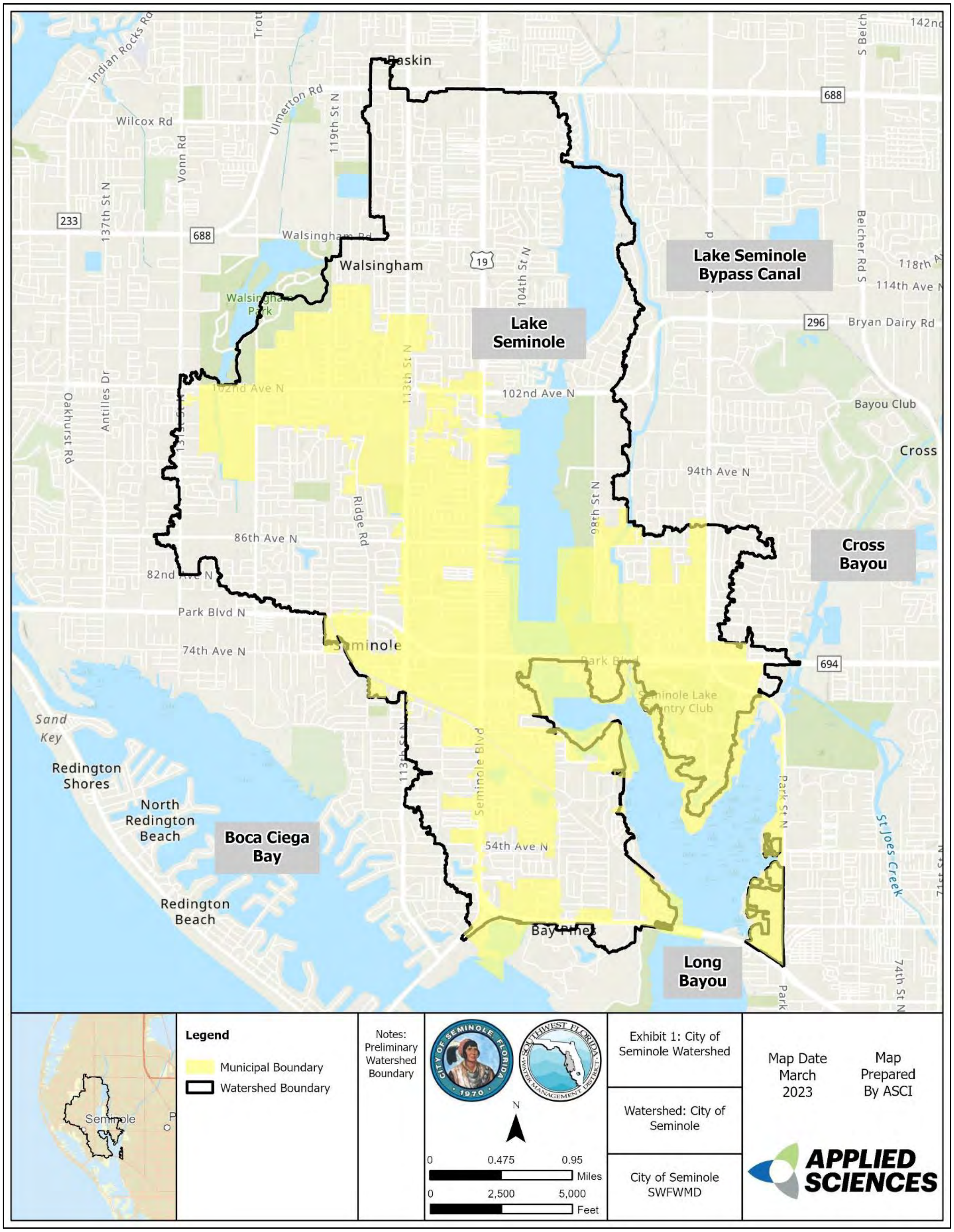


Exhibit 2 SWFWMD defined Watershed Boundaries

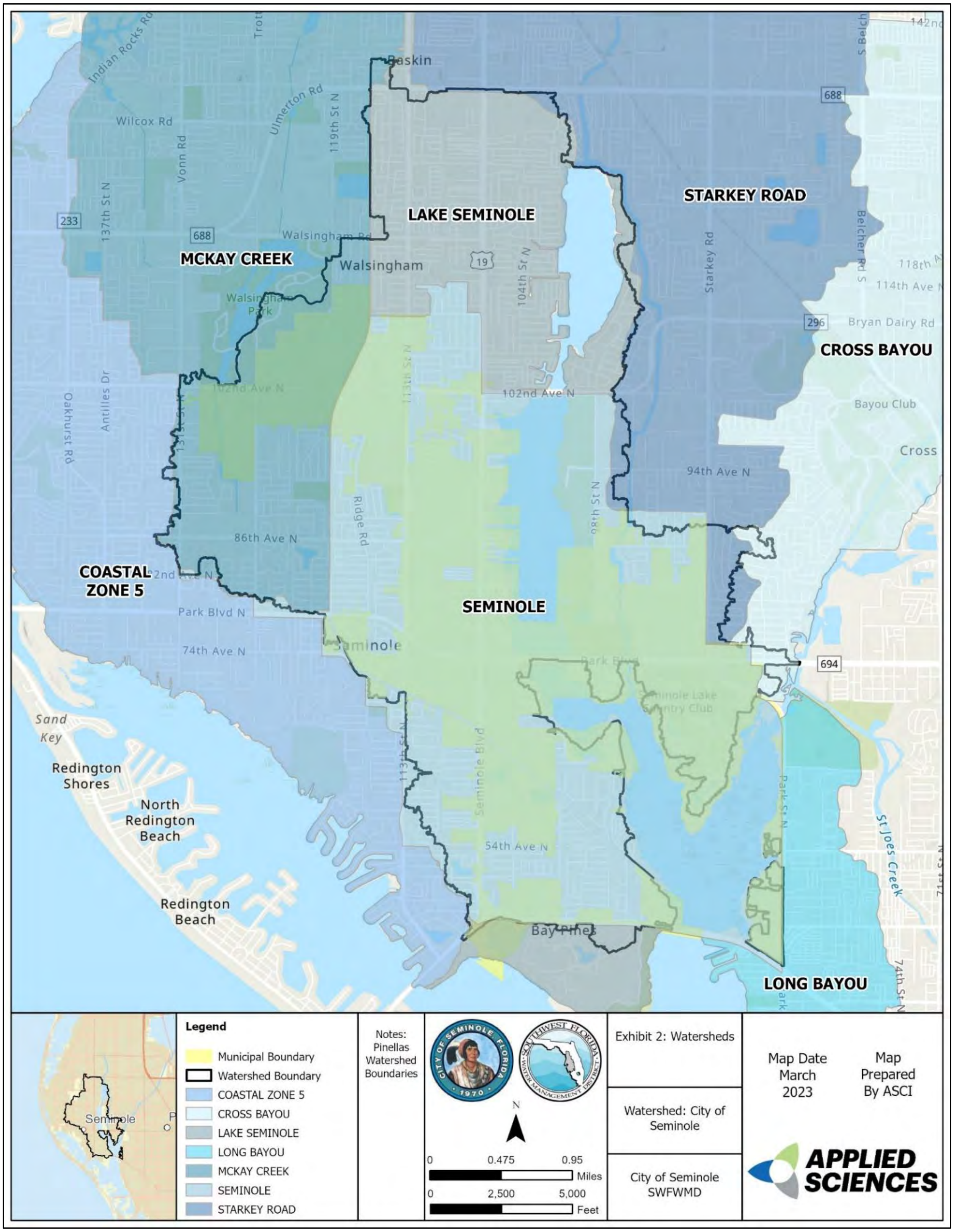


Exhibit 3 Watershed Models

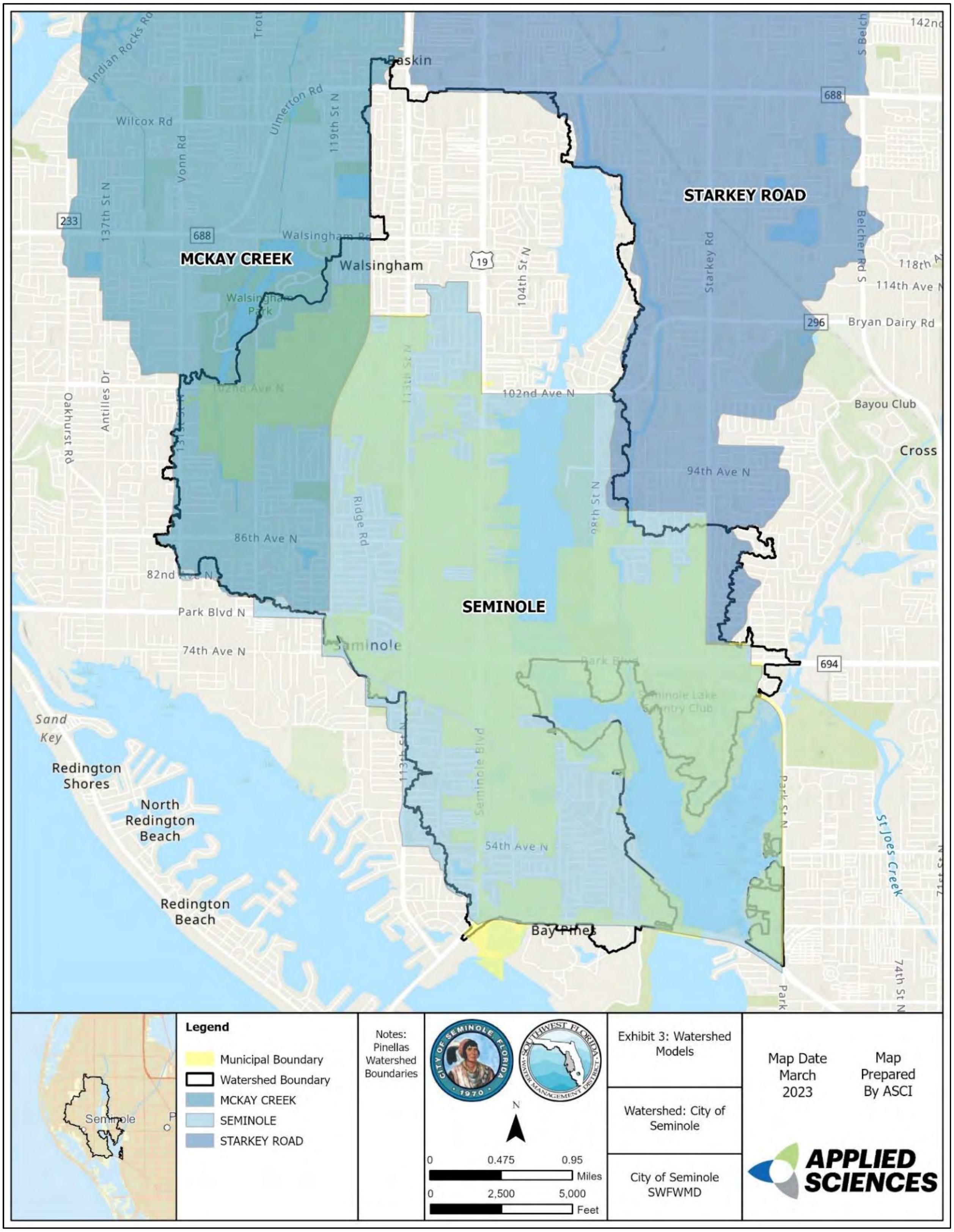


Exhibit 4 DEM

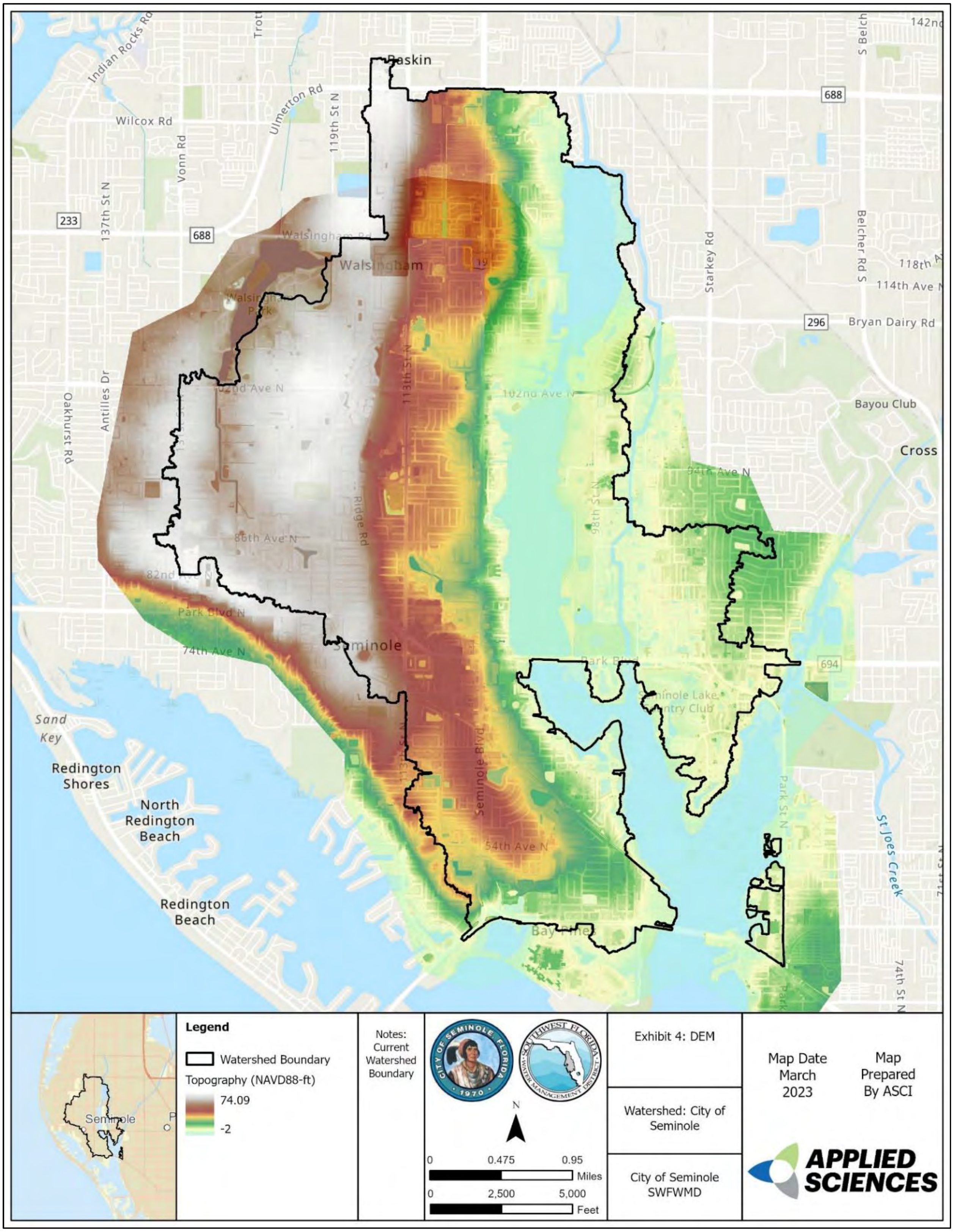


Exhibit 5 WBIDs

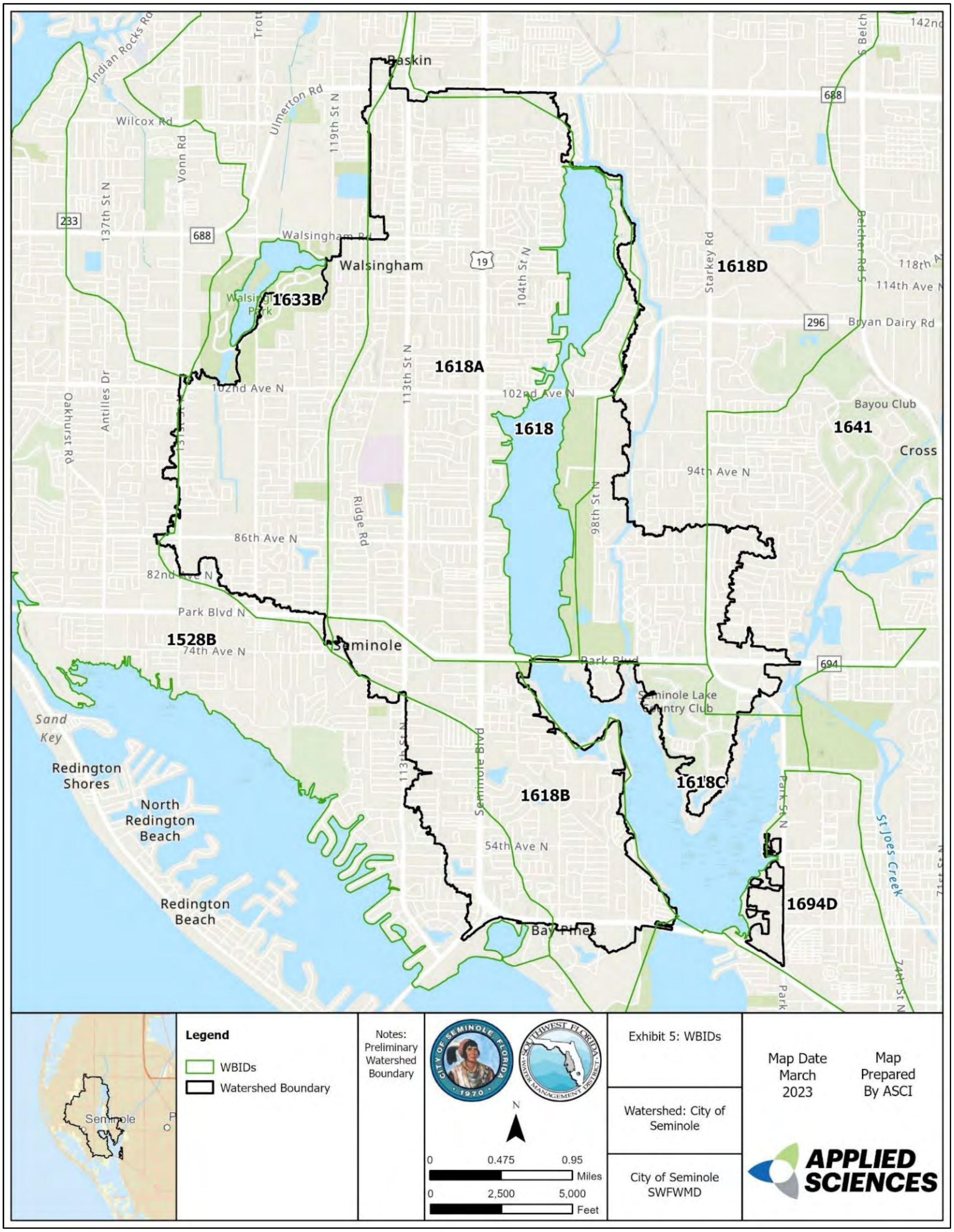


Exhibit 6 Sub-watersheds

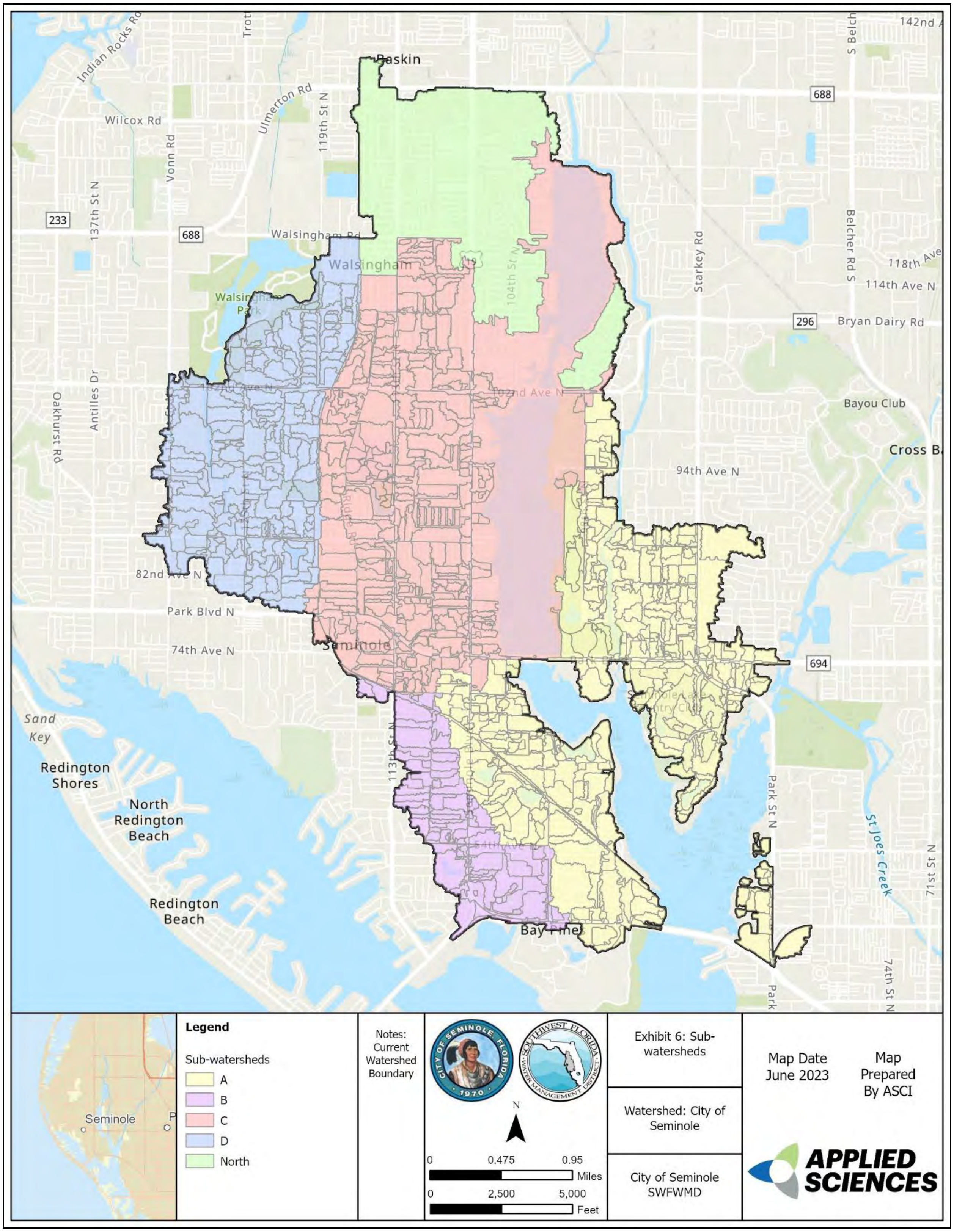


Exhibit 7 Soils

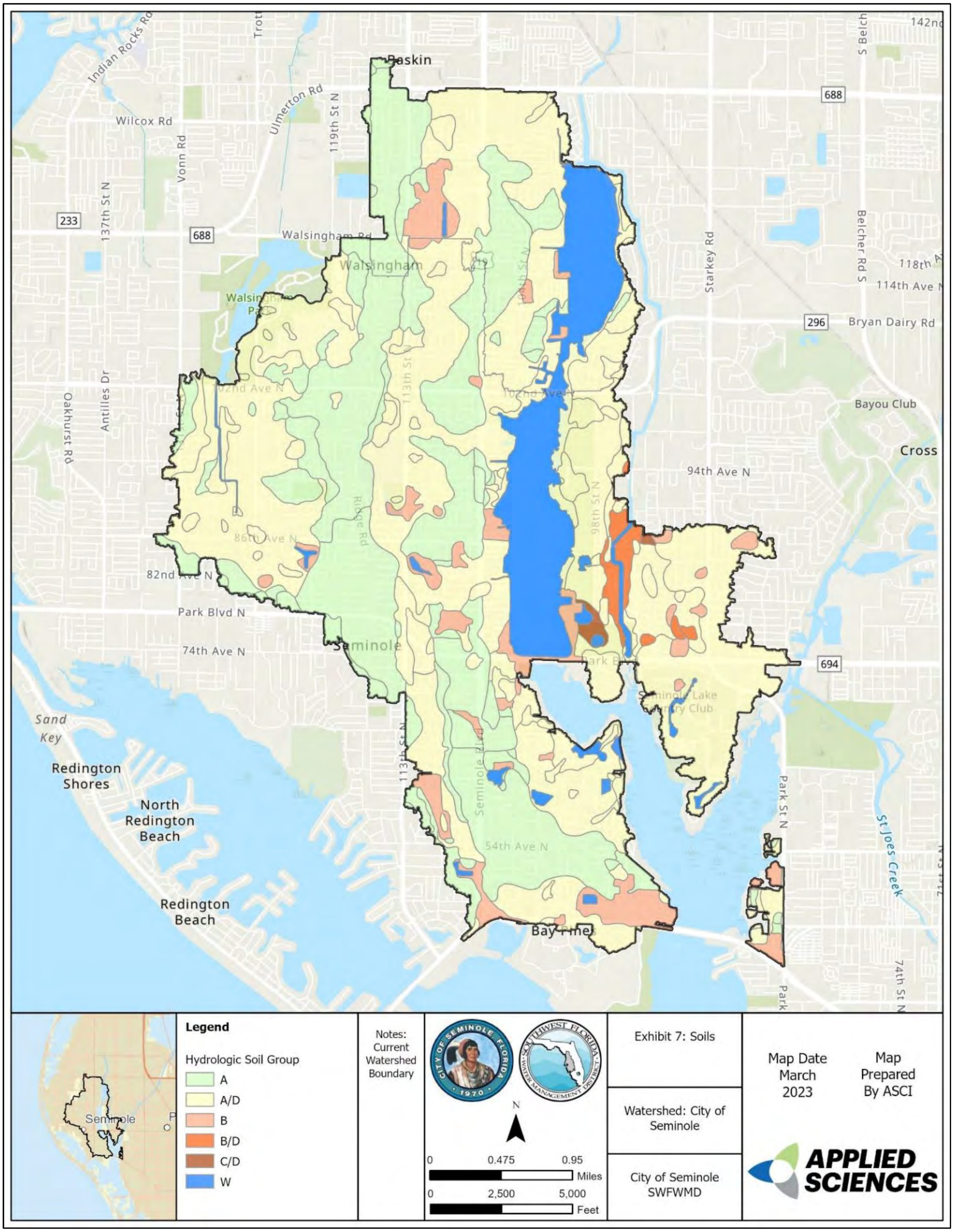


Exhibit 8 LULC

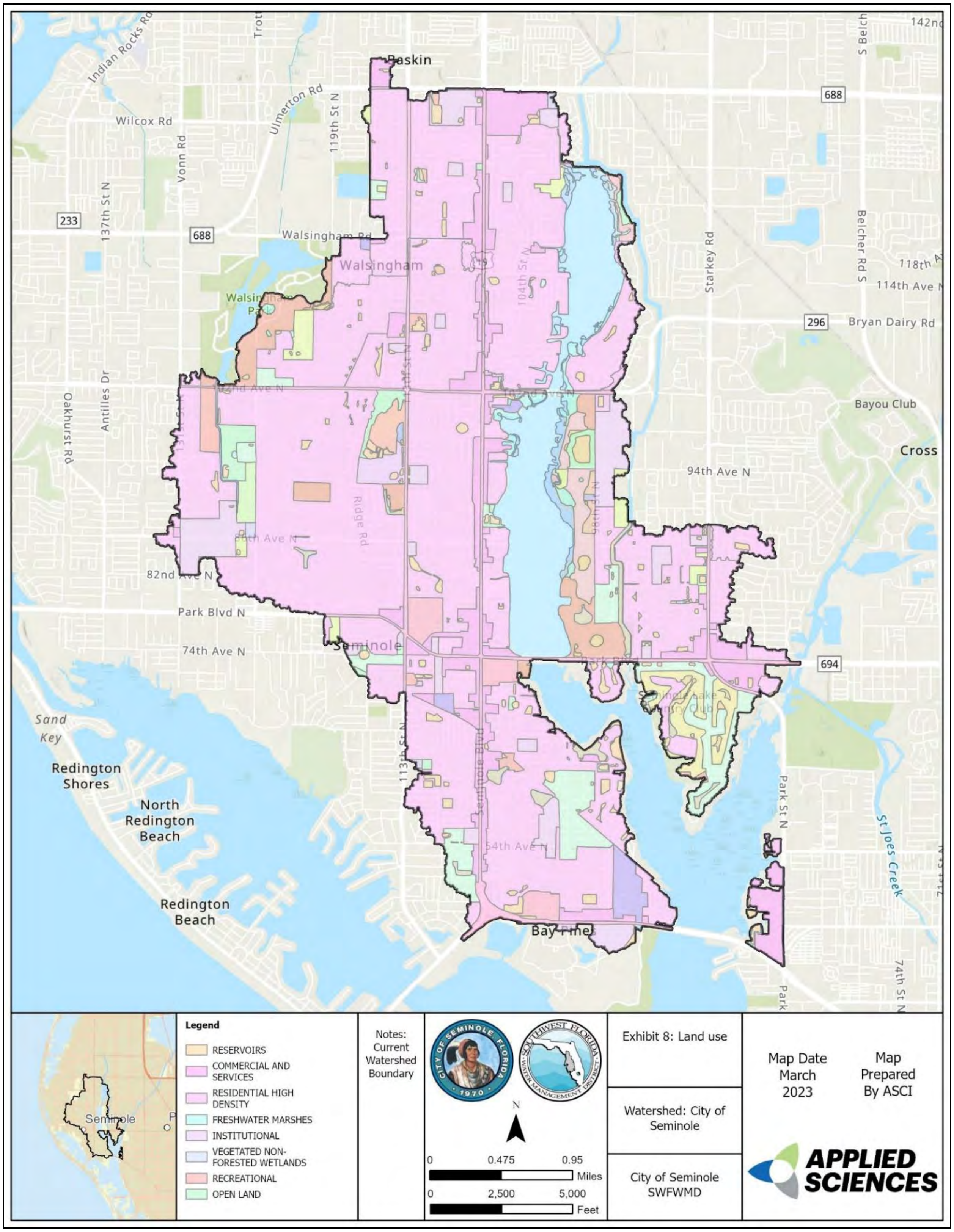


Exhibit 9 FEMA

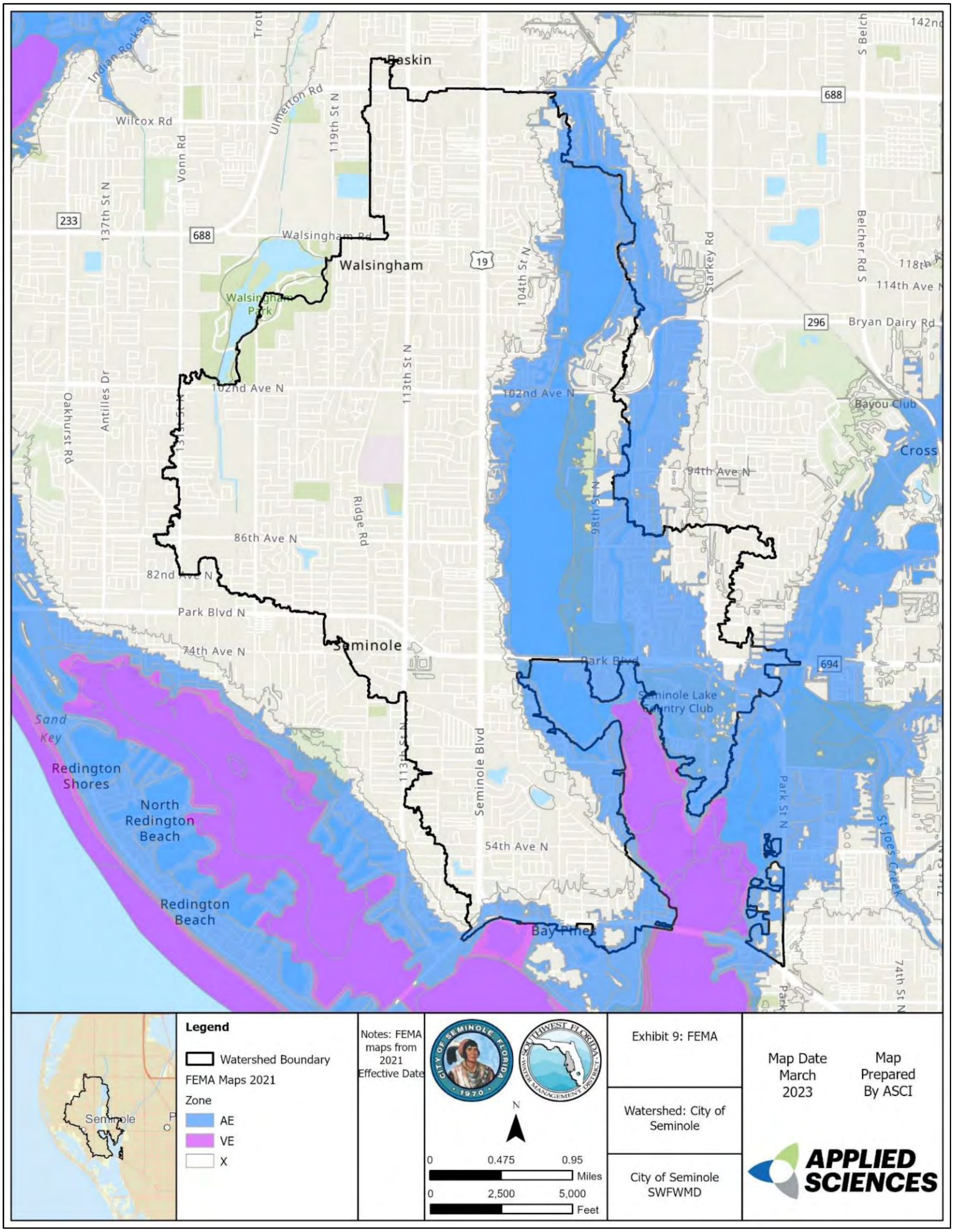


Exhibit 10 Stormwater Inventory

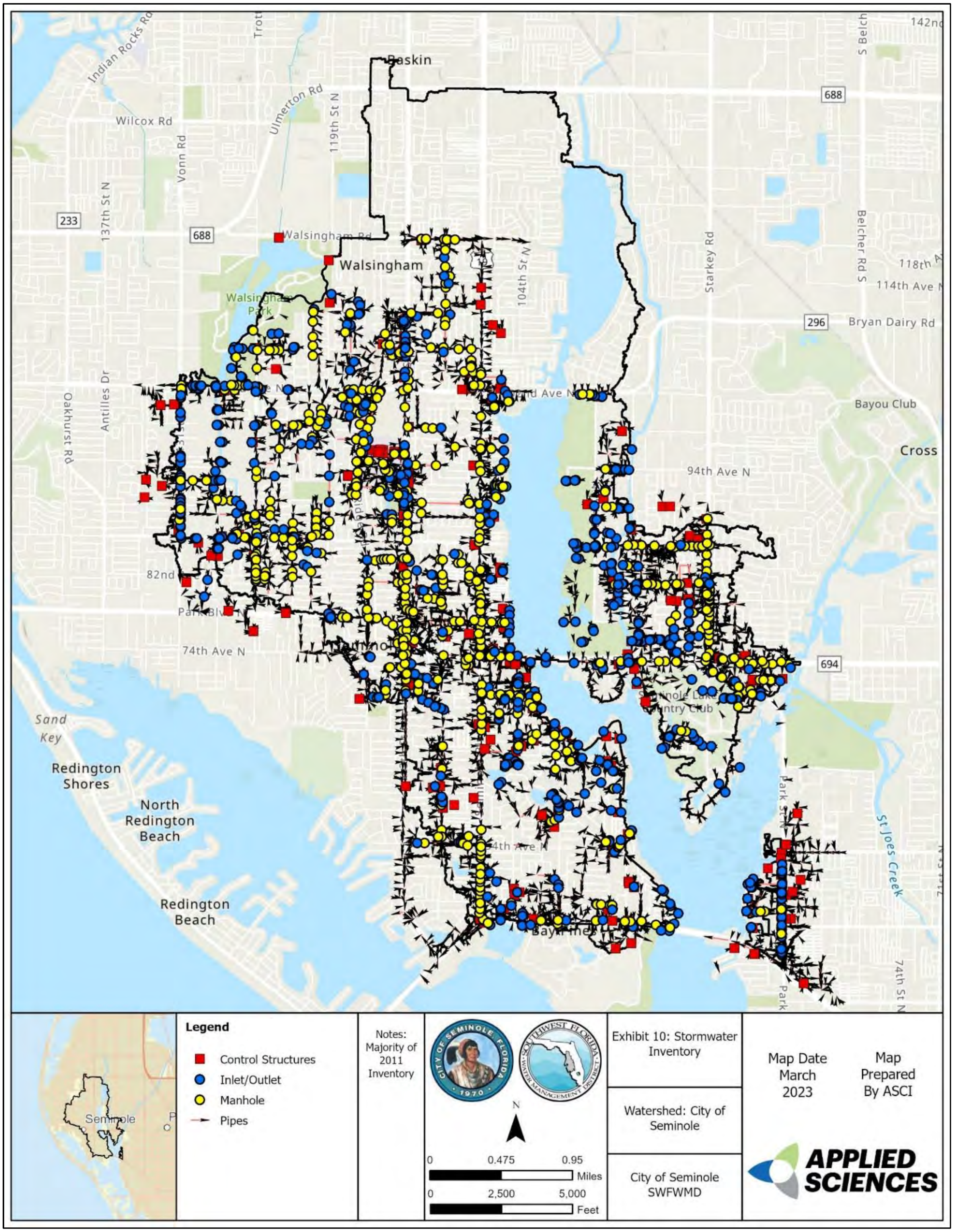


Exhibit 11 ERPs

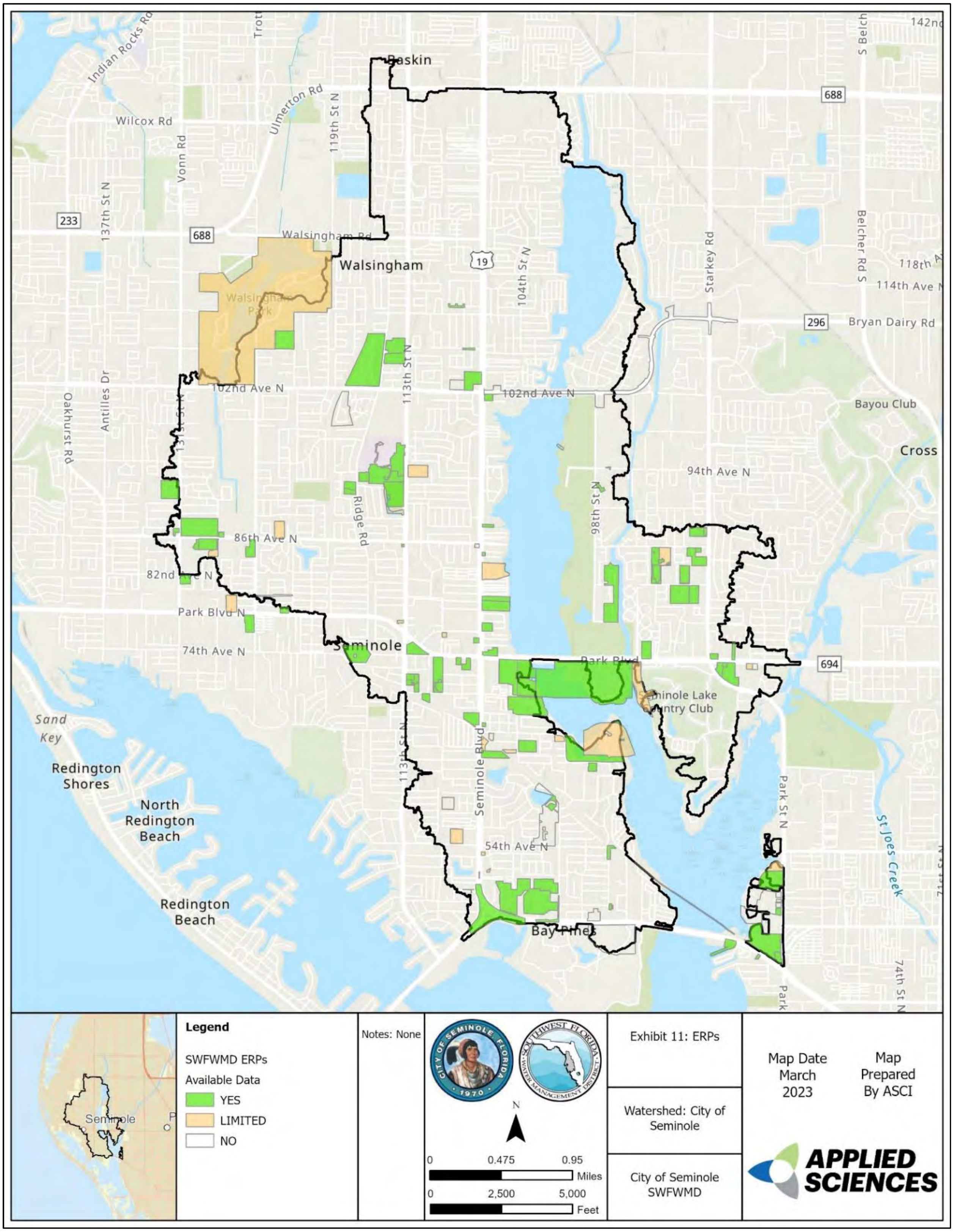


Exhibit 12 Field Data Acquisition

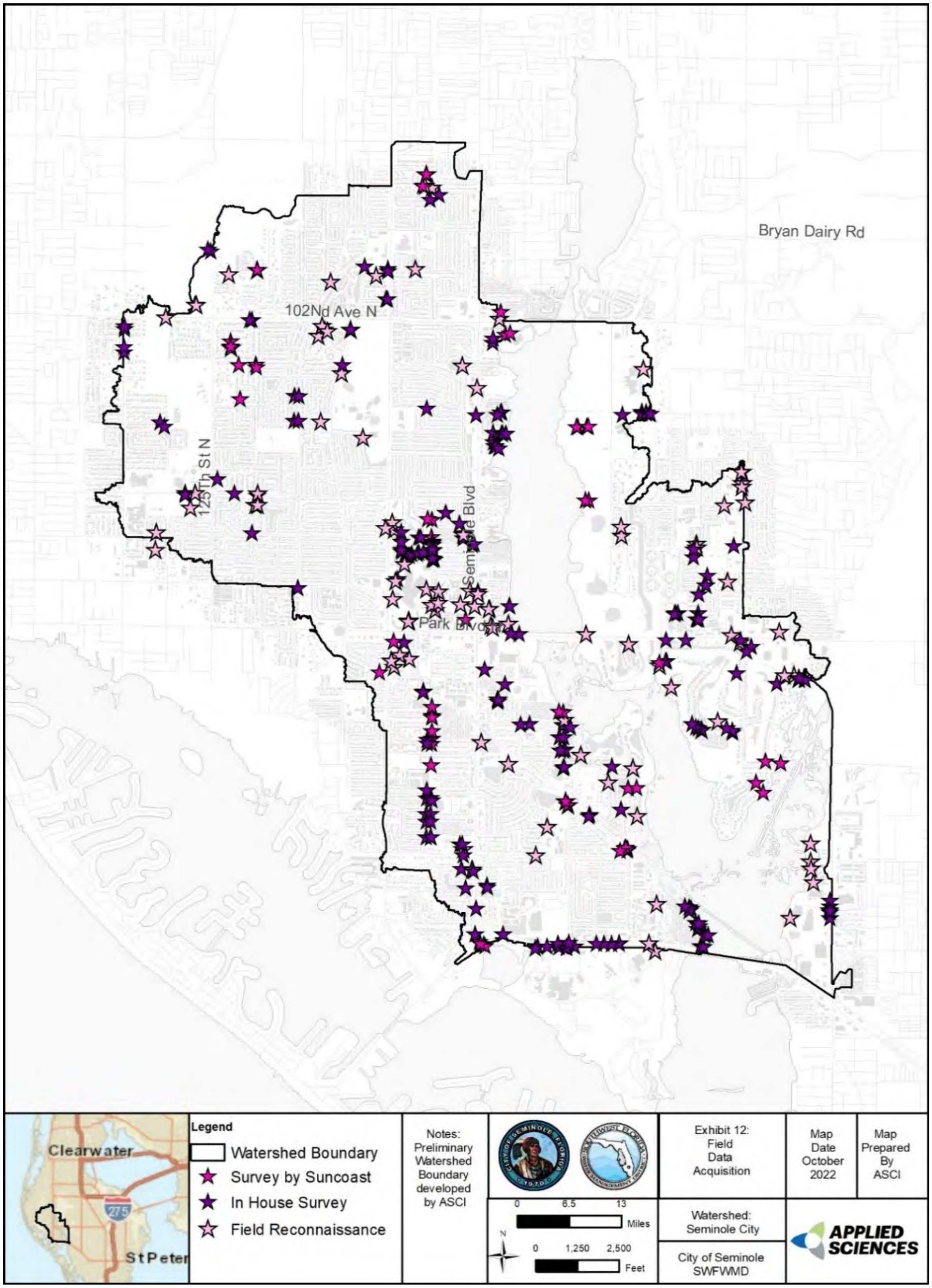


Exhibit 13 Hydro Network

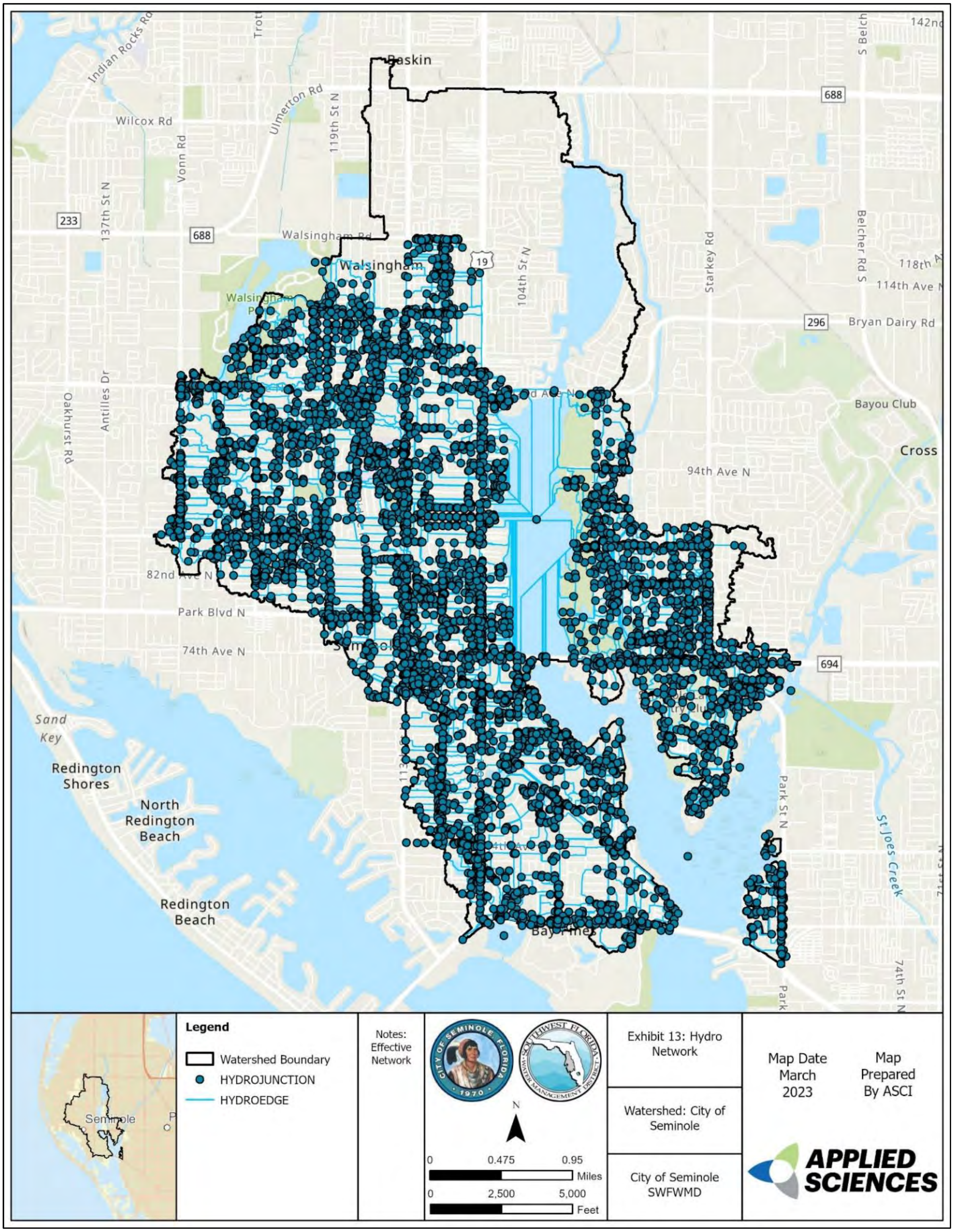


Exhibit 14 HEP Network

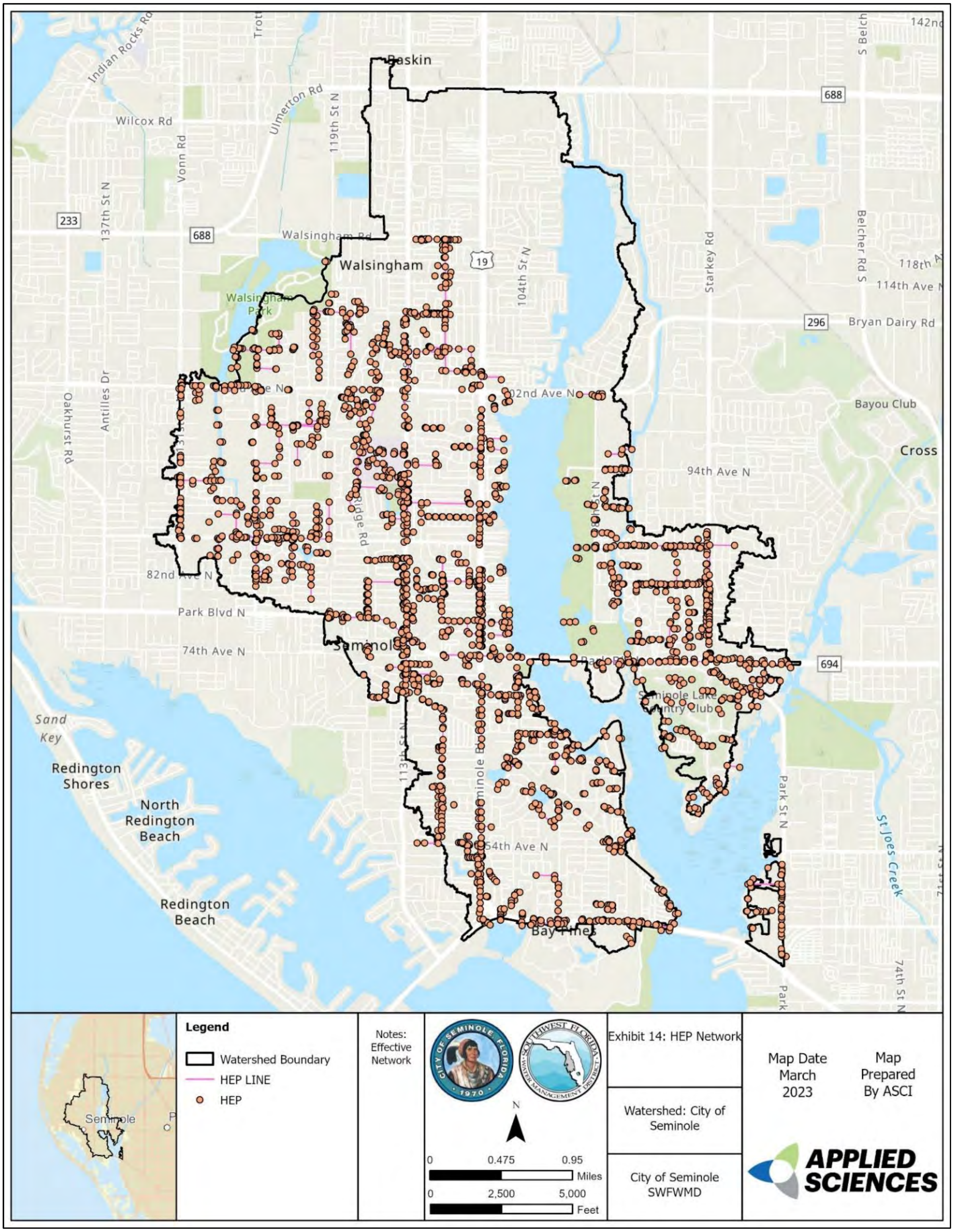


Exhibit 15 Boundary Conditions

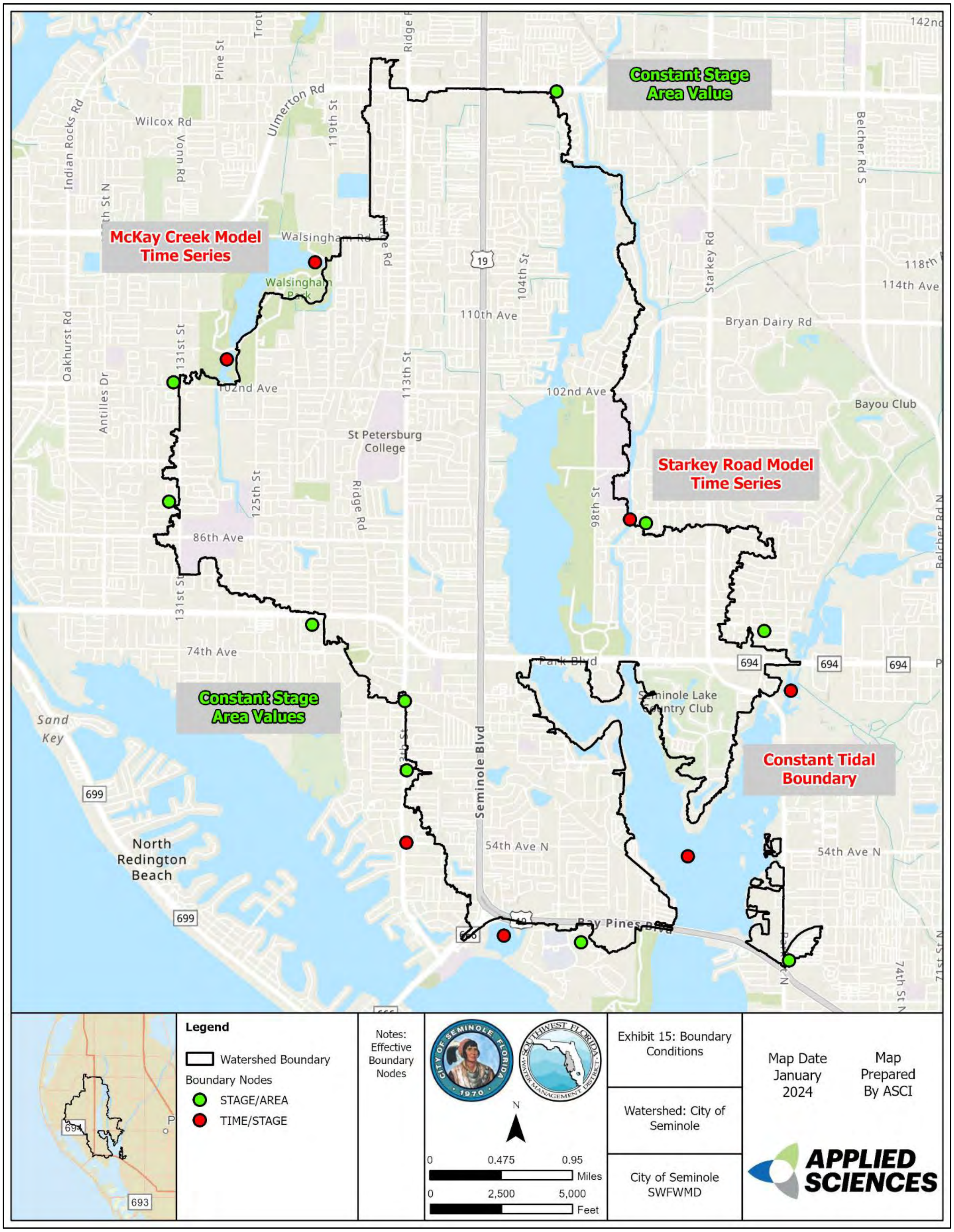


Exhibit 16 Model Network

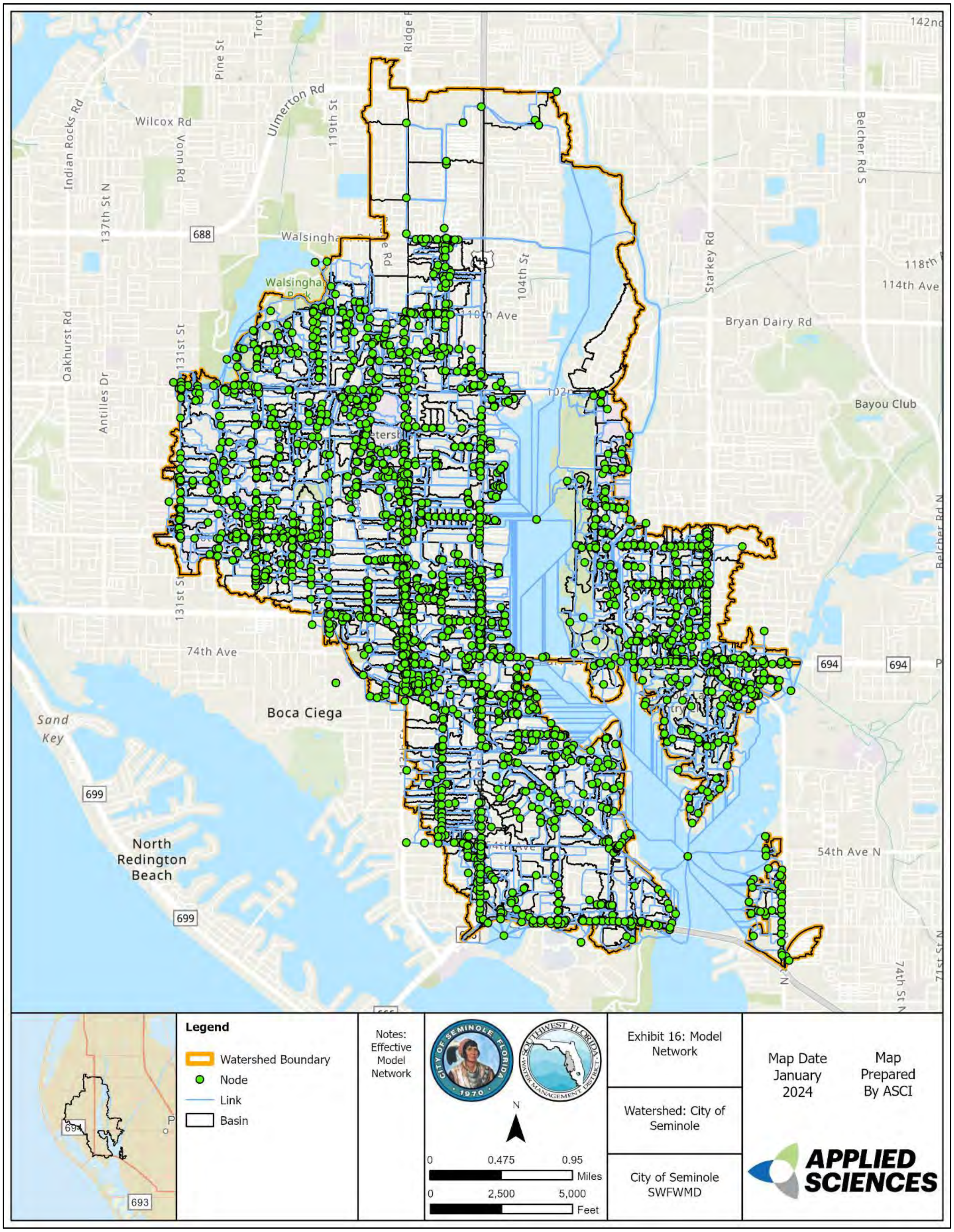


Exhibit 17 Design Floodplains, 100 Year

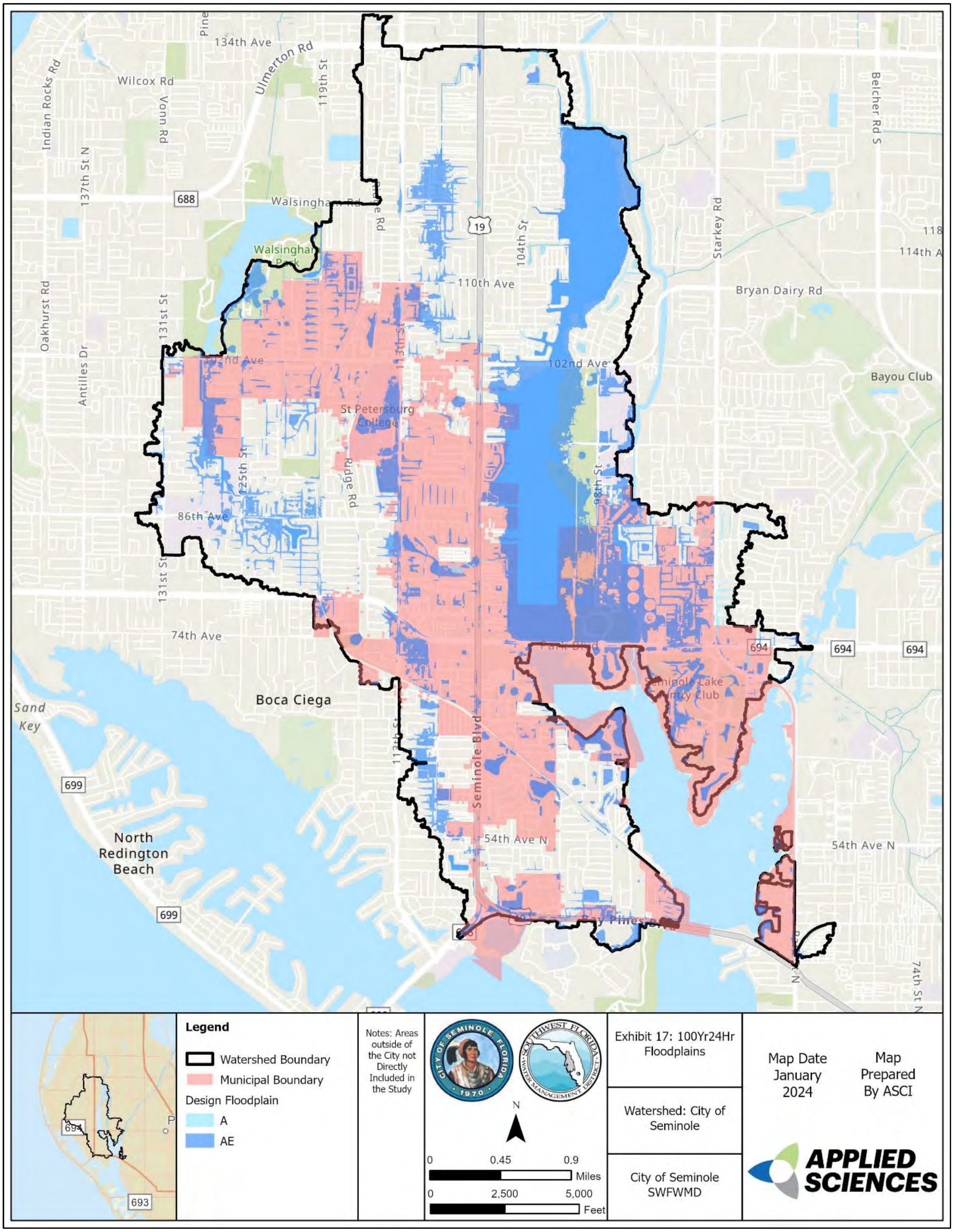


Exhibit 18 Calibration Floodplains

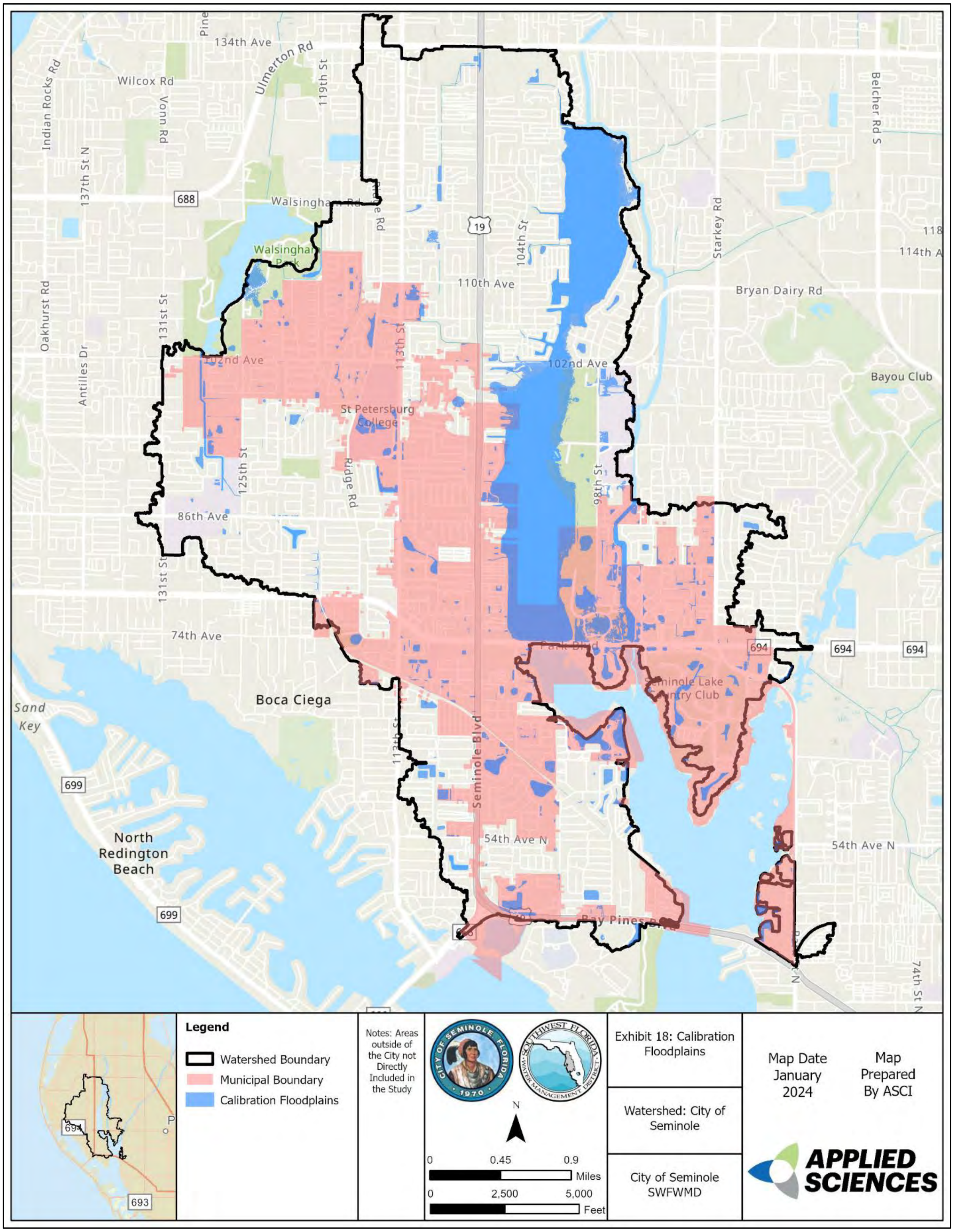


Exhibit 19 Verification Floodplains

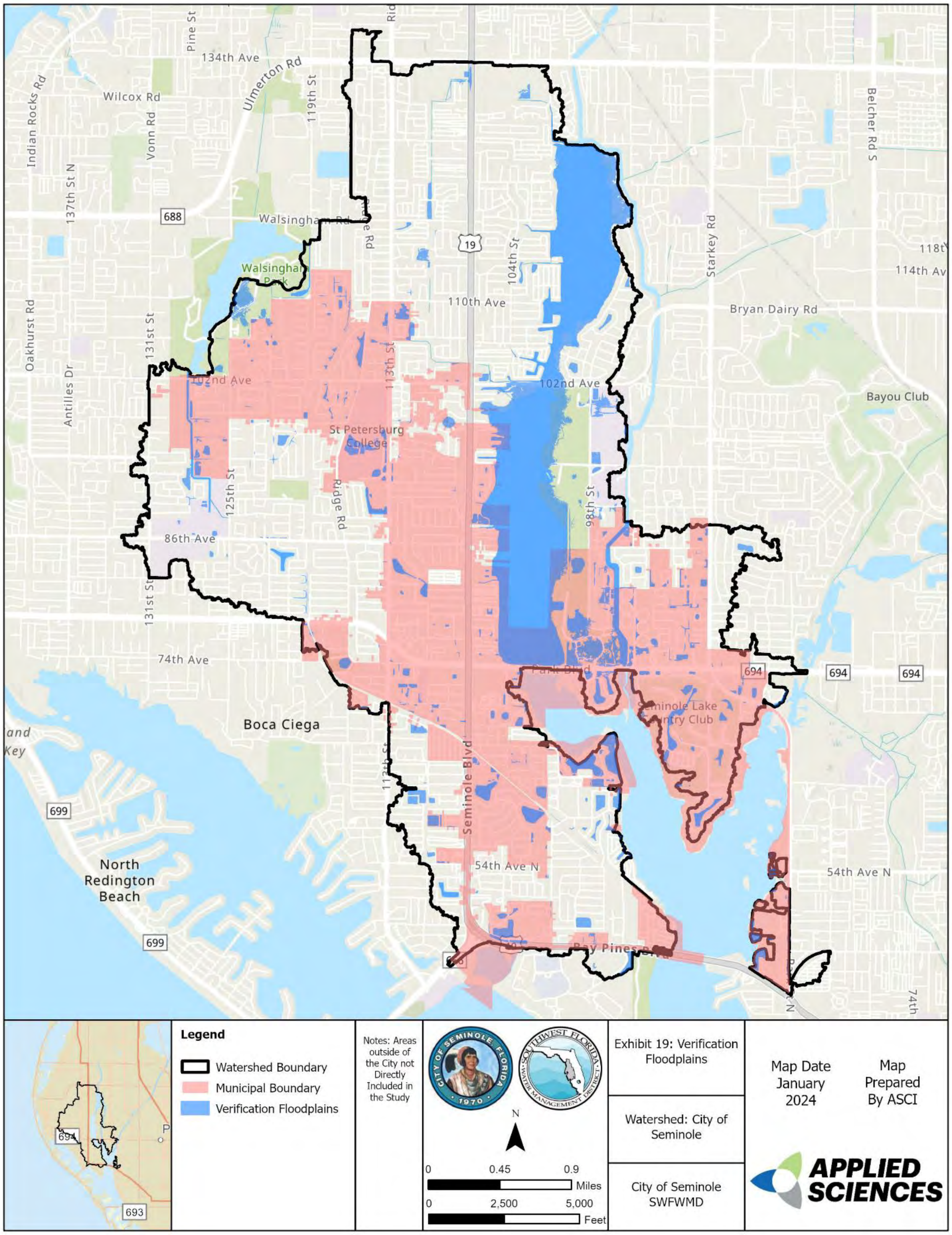


Exhibit 20 Public Meeting Index Map

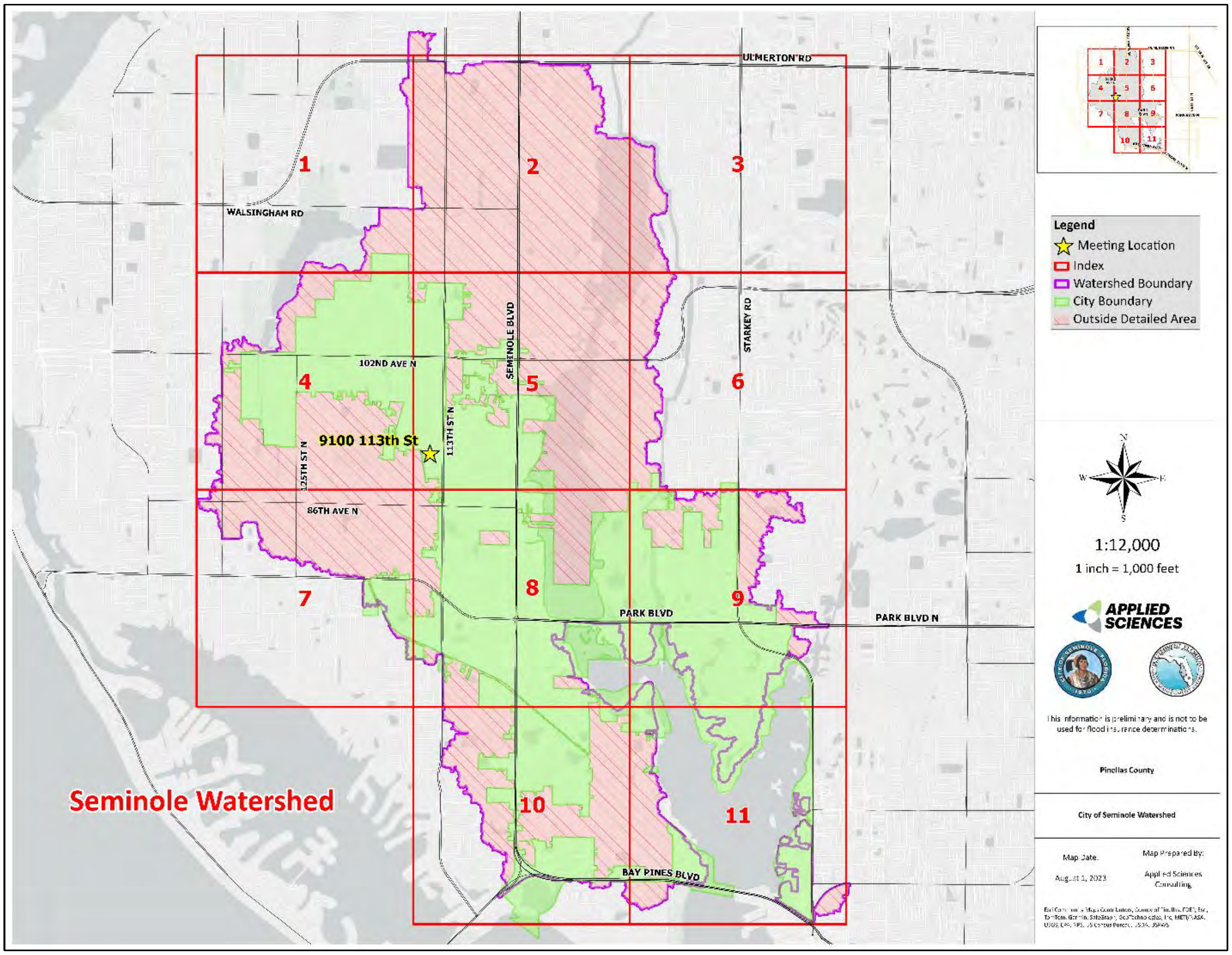
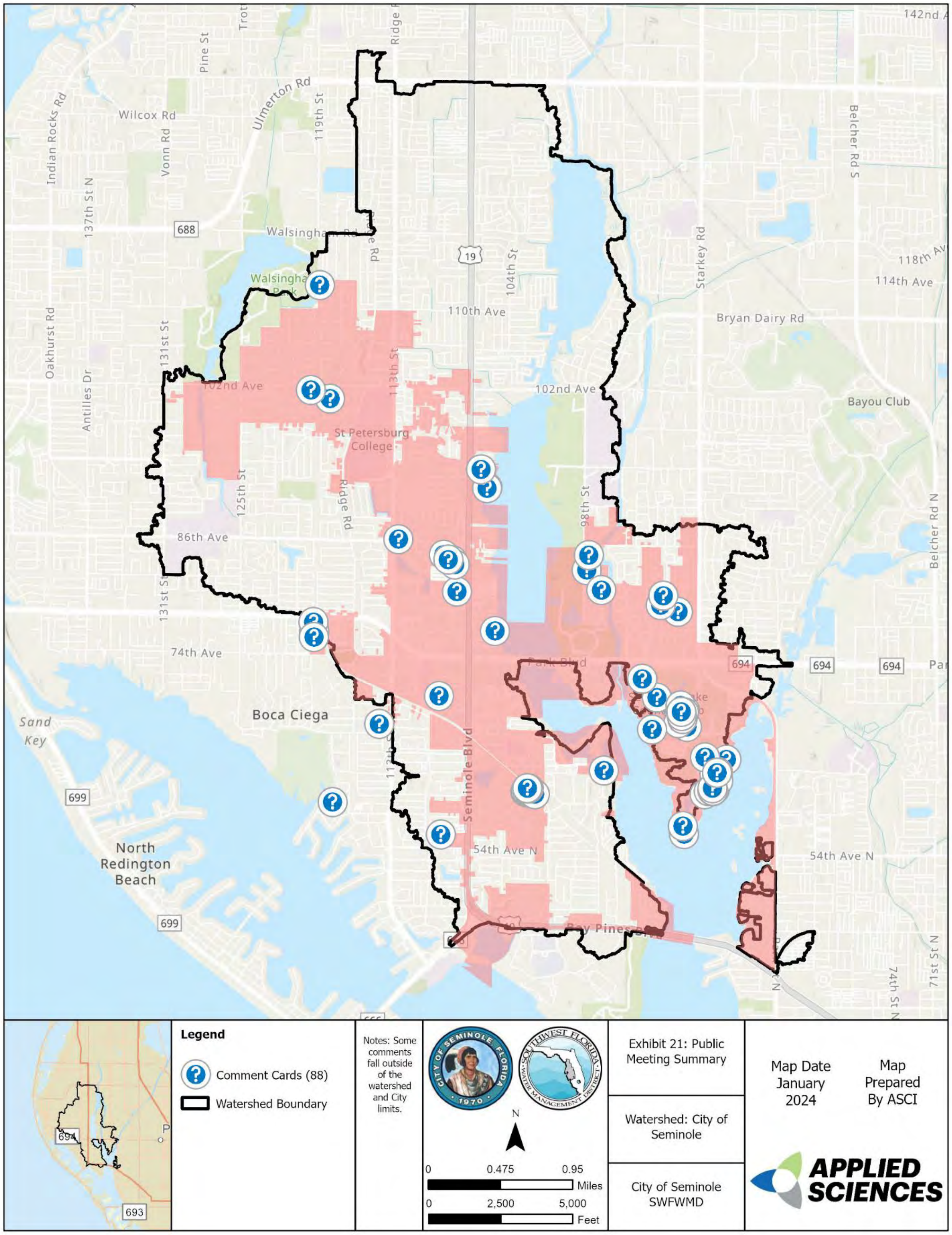


Exhibit 21 Public Meeting Comment Summary



Report 2: Flood Protection Level of Service (FPLOS) Analysis

LEVEL OF SERVICE ANALYSIS REPORT

CITY OF SEMINOLE WATERSHED

Flood Protection Level of Service (FPLOS)

RFQ: 22-0848

District Project: Q163

Prepared for:

Southwest Florida Water Management District
2379 Broad Street
Brooksville, Florida 34604

City of Seminole Public Works Department
11195 70th Ave N. Bldg. A
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February 2024

Prepared by:

Applied Sciences Consulting, Inc.

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Table of Contents

1 INTRODUCTION

1.1 Authorization

Applied Sciences Consulting, Inc. (CONSULTANT) was tasked by the Southwest Florida Water Management District (SWFWMD) and the City of Seminole (City) under RFQ # 22-0848 to continue the City of Seminole Watershed Management Plan (WMP) in assessing the City's Flood Protection Level of Service (FPLOS). Applied Sciences has determined the FPLOS throughout the watershed with a specific focus within the municipal boundary. FPLOS determinations are based on the methodology and criterion developed during Task 2.4.1.1 using inundation polygons and flood depth grids as well as comparing landmark elevations with model results.

1.2 Purpose

The purpose of this report is to document the FPLOS for the City of Seminole Watershed in Pinellas County. The report contains supporting documentation for the FPLOS analysis methodology, FPLOS classifications assigned to basins, and damage estimates for the roads and structure inundation.

2 LOS METHODOLOGY

In the context of public works, Level of Service (LOS) refers to the quality and effectiveness of a particular service provided to the community. Each department within the municipality may have specific LOS goals and criteria. For example, LOS is often associated with transportation networks. Qualitative descriptions are assigned to each roadway, typically focused on specific traffic flow metrics – vehicle speed, density, delay times, etc. Letter grades (A-F) are assigned to each roadway depending on observed performance. High grades (A-C) indicate excellent performance and represent free flowing traffic patterns where vehicles have complete mobility between lanes and adequate space between vehicles. Lower grades (D-F) correspond to areas subject to frequent traffic jams, high delays due to accidents, and extreme variability depending on the time of day. Communities aim to achieve minimum LOS standards, typically between the C to D designations.

For Flood Projection Level of Service (FPLOS), we focus on public facilities and services that involve impacts related to stormwater management and flood protection. Mostly, impacts to streets and residential/commercial structures are considered in a FPLOS discussion. Additional metrics might be related to channel and stormwater pond performance. Through stormwater modeling and observed conditions, deficient facilities can be identified and potentially improved to elevate FPLOS performance. In this study, we focus on specific FPLOS criteria developed for the City of Seminole.

In 2014, the City of Seminole defined the following FPLOS standards related to the City's existing public drainage system (Resolution No. 01-2014). See **Table 1** below:

***Table 1**: Resolution No. 01-2014, Stormwater Level of Service Standard*

LOS Designation	Description
LOS A	Maximum water level below the top of the curb and all traffic lanes are open.
LOS B	Partial yard flooding and standing water in traffic lanes.
LOS C	Yard flooded, but first floor of building, including garages are dry and one traffic lane open.
LOS D	Garage flooded.
LOS E	First floor of building is flooded.
LOS F	No flood protection.

The above designations and descriptions were defined in the City of Seminole Master Drainage Plan (2000). The study recommended the City strive to achieve a LOS D for flood protection services related to the 25 Year, 24 Hour storm event. This designation corresponds to adequate protection while considering high economic costs for improving stormwater systems. Garage and street flooding can be expected from time to time; however, no habitable structures should be impacted.

Street depths were originally defined in the 2000 Master Drainage Plan but were not included in the 2014 City resolution. Applied Sciences added street flooding depths to the previous FPLOS descriptions, see **Table 2**. Allowable street depths were reduced slightly from those reported in the 2000 Master Drainage Plan. For example, the Master Drainage Plan recommended the LOS E street flooding depth to be anything greater than 18 inches. Due to greater accuracy in modeling and LiDAR derived terrain datasets, Applied Sciences reduced this maximum depth to 12 inches. Additionally, the updated street depths align more closely with other LOS methodologies that recommend specific street flooding depths like those from Citrus County, FL.

Table 2*: LOS Designations with Street Flooding Depths Associated with the 25 Year, 24 Hour Design Storm Event*

LOS Designation	Description
LOS A	Maximum water level below the top of the curb and all traffic lanes are open. *Water level at crown of road is less than 3 inches.*
LOS B	Partial yard flooding and standing water in traffic lanes. *Standing water is between 3 and 6 inches at the crown of road.*
LOS C	Yard flooded, but first floor of building, including garages are dry and one traffic lane open. *Standing water is between 6 and 9 inches at the crown of road.*
LOS D	Garage flooded. *Standing water is between 9 and 12 inches at the crown of road.*
LOS E	First floor of building is flooded. *Standing water is greater than 12 inches at the crown of road.*
LOS F	No flood protection; flooding threatens lives, structures and property.

The street flooding depths will help quantitatively assign FPLOS designations for specific roadway segments. Additionally, **Table 3** contains a subset of the current Pinellas County FPLOS standards as follows (Stormwater Manual, 2021).

Table 3*: Subset of Pinellas County FPLOS Standards, 2021 Stormwater Manual*

Level Of Service	Design Storm
No Flooding at centerline on Bridges and/or Cross Drains on Evacuation Routes	100-yr./24-hr.*
No Flooding at centerline on Bridges and/or Cross Drains on Arterial and High-Use (ADT >1500) Roads	50-yr./24-hr.

**or 100-yr./multi-day storm if that is what is determined by the watershed management plan FPLOS*

The Pinellas County LOS reference provides further design storm criteria for specific types of roadways. For example, Evacuation, Arterial and other High-Use roads are held to higher standards and cannot experience flooding even under severe events (100 Year Storm). Applied Sciences recommends incorporating the specific stricter FPLOS design storm criteria for Evacuation/High-Use roads as noted in the Pinellas County methodology, while adhering to the overall goal of the City's Comprehensive Plan - achieving LOS D for the 25-year/24-hour storm event.

2.1 Supporting Data and Processing

The FPLOS analysis was specifically concentrated within the municipal boundary of the City, rather than encompassing the entire watershed area. The key focus was on datasets that are relevant to areas within the City that are close to floodplain elevations or extents. This targeted approach aims to efficiently utilize resources and efforts where they are most needed. GIS data related to street centerlines, building footprints, and parcels were obtained from the City and Pinellas County. The following sections further describe these resources and the processing routines used for analysis in the FPLOS study.

2.1.1 Digital Elevation Model (DEM)

The baseline LiDAR product selected for this project was the U.S. Geological Survey (USGS) 2018-19 LiDAR data set for Pinellas County. The product was prepared for USGS, performed by Dewberry and Dow Gallagher, and further reviewed and hydro enhanced by SWFWMD in January 2022. The Digital Elevation Model (DEM) meets QL1 standards (Vertical Accuracy RMSEz 10 cm, Nominal Pulse Spacing (NPS) < 0.35 m, NPS density ≥ 8 pts/m2, DEM cell size 0.5 m). It has been approved by SWFWMD for use in WMP and other planning projects. Review of the DEM and QC Ground Survey accuracy checks discussed in the LiDAR Report suggest that it is overall acceptable for modeling purposes in City of Seminole. All elevations associated with the DEM were referenced to the North American Vertical Datum of 1988 (NAVD88).

The City of Seminole DEM was used to determine elevations associated with street centerlines and building footprints. For each street segment, the low point of the road was calculated through interpretation of the underlying DEM. For building footprints, a unique GIS processing routine was developed to assist with estimating the Finished Floor Elevation or FFE and driveway/garage elevations. Finally, the terrain elevation surface was used to assist with floodplain delineation through comparison to design storm peak model results.

2.1.2 Streets

A GIS representation of the City of Seminole transportation network was downloaded from the Pinellas County GIS hub. According to the feature service metadata, the dataset was last updated on April 26, 2019, and represents centerlines for all roadways and road segments within Pinellas County, Florida. Applied Sciences reviewed the overall spatial coverage of the streets feature class and determined it was sufficient for moving forward with FPLOS processing.

Applied Sciences performed minor edits to the streets feature class to aid in better FPLOS results. For example, some street segments were reshaped to better align with aerial imagery and the DEM. Additionally, Applied Sciences digitized the unique lanes of larger street networks to gain a better understanding of “per lane” flooding impacts. The following figure, **Figure 1**, demonstrates the expansion of Seminole Blvd.

Original Road Centerline	Unique Lane Representation

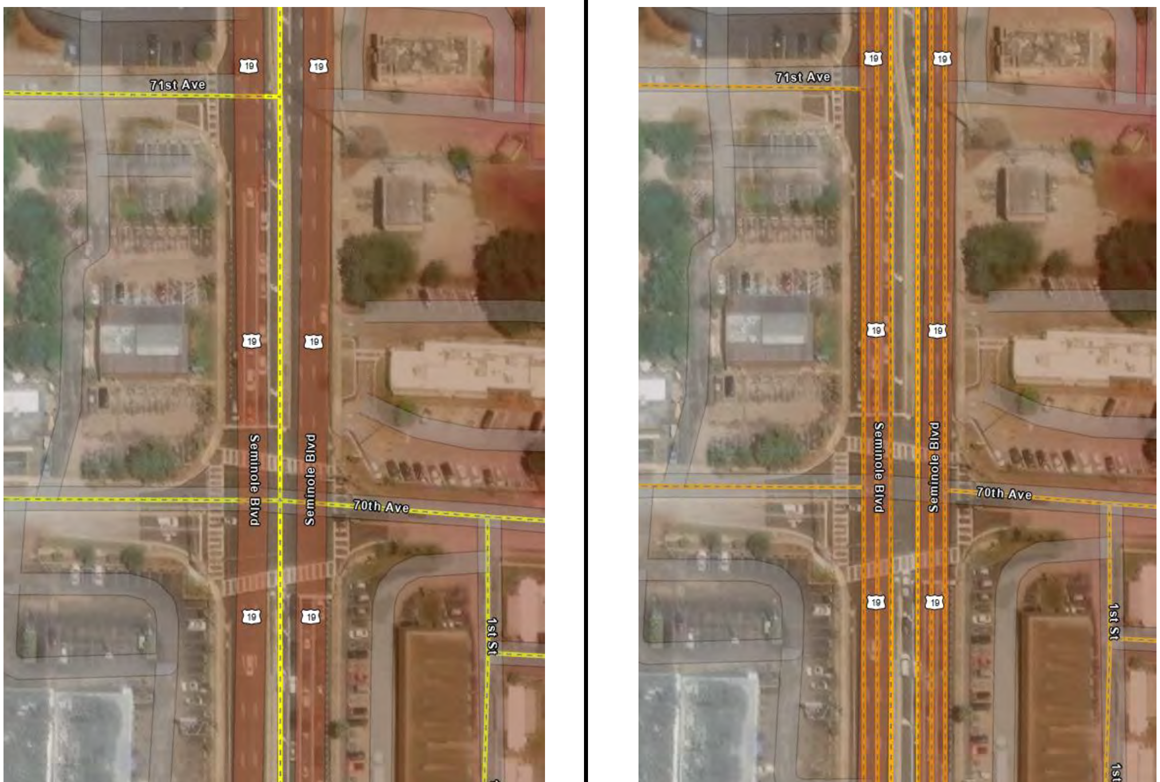


***Figure 1**: Digitization of Unique Lanes*

The streets feature class contained specific fields of interest; mainly, the FULLNAME and ROADCLASS fields. The streets feature class did not contain any designations for Evacuation Routes. Applied Sciences referenced additional Pinellas County GIS datasets for Evacuation Routes and noted the following three streets:

1. Seminole Blvd
2. Park Blvd N
3. 113th St N
4. Bay Pines Blvd

The LOS methodology specifies no impacts to Evacuation Routes up to and including the 100 Year design storm event.

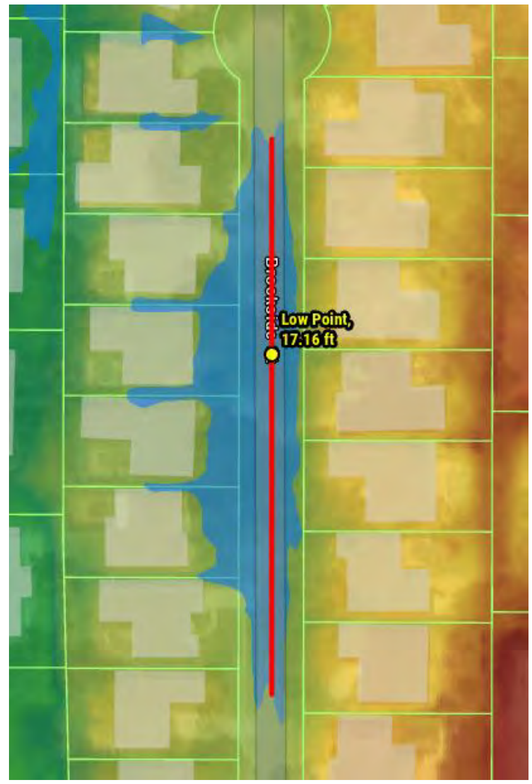
For LOS and flood damage estimation, Applied Sciences added the following attribute fields to the streets feature class, see **Table 4** below.

***Table 4**: Additional Fields for Streets Feature Class*

Attribute Field	Description
Road Type	Interpretation of County provided field, ROADCLASS (LS, LM, LC, etc.) - Principal Arterial - Minor Arterial - Major Collector - Minor Collector - Local - Trail
Road Lanes	Number of lanes for the street segment. Typically, two lanes, unless explicitly represented as unique lanes (major highways, see example above)
Daily Vehicles	FDOT Florida Traffic Online resources for specific roads – Annual Average Daily Traffic (AADT) for 2022. Allowed for interpretation/assignment for un-monitored streets. For example, Local streets may see around 650 vehicles per day. Pinellas Forward (2022) – additional traffic count resources; https://forwardpinellas.org/blog/planning-for-the-future/the-traffic-counts-are-in/
Detour Time	Delay time associated with traveling an alternate route due to roadway flooding.

Ultimately, each roadway segment is compared against the stormwater modeling results for all design storm events. The total length of flooding and duration of flooding are reported. **Table 5** provides an example street segment and supporting attribute information.

***Table 5**: Example Street Segment and Supporting Attribute Information*

Flood Length	Low Point of Road (Flood Duration)
	

Roadway Segment ID	Roadway Name	Roadway Type	Lowest Crown Elevation (ft NAVD)	# of Lanes	Est # Daily Vehicles Affected	Est Detour Time Daily Per Vehicle (hr)
1	BROOKSIDE CT	Local	17.16	2	100	0.25

2.1.3 Structures

Polygon features representing building footprints were downloaded from Pinellas County and saved into the project LOS geodatabase. Only specific structures within the City of Seminole municipal boundary were preserved for further processing. Applied Sciences reviewed the spatial extent of the buildings feature class and determined that the majority of the structures were digitized. Any missing building footprints within the proximity of the 100 Year floodplain were digitized and added to the analysis.

Structural Finished Floor Elevation (FFE) values were needed for the FPLOS analysis. The predicted peak stages from the stormwater model are compared to the FFE of a structure to understand potential flooding impacts. A unique geoprocessing routine was developed to help estimate FFE values. The processing routine utilizes the building footprint geometry along with the project DEM. A 2.5-foot buffer was created for each building footprint polygon and DEM zonal statistics were extracted from this small region. The buffer was used to represent elevations along the perimeter of the building footprint. The following calculations were used to estimate FFE values for fixed floor structures and manufactured homes:

$$FFE_{Fixed} = \frac{Zonal_{Min} + Zonal_{Avg}}{2} + 1$$

$$FFE_{Mobile} = \frac{Zonal_{Min} + Zonal_{Avg}}{2} + 2$$

The formulas consider the minimum elevation found in the buffered perimeter along with the average elevation. For fixed structures (slab on grade construction), an additional foot is added to the calculation. For mobile/manufactured homes, 2 feet is added.

Applied Sciences supplemented DEM derived FFE values with digitally sourced Elevation Certificates (ECs). Digital ECs were accessed through the Florida Department of Emergency Management's (FDEMs) website: https://florida.withforerunner.com/properties. An isolated set of property addresses were searched on the FDEM website. If a digital EC was available, Applied Sciences assigned the reported FFE value to the building footprint. Applied Sciences included an additional field in the buildings feature class called *FFE_Source* to help document the source of the FFE overwrite. The overall FPLOS processing routine will utilize the updated FFE instead of the terrain derived value if an updated FFE value was available. The updated FFE values were often quite similar to the terrain derived calculations; however, the surveyed information should be considered more accurate. Additionally, the FFE update approach helps better define flooding impacts to **elevated buildings**, where the finished floor might not align with terrain derived estimates.

Another consideration for the FPLOS analysis was related to flooding impacts to garages and parcels (yard flooding). These impacts were only associated with the 25 Year storm event. We need to understand garage flooding (LOS D), yard flooding (LOS C), and partial yard flooding (LOS B). The following assumptions were utilized to estimate impacts to garages and parcels:

- Garage impacts were assumed to occur at elevations 1 foot lower than the estimated FFE.

   - Note: this value also tends to correspond to driveway elevations which are used to calculate flooding costs for impacted vehicles. This is a separate analysis from the LOS determinations.

- Parcels were intersected with the 25 Year floodplain and a percent flood area was determined. If more than 20 percent of the parcel was inundated, a LOS C would be defined. If the parcel was inundated between 5 and 20 percent, a LOS B was assigned.

Finally, Applied Sciences identified critical assets within the City through additional GIS resources. Specific City owned buildings, emergency operation centers, and essential service buildings were identified and highlighted in the FPLOS (see **Exhibit 6**).

The following figure, **Figure 2**, displays an example building footprint along with the key attribute information needed for LOS assignment and flooding cost estimation.

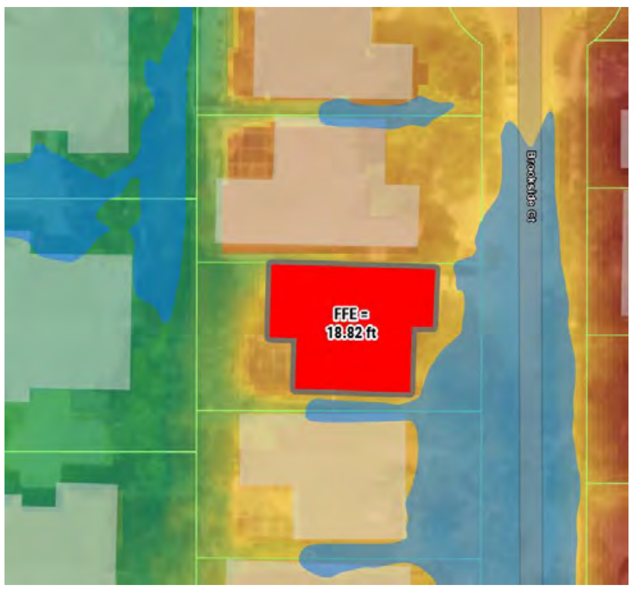


***Figure 2**: Example Building and Supporting Attribute Information*

Structure ID	Parcel ID	Residential Structure Type	Building Area (sq-ft)	Building Value	Finished Floor Elev (ft NAVD)	Driveway Min Elev (ft NAVD)	Vehicle Type
1	15 28 11 28959 000 0170	One Story, No Basement	3,500	$423,404	18.82	17.82	Unknown

2.1.4 Parcels

Parcels were downloaded from the FDOT DOR feature service layer: https://gis.fdot.gov/arcgis/rest/services/Parcels/FeatureServer/52.

Based on the feature service metadata, the parcel information is valid for the 2022 reporting year. Parcel information typically contains relevant fields for better understanding the built structure on the property – single family home or manufactured home. Additionally, the parcel dataset provides information related to land use (residential, commercial, industrial, etc.), year built, total living area, and property address. The PARCELNO field served as a unique identifier throughout the dataset. Applied Sciences reviewed the spatial and attribute coverage of the downloaded parcel dataset and determined the dataset was sufficient for the FPLOS analysis. No additional processing was performed for parcels.

2.1.5 Detailed H&H Watershed Model

Applied Sciences utilized the City of Seminole ICPR4 model for the FPLOS study. The model was previously developed by Applied Sciences in 2023. The ICPR4 model represents a detailed description of the City and corresponding stormwater systems. The model contains a high level of detail, consisting of around 2,000 nodes, 6,000 links, and 1,400 basins.

Design storm simulations including the 2.33-, 5-, 10-, 25-, 50-, and 100-Year rainfall results were extracted and added to the project directory. The FPLOS and cost estimation methodologies require both the peak model stages along with the stage timeseries information for all storm events. Additionally, the peak stages from the model were used to generate floodplain polygons and depth grids for all simulations.

2.2 QA/QC Support Data

The above methodology and approach were developed from City provided documentation and SWFWMD established methodologies. The following GIS reviews were performed for raw building footprints and street features by a separate staff member:

- Streets and structure footprints were reviewed against DEM and imagery
- Large highways were represented as individual street lanes
- Streets and structures were reshaped and/or adjusted to better align with underlying DEM and imagery

The above QA/QC measures were implemented to ensure the accuracy of the underlying support data and ultimately the accuracy of the overall analysis.

3 LEVEL OF SERVICE RESULTS

The length of modeled street and number of structures within 1 foot of flooding by storm return period are summarized in **Table 6** and **Table 7** below.

Table 6: *Street Inundation Length per Storm Event*

Storm Return Period (24 Hour Event)	Street Inundation (ft)	Percent Total Length
Mean Annual	13,550	2
5 Year	28,330	3
10 Year	50,780	6
25 Year	95,865	12
50 Year	142,810	17
100 Year	194,035	24

Table 7: *Structures within 1 foot of Flooding per Storm Event*

Storm Return Period (24 Hour Event)	Impacted Structures*	Percent Total Structures
Mean Annual	21	0.32
5 Year	40	0.62
10 Year	73	1.12
25 Year	155	2.39
50 Year	288	4.43
100 Year	483	7.43

* Structures Finished Floor Elevation (FFE) is estimated to be flooded or within 1 foot of flooding

Applied Sciences assigned an LOS classification to each basin based on the lowest street or structure LOS classification within the basin. The overall basin LOS classifications were populated in the BasinLOS feature class in the supporting LOS geodatabase. The BasinLOS feature class also contains the specific LOS designations for the streets and structures within each basin.

The number of basins per subwatershed that were assigned to each LOS code is summarized in **Table 8** below. See **Exhibit 1** for the subwatersheds in the City of Seminole. Approximately 32% of the basins were classified as LOS A for street and structure flooding. Around 16% of the basins were assigned a LOS E classification for either street or structural flooding issues. These areas are considered insufficient from a FPLOS perspective and could become areas of improvement for the City moving forward.

***Table 8**: Number of Basins per Level of Service Code and Subwatershed*

Subwatershed	Level of Service					
	A	B	C	D	E	NA
A	172	82	25	21	73	127
B	67	10	5	2	20	35
C	167	53	19	26	115	114
D	41	13	11	12	20	176
North	0	0	0	0	1	6
Total	**447**	**158**	**60**	**61**	**229**	**458**

Since the FPLOS study focused on the specific areas within the City boundary, there were several basins associated with the watershed model that were labeled with a value of *NA* for the LOS designation. These basins are technically outside of the City and were not considered for the FPLOS analysis.

Refer to **Exhibit 2** for an overall map of the Basin LOS designations for the City of Seminole watershed. The 100 Year floodplain, City boundary, and basins symbolized by LOS classification are included on the figure. **Exhibit 3** displays LOS designations for individual structures throughout the City. Only the LOS C, D, and E structures are symbolized in red. **Exhibit 4** displays the LOS designations for all street segments throughout the City. Finally, **Exhibit 5** focuses on the Pearl Lake area of the City with both individual structures and streets displayed in terms of LOS classification.

4 FLOOD DAMAGE ESTIMATE DETERMINATION

In addition to LOS determinations for building structures and streets, Applied Sciences developed flood cost estimates for the City by interpreting the SWFWMD Benefit Cost Analysis (BCA) spreadsheet. SWFWMD developed the BCA spreadsheet through referencing established methodologies from FEMA and FDOT resources. The BCA spreadsheet is typically used to compare two scenarios – existing and proposed conditions - and understand the overall benefits of constructing a stormwater management facility. The tool helps quantify flooding costs related to structures (structure, content, displacement, and vehicle damages) and streets (repair and loss of service damages). The workflow also calculates Expected Annual Damages (EAD) which considers costs from lesser design storms (mean annual and five-year events) more heavily than the extreme events (50- and 100-year events).

The following displays an example EAD calculation for fictitious property and street related damages.

EAD Example	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.00	$10,000	$20,000	$30,000	$150,000	$750,000	$1,500,000
Street Related Damage ($)	0.00	$10,000	$20,000	$30,000	$150,000	$750,000	$1,500,000
Total Damage ($)	0.00	$20,000	$40,000	$60,000	$300,000	$1,500,000	$3,000,000
EAD ($)	$98,900						

EAD = Average(0.00, $20,000)*(1.00 – 0.43) + Average($20,000, $40,000)*(0.43 – 0.20) + Average($40,000, $60,000)*(0.20-0.10) + Average($60,000, $300,000)*(0.10-0.04) + Average($300,000, $1,500,000)*(0.04-0.02) + Average($1,500,000, $3,000,000)*(0.02-0.01) + $3,000,000*0.01

The calculation takes the average cost of each return interval (1-year and 2.33 year for example) and multiplies this average by the difference in the probability of the return period interval (1.00 – 0.43). This process is continued through each return period window. Finally, the 100-year event is multiplied by the corresponding probability (0.01 or 1 %).

4.1 Street Damage

Applied Sciences estimated the expected annual damages for street flooding in accordance with the general methodology defined by the SWFWMD Benefit Cost Analysis (BCA) spreadsheet. Street damage costs were estimated for each street segment where the inundation elevation exceeded the estimated low point of the road. Vehicle delay costs were estimated for each street where the inundation elevation exceeded the *impassable* depth for the street. Typically, a street is considered impassable when the depth of flooding exceeds 6 inches. This metric was used to evaluate loss of service delay costs for the City of Seminole watershed and is referenced in the SWFWMD BCA cost estimation spreadsheet. The resulting street flooding costs were calculated as the street damage costs plus the vehicle delay costs using the following equations:

Road Damage Cost = length of street flooding (feet) **x** number of inundated lanes **x** cost of flood repair for road type ($)

Loss of Service Cost = vehicles/day **x** average detour time (hours) **x** flooding duration (hours) **x** delay cost ($) per vehicle per hour

Total Cost = Road Damage Cost + Loss of Service Cost

Typically, the road damage costs are much greater than the delay costs associated with loss of service/access. Additionally, delay times and flooding duration are often quite short in dense urbanized areas like the City of Seminole.

Table 9 contains the cost estimation references were used to populate the above equations.

Table 9*: Street Damage References*

Metric	Value	Units
Max Drivable Depth	6	Inches above roadway crown
Principal Arterial	300	USD (repair costs per lane foot)
Minor Arterial	300	USD (repair costs per lane foot)
Major Collector	150	USD (repair costs per lane foot)
Minor Collector	150	USD (repair costs per lane foot)
Local	115	USD (repair costs per lane foot)
Unknown Road	133	USD (repair costs per lane foot)
Trail	50	USD (repair costs per lane foot)
Vehicle Delay Cost	32.18	USD/Vehicle/Hour

The total road flooding costs were summarized by storm return period and the expected annual road flooding costs were calculated according to the methodology in the SWFWMD BCA spreadsheet. The following table, **Table 10**, provides a summary of the total repair and loss of service costs associated with street flooding in the City of Seminole.

***Table 10**: Street Cost Summary for Design Storms*

	Mean Annual	*5 Year*	*10 Year*	*25 Year*	*50 Year*	*100 Year*
Total	$3,284,271	$6,833,973	$12,482,708	$24,527,450	$37,785,895	$53,583,415
Expected Annual Damage (EAD)	$5,791,568					

4.2 Structure Damage

Similar to street flooding, Applied Sciences utilized the established methodology from the SWFWMD BCA spreadsheet to provide flood cost estimates for building structures throughout the City of Seminole. Structure damages consider four categories of impact:

1. **Structure** – direct flooding impacts to the building structure; estimated from Depth Damage Function (DDF) curves; depends on the type of structure and replacement value.
2. **Content** – damages to the contents of a building from DDF curves; established form historic flood insurance claim data.
3. **Displacement** – additional costs associated with the displacement of residents to temporary housing due to a flooding event. Displacement costs only occur after sufficient damage to the structure, causing displacement of residents.
4. **Vehicle** – flooding costs related to inundation to vehicles, dependent on vehicle type.

The final building feature class in the supporting GIS deliverables contains fields that correspond to the above damage values. **Table 11** displays descriptions of these fields.

***Table 11**: Structure Damage GIS Field Descriptions*

Field Name	**Description**
_04_24HR25YR_strucDam	Structure damage in dollars for the 25-year storm event.
_04_24HR25YR_contDam	Content damage in dollars for the 25-year storm event.
_04_24HR25YR_displDam	Displacement damage in dollars for the 25-year storm event.
_04_24HR25YR_vehDam	Vehicle damage in dollars for the 25-year storm event.

The following table, **Table 12**, displays general metrics used to evaluate the four components of structure damage costs.

***Table 12**: Structure Damage Reference Metrics*

Metric	Value	Units	Cost Category
Building Replacement Cost	120	USD/SQFT	Structure and Content Costs
Vehicles Per House	1.6	Number	Vehicle Costs
Sedan	10,933	USD	Vehicle Costs
Pickup	15,979	USD	Vehicle Costs
SUV	13,013	USD	Vehicle Costs
Sport	15,979	USD	Vehicle Costs
Mini Van	13,013	USD	Vehicle Costs
Unknown Vehicle	13,783	USD	Vehicle Costs
Displacement Cost	1.44	USD/SQFT/Month	Displacement Costs

As previously noted, the structure damage categories often rely on Depth Damage Function (DDF) curves to establish impacts. For example, structure damages are governed by the following curves, see below in **Figure 3**.

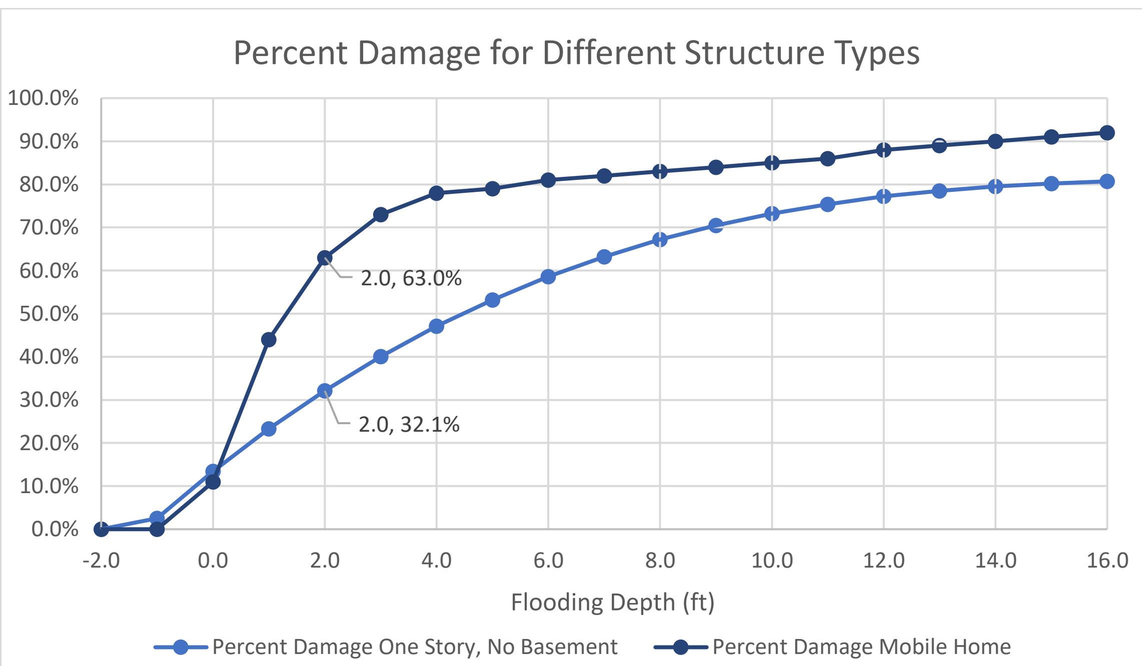


***Figure 3**: Depth Damage Curves for Building Structures*

Only One Story, No Basement and Mobile Home functions are displayed. These were the only types of buildings considered for this analysis. A reliable dataset was not available to discern other building types like multi-storied buildings. As the depth of flooding increases, the damage percentage increases. From the chart above, assume two buildings were impacted with a flood depth of two feet. The following costs can be calculated for these structures, see **Table 13**.

Table 13*: Example Flooding Depth Cost Calculations*

Structure	Replacement Value	Depth, ft	Percent Damage	Flooding Cost
One Story, No Basement	$ 250,000	2	32.1	$ 80,250
Mobile Home	$ 75,000	2	63.0	$ 47,250

An additional note regarding the DDF curve for structures is related to impacts occurring prior to finished floor inundation. The curve assigns a 2.5% damage estimate when flood waters are approximately 1 foot **below** the finished floor. This damage might be associated with soil saturation impacting building foundations, detached garages, and other features associated with typical residential structures.

Content and vehicle damages are treated in a similar manner as structure damages. As the depth of flooding increases, specific DDF curves are utilized to define the percent impact. For Displacement costs, the reference curves focus on the relationship between depth of flooding and resident displacement days. The following figure, **Figure 4**, represents the expected displacement time in days for various structural flooding depths.

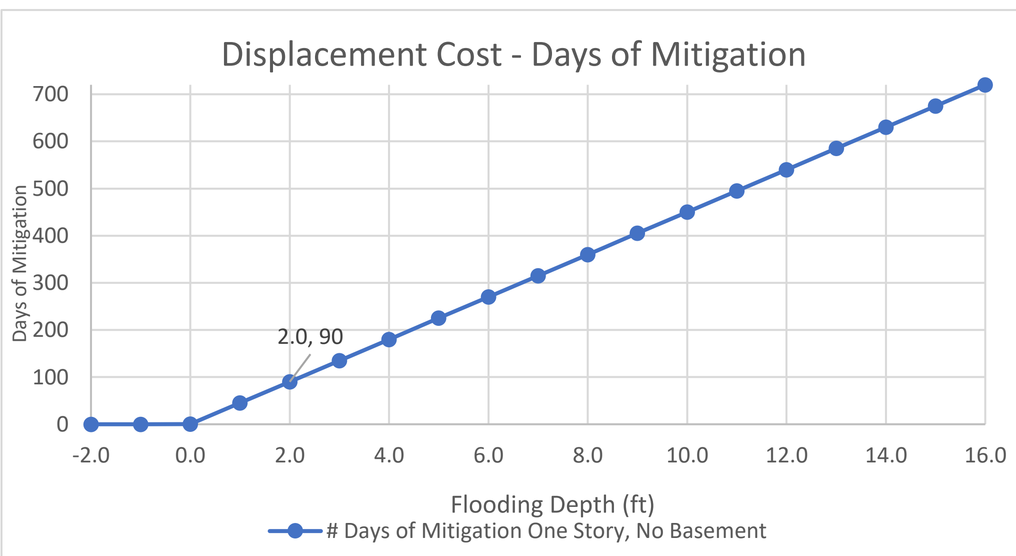


Figure 4*: Displacement Depth Damage Curve*

If we consider the same one-story building with a flood depth of 2 feet, an estimated displacement time of 90 days is determined.

The following table, **Table 14**, and equations demonstrate the total flooding cost associated with the one-story building with a flooding impact of 2 feet and an assumed vehicle type.

***Table 14**: Structure Depth Example Details*

Structure	Area, sq ft	Replacement Value	Depth, ft	Vehicle
One Story, No Basement	~2,083	$ 250,000	2	Sedan

$$Structure\ Costs = \$250{,}000 * 32.1\% = \$\,80{,}250$$

$$Content\ Costs = \$250{,}000 * 17.9\% = \$\,44{,}750$$

$$Displacement\ Costs = 2{,}083\ \text{sq ft} * 90\ \text{days} * 1.44\frac{\$}{\frac{\text{sq ft}}{\text{month}}} * \frac{1}{30.4\frac{\text{days}}{\text{month}}} = \$\,8{,}880$$

$$Vehicle\ Costs = \$10{,}933 * 28\% = \$\,3{,}061$$

$$\boldsymbol{Total} = \$\mathbf{80{,}250} + \$\mathbf{44{,}750} + \$\mathbf{8{,}880} + \$\mathbf{3{,}061} = \$\mathbf{136{,}941}$$

The total structure flooding costs were summarized by storm return period and the expected annual structure flooding costs were calculated according to the methodology in the SWFWMD BCA spreadsheet. **Table 15** provides a summary of the total structural damage costs associated with flooding in the City of Seminole.

***Table 15**: Structure Cost Summary for Design Storms*

	Mean Annual	*5 Year*	*10 Year*	*25 Year*	*50 Year*	*100 Year*
Total	$ 4,094,459	$ 6,353,166	$ 9,932,020	$ 17,232,986	$ 25,523,442	$ 38,765,490
Expected Annual Damage (EAD)	$5,134,271					

4.3 QA/QC Flood Cost Estimation

Applied Sciences reviewed the structure and street damage costs with a particular focus on the extreme outliers. The costliest structures and streets were reviewed for reasonableness and appropriateness. In some cases, the FFE values for building structures were updated to better represent the elevation of the structure. See the *FFE_Source* field in the buildings feature class in the supporting GIS deliverables. Due to small inaccuracies in the underlying DEM and GIS representation of building footprints, estimated FFE values can indicate flood impacts. Upon further review, these buildings would most likely not experience flooding. Often, these instances are localized to large commercial properties near stormwater ponds. The building footprint extends into the stormwater pond, thus impacting the FFE estimate. In some situations, Applied Sciences referenced supporting as-built Environmental Resource Permits (ERPs) for FFE assignment.

5 FLOOD DAMAGE ESTIMATE RESULTS

Applied Sciences calculated expected flooding costs for streets and buildings within the City of Seminole. Cost calculations were estimated through interpretation of the SWFWMD Benefit Cost Analysis (BCA) methodology. Flooding costs were also calculated on an expected annual basis, where impacts due to more frequent events (mean annual and five-year storms) are weighted more significantly than impacts from more extreme events (50-year and 100-year storms). This is inherent to the idea of the Expected Annual Damages calculation, see example in Section 4 above. The following table, **Table 16**, displays the top 20 most costly basins within the City of Seminole.

***Table 16**: Estimated Annual Flood Damage Per Basin, Top 20 Basins*

Count	Basin Name	Street LOS	Structure LOS	Basin Overall LOS	Total Expected Annual Cost
1	COSC080040	A	D	D	$739,523
2	COSA290020	A	D	D	$490,221
3	COSC550020	A	D	D	$276,435
4	COSC220040	A	E	E	$257,921
5	COSD380010	E	D	E	$198,442
6	COSC070040	E	C	E	$197,833
7	COSA010041	E	E	E	$197,307
8	COSD390031	A	D	D	$184,658
9	COSC120100	D	D	D	$179,598
10	COSA220041	E	E	E	$176,240
11	COSA490010	E	C	E	$170,302
12	COSA250051	E	B	E	$156,491
13	COSA170010	E	D	E	$150,550
14	COSA220050	E	D	E	$150,135
15	COSA180010	E	B	E	$141,959
16	COSC370050	E	B	E	$134,835
17	COSD380060	E	D	E	$129,962
18	COSA390021	A	D	D	$125,764
19	COSB080072	A	D	D	$125,563
20	COSD180060	E	D	E	$125,511

Three example basins, as highlighted in **Table 16**, are seen below with brief descriptions describing the apparent flooding issues and correlations to the expected annual flooding costs.

Basin 1 – COSC080040

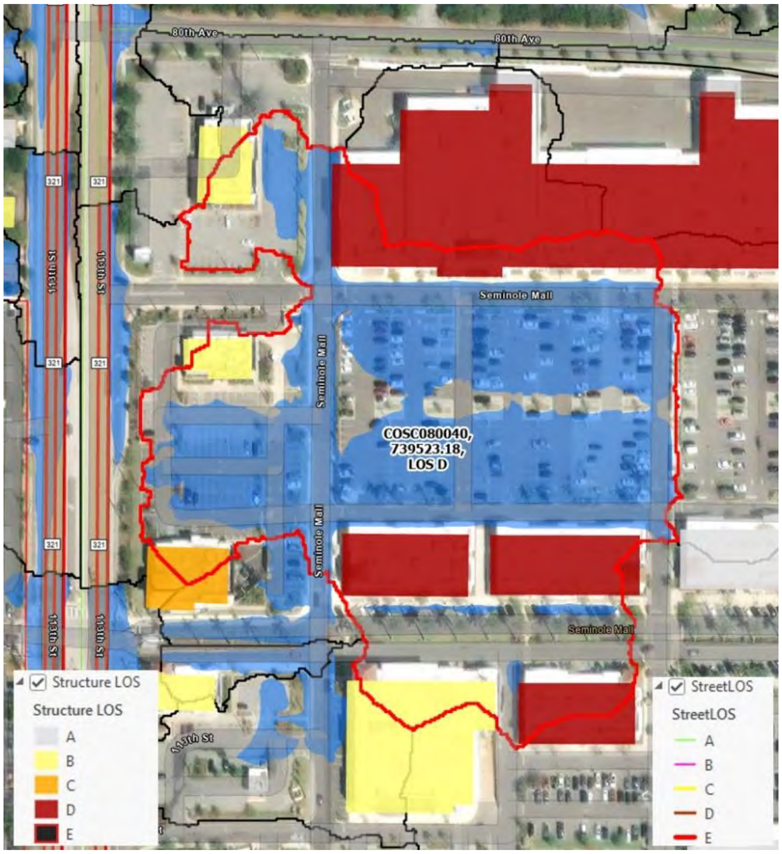


***Figure 5**: Basin 1 – COSC080040*

Basin COSC080040 is shown in **Figure 5** above. This basin is located in the central portion of the watershed just east of 113th Street. The area is heavily urbanized and is associated with the Seminole Mall. Stormwater modeling results indicate potential inundation of parking lots throughout the area. Although no structures are directly impacted (all Finished Floor Elevations are above the 100 Year floodplain), flooding impacts are calculated before FFE inundation. Because of this, many large, costly, commercial buildings are included in the annual cost estimates. Although annual costs are high, this area doesn't appear to require immediate attention regarding flood protection level of service goals.

Basin 2 – COSD380010

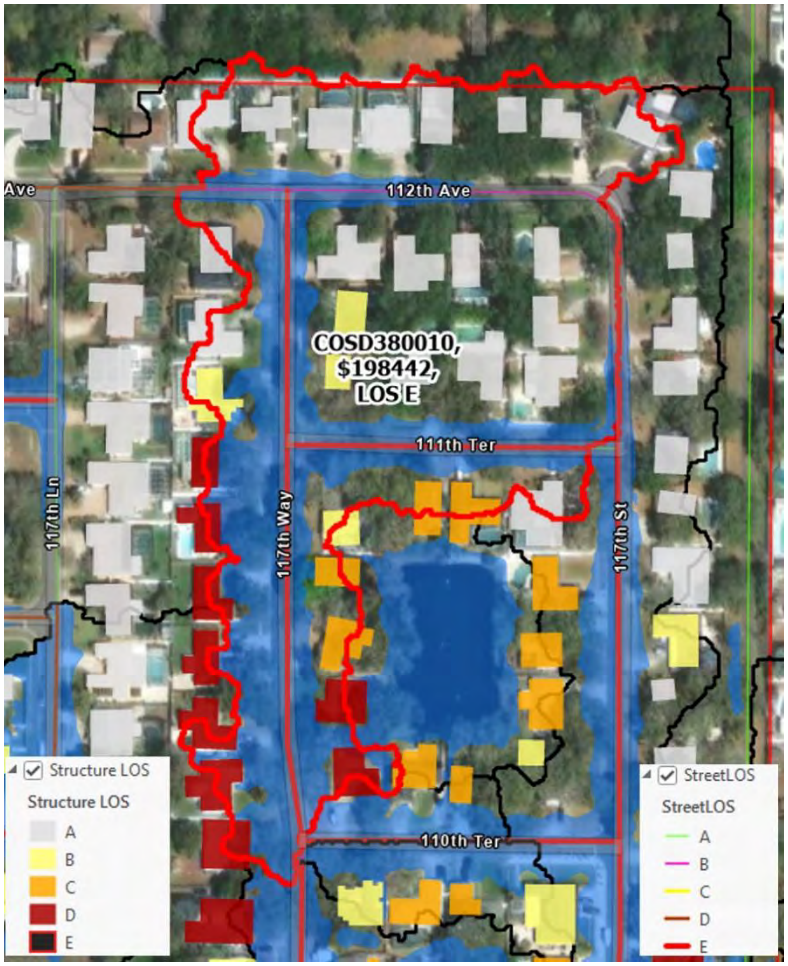


Figure 6*: Basin 2 – COSD380010*

Basin COSD380010, see in **Figure 6** above, is located in the northwest corner of the City, near Walsingham Park. The area appears to have been developed in the early 1980s, with minimal stormwater management. Street and structure flooding issues are observed with some minor street impacts seen in frequently occurring storms (mean annual event). Although no structures are expected to be inundated in the 100-year event, the area should be considered for improving street and structure LOS goals.

Basin 3 – COSA220041

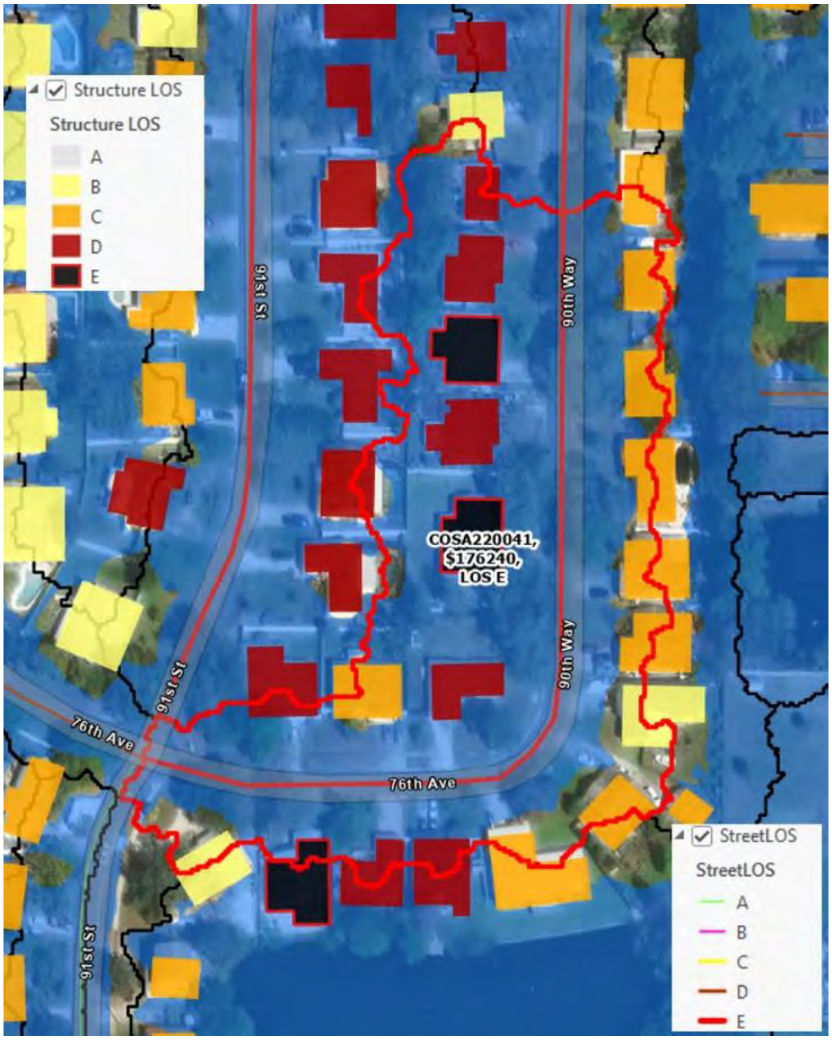


Figure 7*: Basin 3 – COSA220041*

The final example, Basin COSA220041, is located just north of Pearl Lake. See **Figure 7** above. This area is known for problematic flooding issues, with stormwater modeling supporting these observations. Street and structure flooding is predicted during the 100-year storm, while more frequent events consistently impact streets. Annual flooding costs are associated with streets and structures in this area. Improving frequent flooding issues and the impact from extreme events should be a focus in this area. Stormwater management improvements may help improve LOS goals and reduce the overall annual cost of flooding.

The **APPENDIX** of this report contains large, formatted maps displaying the estimated annual flooding damages, street LOS designations, and structure LOS designations for the entire City. These maps should be considered complimentary to the underlying GIS data submitted with the FPLOS report.

6 REFERERENCES

City of Seminole Master Drainage Plan. Tampa Bay Engineering, Inc. 2000.

Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures (Third Edition). FEMA P-259. 2012.

Pinellas County Stormwater Manual. Pinellas County. 2021.

SWFWMD BCA Tool Spreadsheet. SWFWMD. 2017.

7 EXHIBITS

Exhibit 1 – City of Seminole Subwatersheds

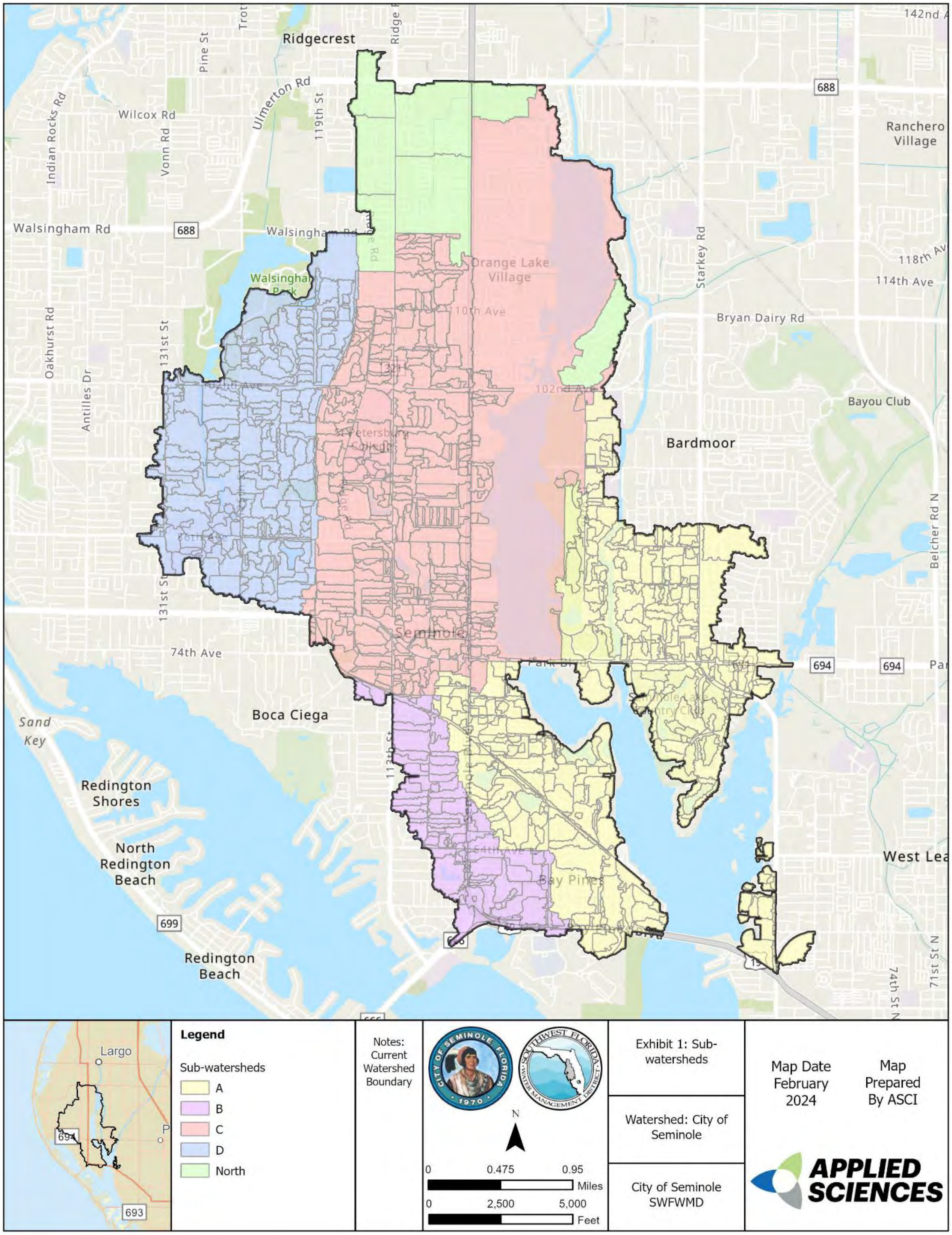


Exhibit 2 – Overall Basin FPLOS

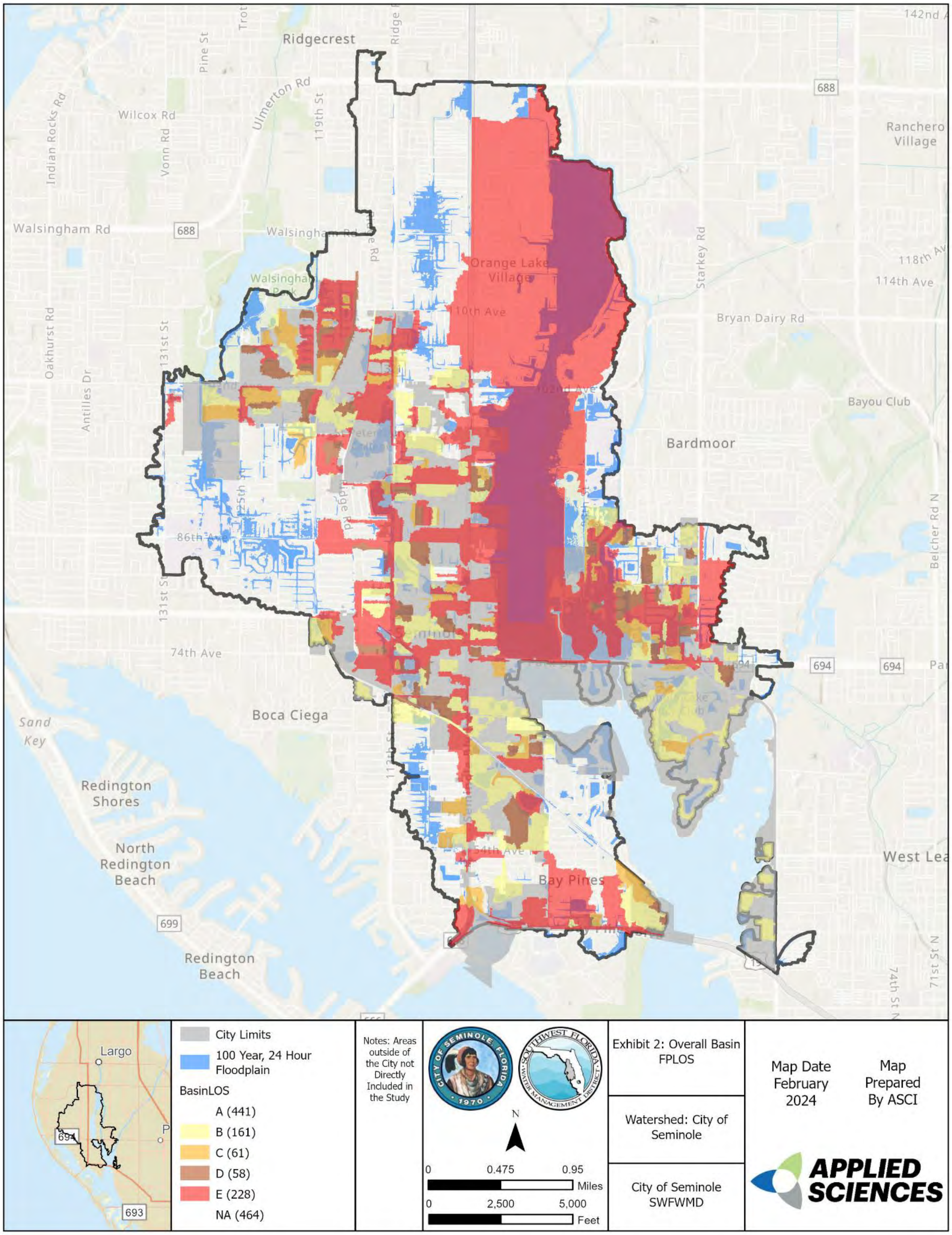


Exhibit 3 – FPLOS Structures

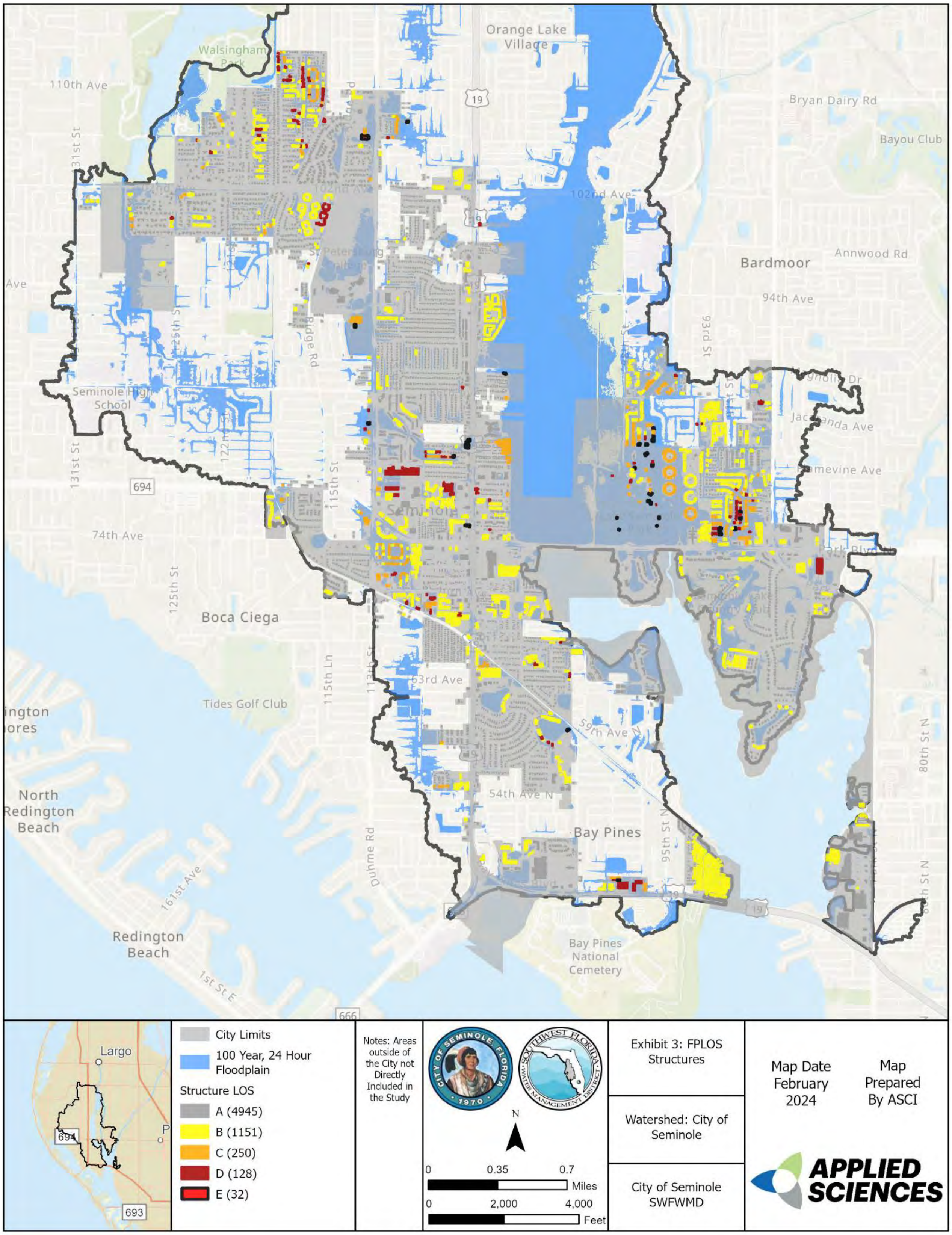


Exhibit 4 – FPLOS Streets

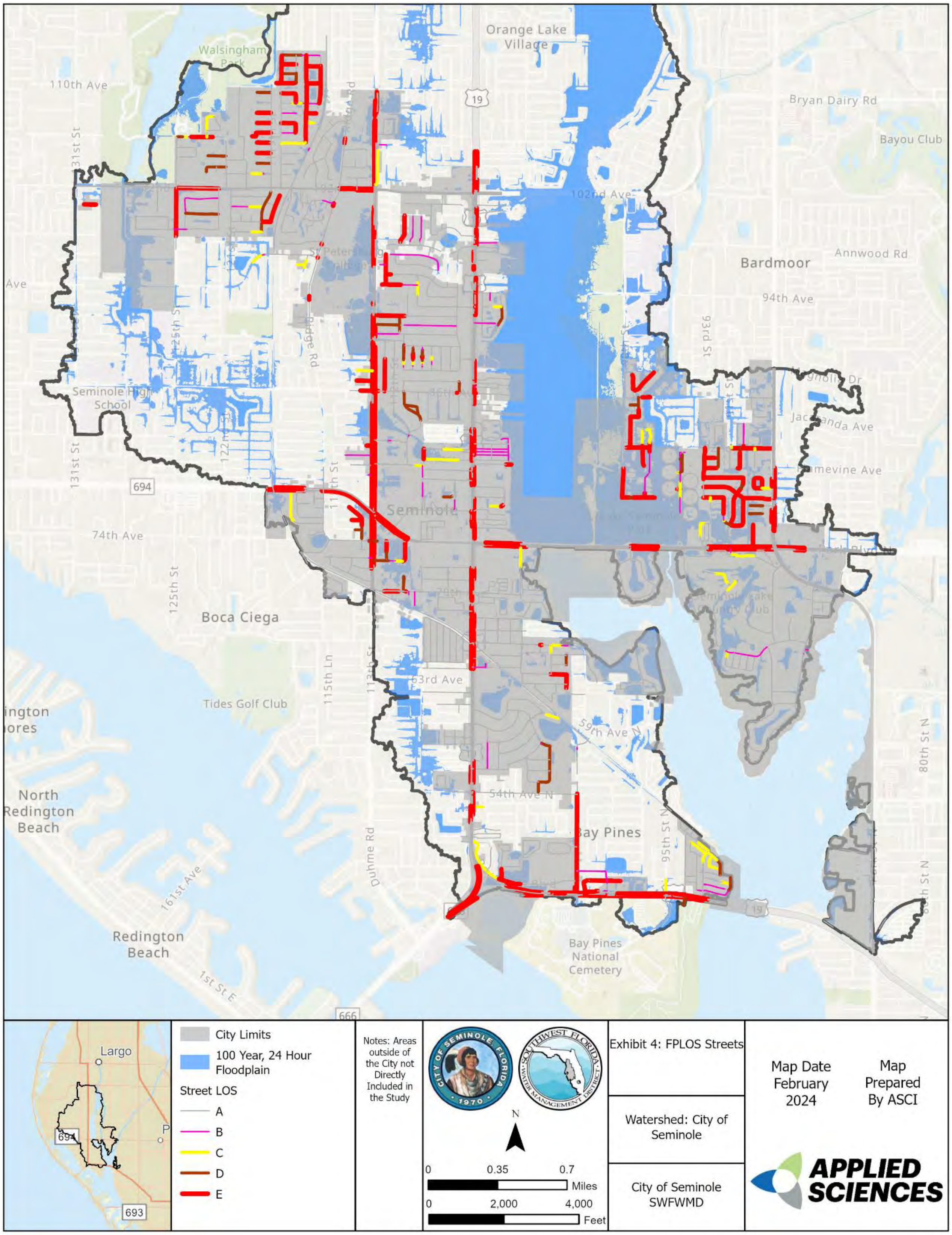


Exhibit 5 – Pearl Lake Area

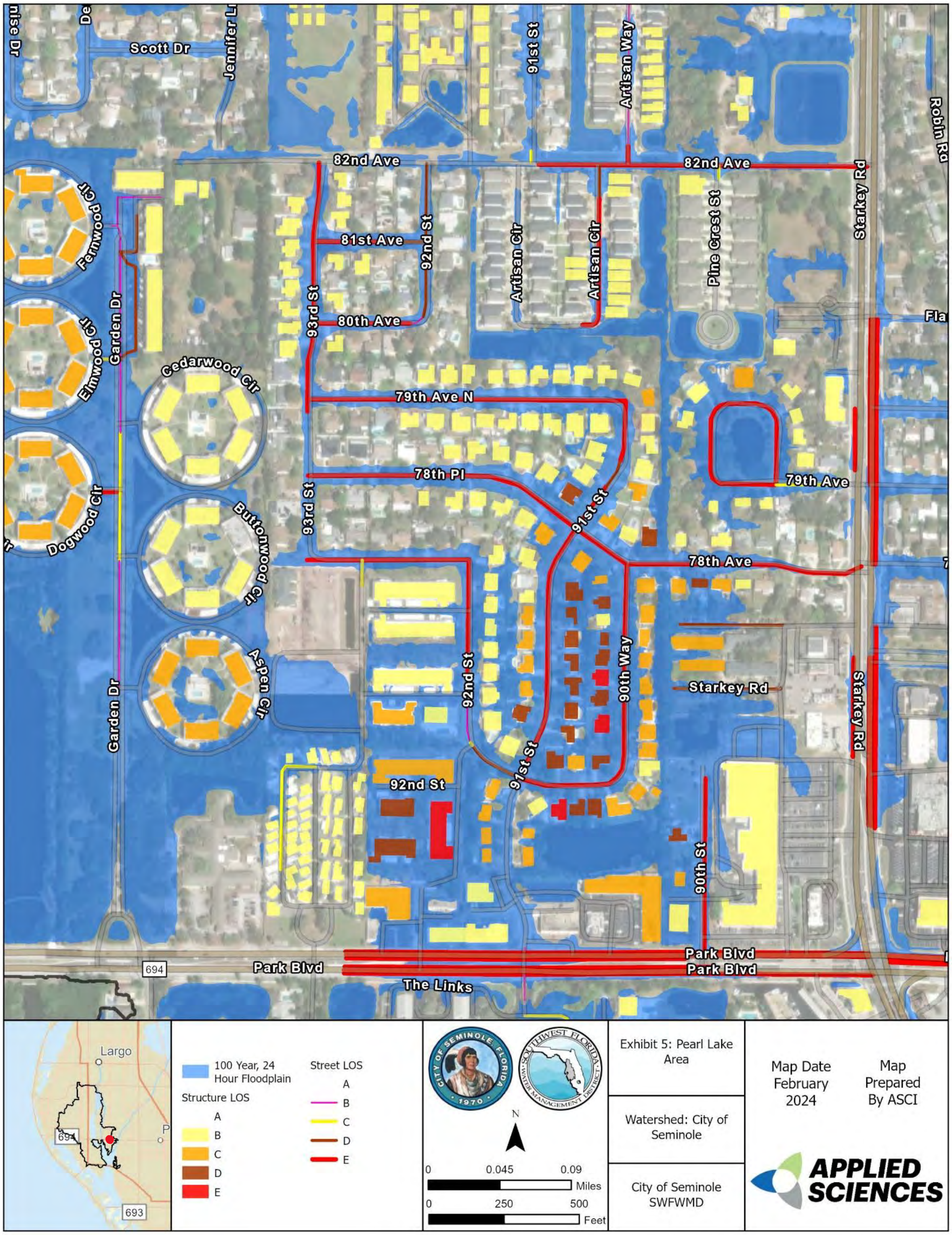
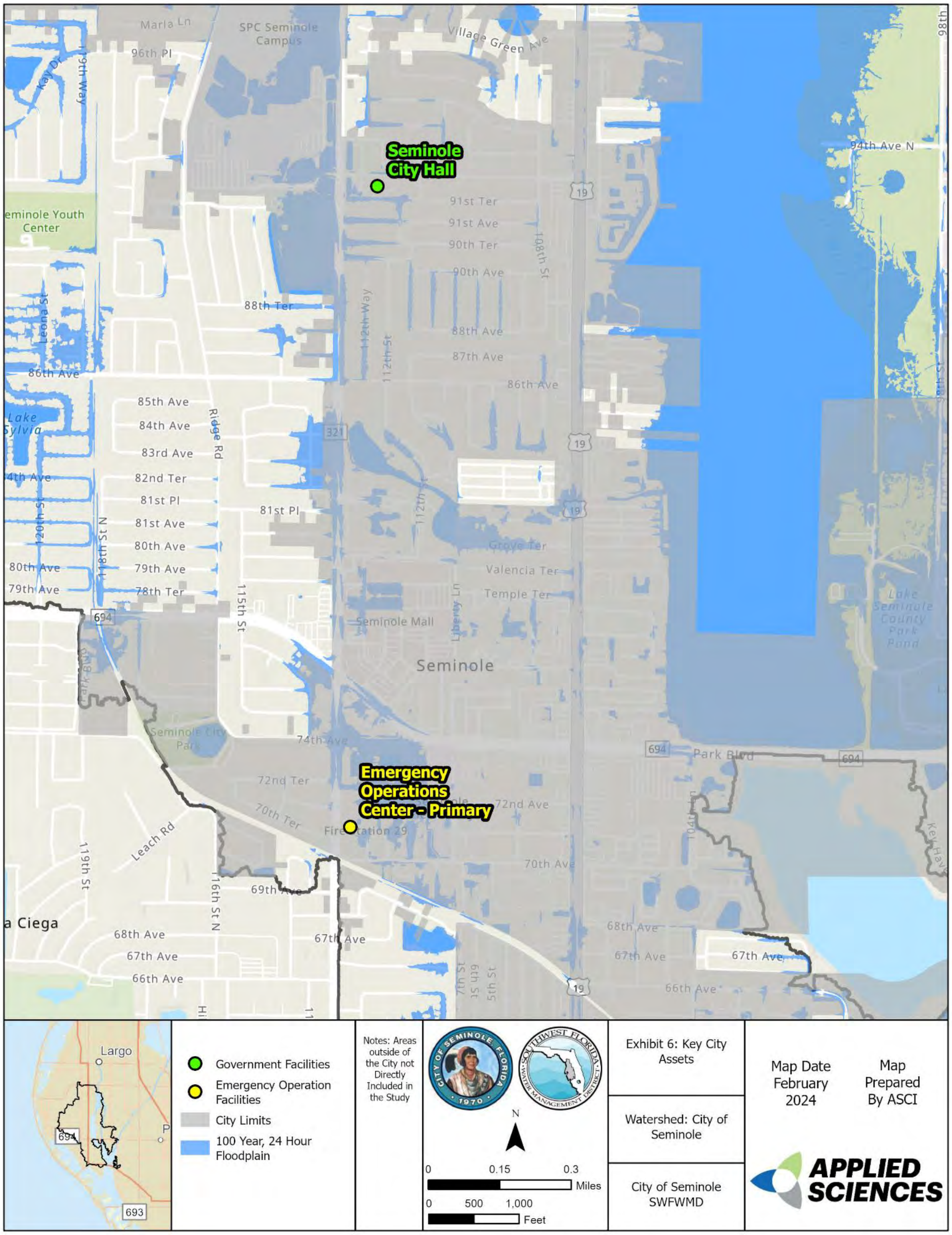


Exhibit 6 – Key City Assets



Report 3: Best Management Practices (BMPs) Alternatives Analysis

BEST MANAGEMENT PRACTICE ALTERNATIVES ANALYSIS REPORT
CITY OF SEMINOLE WATERSHED

RFQ: 22-0848

District Project: Q163

Prepared for:

Southwest Florida Water Management District
2379 Broad Street
Brooksville, Florida 34604

City of Seminole
Public Works Department
11195 70th Ave N. Bldg. A
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March 2024

Revised June 2024

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APPLIED SCIENCES

Table of Contents

1 INTRODUCTION

1.1 Authorization

Applied Sciences Consulting, Inc. (CONSULTANT) was tasked by the Southwest Florida Water Management District (SWFWMD) and the City of Seminole (City) under RFQ # 22-0848 to continue the City of Seminole Watershed Management Plan (WMP) in developing Best Management Practice (BMP) Alternatives within the City. Applied Sciences previously completed the development of a detailed Hydrologic and Hydraulic watershed model focused on the City boundary along with a determination of the Flood Protection Level of Service (FPLOS) for streets and structures.

1.2 Watershed Background

The City of Seminole is generally located in the west-central region of Pinellas County with a municipal area of approximately 5.7 square miles. There are 4 major waterbodies associated with the City watershed: Lake Seminole, Long Bayou, Cross Bayou, and Boca Ciega Bay that separate the watershed into three land areas. The City of Seminole watershed boundary is approximately 12.45 square miles and abuts six (6) other watersheds: McKay Creek to the west, Lake Seminole to the North, Starkey Road, Cross Bayou and Long Bayou to the east, and Coastal Zone 5 to the southwest.

Most of the City drains towards the large waterbodies through man-made stormwater conveyance, with a portion of the City draining towards McKay Creek in the northwest. Elevations within the City of Seminole watershed range from sea level to around 72 feet (NAVD88) in the northwestern portion of the watershed.

Approximately one third of the City's watershed consists of hydrologic soil group A – well drained soils with low runoff potential. Around sixty percent consists of soil group A/D, B/D, and C/D. Dual classification soils vary in their hydrologic response based on seasonality of the water table and/or man-made drainage improvements.

Landuse throughout the watershed is mostly developed, where over 80% of the area consists of urban land uses. More specifically, the developed portions mostly consist of high and medium density residential areas (60%), Commercial and Services (8%), Institutional (5%), Recreational (4%), and Transportation (3%). Waterbodies make up almost 9%. The remaining 11% are a mix of other natural and developed land uses.

1.3 Purpose

The purpose of this report is to document the BMP Alternative Analysis for the City of Seminole Watershed in Pinellas County. The report contains supporting documentation for the identification of flood prone areas, selection of specific areas for BMP development, a review of the BMP evaluation methodology, and the summary of conceptual improvement projects addressing flooding and water quality when relevant.

2 IDENTIFICATION OF FLOOD-PRONE AREAS

Flood prone areas within the City of Seminole watershed were identified in the *City of Seminole Flood Protection Level of Service (FPLOS) Analysis Report* developed by Applied Sciences (2024). The Level of Service (LOS) analysis utilized the previously developed, ICPR4 H&H stormwater model to evaluate flooding impacts to buildings and streets within the City. City streets and structures not meeting the desired LOS criteria were highlighted and estimated flooding damages were calculated. Additionally, historic flooding areas and common flood related complaints were shared by the City. These locations often aligned well with the LOS results, further validating the specific locations identified for BMP site selection.

3 BMP SITE SELECTION

As previously mentioned, the results of the FPLOS analysis were the main driver for identifying flood prone areas and thus locations for potential BMP concept development. Additional considerations were noted based on City specific issues and flooding concerns. Historical feedback from residents and complaints, obtained from the open house public meeting, were included in discussions with the City.

Applied Sciences met with City and SWFWMD staff on February 16, 2024 to review the results of the FPLOS analysis and evaluate preliminary BMP site areas. Around 10 sites were discussed during this meeting. To narrow down the sites to a final 7, sites with larger contributing areas were determined to be a higher priority. Often, BMPs developed through the Watershed Management Program (WMP) focus on the intermediate and regional stormwater management system. These systems typically involve larger ponds and pipe systems. **Figure 1** displays the final 7 sites for BMP development. **Table 1** summarizes the BMP sites with project naming conventions.

***Table 1**: City of Seminole BMP Sites and Names*

BMP Number	BMP Name	BMP Focus
1	Lake Pearl Flooding	Flood Protection
2	Lake Seminole Bypass Canal Improvements	Flood Protection
3	70^{th} Ave Commercial Site	Flood Protection and Water Quality
4	112^{th} St North Flooding	Flood Protection and Water Quality
5	Walsingham Park East	Flood Protection and Water Quality
6	Seminole Lake Country Club	Sea Level Rise Analysis
7	Oaks of Seminole Condominium	Flooding and Water Quality

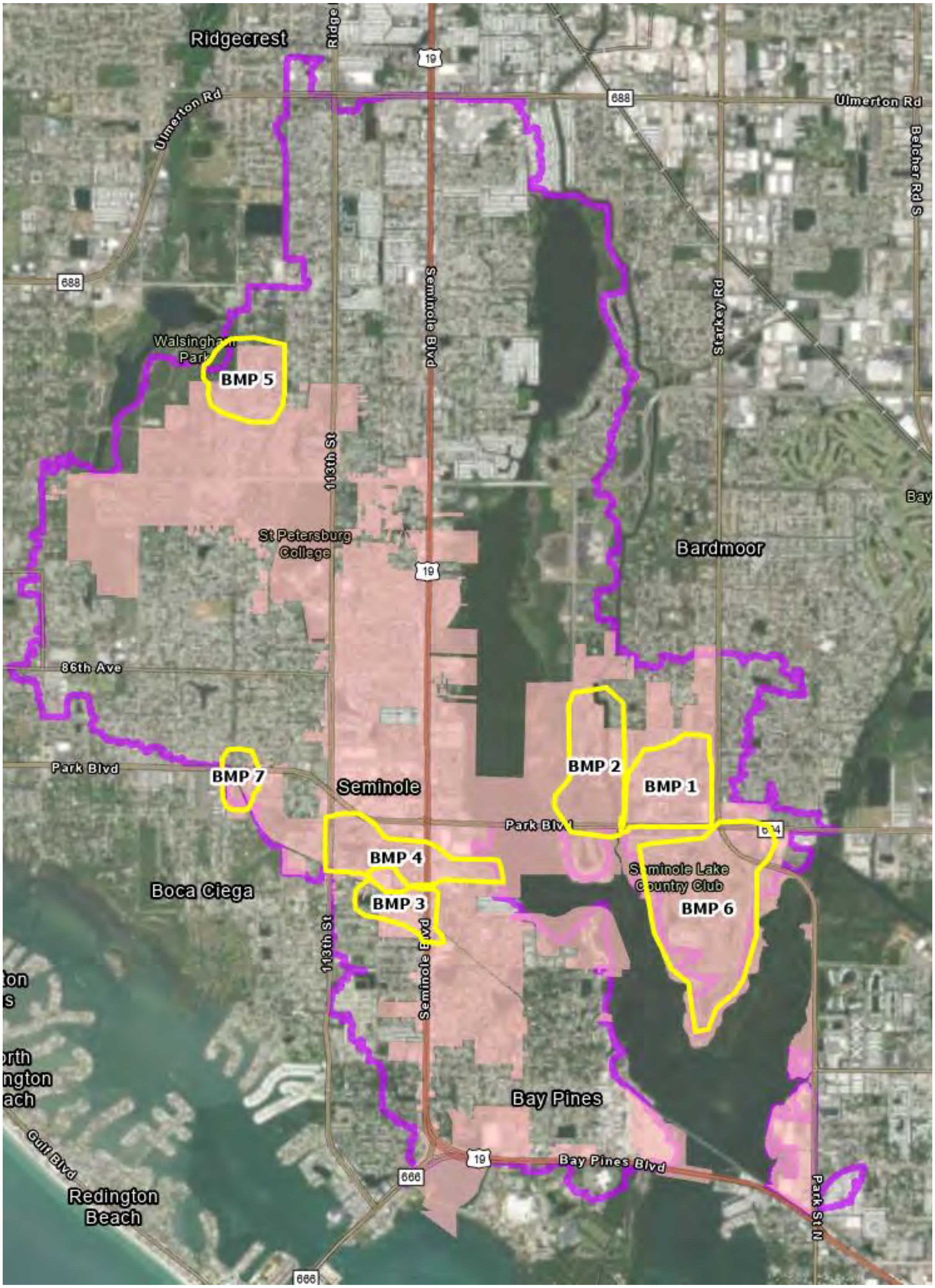

***Figure 1**: Overall BMP Sites*

4 WATER QUALITY SUMMARY

Although a specific water quality analysis was not included in this study, a brief water quality summary was performed by Applied Sciences staff (see **APPENDIX A – WATER QUALITY SUMMARY**). The water quality summary identified existing reports, studies, and historical records and available water quality data. This summary should serve as the basis for detailed water quality analysis projects in the future.

5 BMP EVALUATION METHODOLOGY

Each BMP site was evaluated for both structural and non-structural solutions with a focus on relieving flooding for the 25-year, 24-hour storm event. This event aligns with the City's FPLOS goals. Applied Sciences considered utilization of existing infrastructure, City/County owned parcels, and aesthetic/practical routing of new infrastructure when evaluating BMP concepts.

The following components were addressed for each conceptual BMP:

- Measurable Benefit (e.g., acres treated)
- Resource Benefit (e.g., providing flood protection during 25- year, 24-hour storm, lbs/year of target contaminant removed, if applicable)
- Proposed Conditions Modeling
    - Each proposed alternative was modeled in ICPR4 using all design storms (mean annual, 5-year, 10-year, 25-year, 50-year, and 100-year; all 24-hour events)
    - Inundation polygons for proposed development were also included in the electronic deliverables.
- Water Quality Evaluation (if applicable) using BMP Trains 2020 (Version 5.3.2); quantification of nitrogen and phosphorus removal (lbs/year)
- Environmental Considerations
- Geotechnical Considerations
- BMP Permitting Analysis
    - Applied Sciences attended an informal ERP pre-application meeting with SWFWMD staff on March 4, 2024 to present each conceptual BMP and understand any regulatory permitting requirements. See **APPENDIX B – PERMITTING REVIEW** for meeting minutes from this discussion.
- Public Acceptance and Availability
- Opinion of Probable Construction Cost
    - Planning level cost estimate, see **APPENDIX C – OPINION ON PROBABLE COST** for detailed information.

- Benefit Cost Analysis (BCA)
    - For flood reduction BMPs benefit/cost is reduction in flood damages versus cost of project over the life of the project.
        - The methodology defined in the SWFWMD BCA spreadsheet tool was used to estimate flooding costs for each BMP site.
        - Time series data was only extracted to hour 24 in 15-minute increments. The dynamics of the City of Seminole do not typically have long flood durations.
        - Each BMP site was assigned an average Expected Annual Damage (EAD) flood cost which weights the average flooding cost between two design storm intervals (10-year and 25-year, for example) by the corresponding difference in their return interval exceedance percentages. This would correspond to the difference between the 10-year (10 %) and 25-year (4%) probabilities. The 100-year event has a 1% impact on the overall EAD. More frequent events (mean annual storm, for example) with greater flooding impact have a greater impact on the EAD.
        - Applied Sciences also reported on the number of structures estimated to be within 1-foot of flooding for all design storms. Additionally, the estimated length of street flooding was reported for each design storm. Similar Expected Annual Counts/Lengths were calculated for existing and proposed conditions. The ratio of existing to proposed Expected Annual Structure Counts were included as part of the BMP Ranking matrix, see **Section 7**. Similarly, the ratio of existing to proposed Expected Annual Length of Street Flooding was included in the BMP Ranking matrix.
    - For water quality BMPs benefit/cost is cost per pound or cost per acre of pollutant removed based on the performance of the implemented BMP.
    - Operation and Maintenance (O&M) costs are shown separately.

- BMP Ranking

    - Applied Sciences reviewed BMP Ranking criteria for other local municipalities in Florida along with cooperative funding criteria established by SWFWMD. Typical ranking categories include those related to system scale, benefit cost ratio, and ease of constructability. Specifically, Applied Sciences defined seven categories to include in the BMP Ranking methodology.

        1. **System Scale**

            The system scale category indicates the general magnitude of the proposed stormwater implementation project. The scale can also be related to the impact the improvement project has on the surrounding area. Typically, three system scales are used to describe stormwater systems: Regional, Intermediate, and Local. Larger, more impactful projects are often related to

Regional Scale systems and would be considered higher ranking as compared to Local Scale projects which may only address small pipe systems and have less of an impact overall.

2. **Benefit Cost Ratio**

   The benefit cost ratio is derived from the SWFWMD BCA workflow and compares the present value of expected future benefits due to the project to the present value of expected construction costs. For example, if a project is shown to provide a future benefit of $1,000,000 and costs $500,000 to construction, the benefit cost ratio would be 2, indicating a positive return on investment. For every dollar spent on construction, the project is expected to yield $2.00 of benefits.

3. **Structure Impacts (Expected Annual Count)**

   For each BMP project, Applied Sciences determined the total number of building structures that were within 1 ft of flooding. This includes all inundated structures along with any structure that is within 1 ft of being inundated. These counts were developed for each design storm simulation. Similar to the Expected Annual Damage calculations for monetary flood impacts, Applied Sciences calculated the Expected Annual Count of structures within 1 ft of flooding. This process weighs observed impacts in the mean annual event more than the 100-year event. Finally, the Expected Annual Counts for existing conditions were divided by the Expected Annual Counts for the proposed conditions. A larger ratio (typically greater than 2) indicates that structures are being removed from the floodplain and not within 1 ft of flooding. This analysis also considers annual damages not a single design storm event.

4. **Street Impacts (Expected Annual Length)**

   For each BMP project, Applied Sciences determined the total length of flooding for streets within the contributing area of the BMP site. Flooded street lengths were developed for each design storm simulation. Similar to the Expected Annual Damage calculations for monetary flood impacts, Applied Sciences calculated the Expected Annual Length of street inundation. This process weighs observed impacts in the mean annual event more than the 100-year event. Finally, the Expected Annual Length of street flooding for existing conditions was divided by the Expected Annual Length of street flooding for the proposed conditions. A larger ratio (typically greater than 1.5) indicates that street flooding is being reduced. This analysis also considers expected *annual* damages not a single design storm event.

5. **Water Quality Improvements, Nitrogen, Cost Per Pound Per Acre**

   Water quality metrics were evaluated for nitrogen reduction in terms of pounds per acre. The overall construction cost of the project was used to support this calculation along with the water quality modeling results from the

BMP Trains program. The reported nitrogen removal in pounds per year was then divided by the total contributing area associated with the BMP project to report cost per pounds per acre of nitrogen removed. Cost metrics were sourced from BMP evaluation forms associated with Hernando County and have been applied to various other Watershed Management Plan projects in the recent past.

6. **Water Quality Improvements, Phosphorous, Cost Per Pound Per Acre**

   Water quality metrics were evaluated for phosphorous reduction in terms of pounds per acre. The overall construction cost of the project was used to support this calculation along with the water quality modeling results from the BMP Trains program. The reported phosphorous removal in pounds per year was then divided by the total contributing area associated with the BMP project to report cost per pounds per acre of phosphorous removed. Cost metrics were sourced from BMP evaluation forms associated with Hernando County and have been applied to various other Watershed Management Plan projects in the recent past.

7. **Opinion of Construction Complexity**

   The construction complexity category associated with the BMP Ranking methodology aims to incorporate several aspects related to constructability, including permitting, land acquisition, easements, and the general magnitude of the project concept. Four categories were defined: Simple, Moderate, Complex, and Very Complex. Engineering judgement and general project implementation understanding were used to assign these values.

Conceptual design figures for each BMP can be seen in **APPENDIX D – BMP CONCEPT FIGURES**. These figures were developed in GIS and show any proposed grading contours, proposed subbasin delineations, contributing area of BMP, drainage structures to be removed, proposed drainage structures, roadway reconstruction, etc. BMP model changes were documented for each relevant BMP and can be seen in **APPENDIX E – BMP MODEL UPDATE REFERENCES**.

5.1 Sea Level Rise (SLR) for BMP Concepts

Consideration for future SLR was included for relevant BMP concepts. Any project with a direct connection to a tidal outfall was evaluated for future SLR. This includes BMPs 1, 2, 4, and 6. Future SLR water levels were extracted from information in the latest National Climate Assessment (NCA) and data from the National Oceanic and Atmospheric Administration (NOAA). These sources were compiled by the Tampa Bay interdisciplinary group, the Climate Science Advisory Panel (CSAP) in 2019. CSAP provided the following SLR projections:

***Table 2**: Relative Sea Level Change*

Year	NOAA Int-Low (feet)	NOAA Intermediate (feet)	NOAA Int-High (feet)	NOAA High (feet)
2000	0	0	0	0
2010	0.16	0.23	0.29	0.36
2020	0.36	0.49	0.62	0.72
2030	0.55	0.78	1.01	1.24
2040	0.72	1.08	1.41	1.77
2050	0.95	1.44	1.97	2.56
2060	1.14	1.87	2.62	3.47
2070	1.34	2.33	3.38	4.56
2080	1.54	2.82	4.20	5.71
2090	1.7	3.38	5.15	7.05
2100	1.9	3.9	6.16	8.49

Additional considerations were evaluated based on recent Florida Department of Environmental Protection (FDEP) Vulnerability Assessment grants which specify analysis of the specific planning horizons – 2040 and 2070. For this study, the 2070 timeframe was selected since most BMP projects are considered operational for at least 30 years. Additionally, the NOAA 2017 Intermediate High curve was selected, which predicts a 3.38-foot increase in sea level by 2070. The values from the above table must be added to current sea levels. Through review of the NOAA St Petersburg tide gauge (8726520), it was determined that the current tidal water level was around 0.78 feet. This value represents Mean Higher High Water (MHHW) for the year 2000 and is referenced to the NAVD88 vertical datum. MHHW provides a higher and more conservative design water level as compared to Mean High Water (MHW). MHHW better accounts for the extremes of tidal fluctuations and offers enhanced protection against storm surge and severe weather conditions. This approach ensures a higher level of safety and resilience for coastal infrastructure and stormwater management systems. Based on the relative change values in **Table 2**, one must add 3.38 feet to 0.78 feet to arrive at the 2070 Intermediate High estimate. For any tidally connected BMP concept, an updated tidal boundary condition of 4.16 NAVD88-ft was implemented. Boundary nodes BNDY_0030, BNDY_0050, BNDY_0090 were updated with new tidal conditions.

Future sea level rise conditions were evaluated through simulation of the proposed condition ICPR4 model with the updated tidal boundary. All design storm simulations were executed, and the model results were evaluated using the SWFWMD BCA methodology. Changes in the Expected Annual Damage (EAD) benefits and the total present value of future benefits were reviewed. Ideally, the currently proposed alternative would still show EAD improvements and ultimately positive future benefits under elevated tidal conditions.

5.2 BMP 6 – Seminole Lake Country Club

The analysis for BMP 6 focuses on the Seminole Lake Country Club area, tracing its historical development from a cattle ranch to residential neighborhoods and a golf course. Concerns regarding flooding and stormwater management were raised by residents during the development of the Watershed Management Plan (WMP). Despite minor observed flooding in existing models, resident complaints and unique local hydrological characteristics prompted further investigation.

Alternative 6 analysis delves into elevated tidal conditions and reduction in soil storage, crucial factors influencing flooding. Adjustments were made to model parameters, indicating potential future tidal levels exceeding existing conditions. Simulations suggest increased flooding impacts under future scenarios, particularly along streets and structures in various locations within the community. These locations are discussed in greater detail within **Section 6.6** of this report.

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6 BMP ALTERNATIVE ANALYSIS

6.1 Alternative 1 – Lake Pearl Flooding

Lake Pearl is located in the eastern portion of the City, north of Park Blvd, and consists of approximately 1.8 acres of open water. The lake receives direct rainfall and stormwater runoff through existing stormwater systems. The existing stormwater pipes mostly consist of historic corrugated metal pipes with potentially reduced functionality. The lake outfalls west to the Seminole Bypass Canal through a series of open channels and large, but short pipe crossings.

Street flooding in the Lake Pearl area is common during heavy rainfall events. The City provided several photos and accounts of recent flooding that is summarized in the following figure, **Figure 2**, see below.

***Figure 2**: Recent Flooding, Lake Pearl*

In addition to historical flooding complaints, the FPLOS analysis also pointed towards the Lake Pearl area for street and structure deficiencies.

6.1.1 Alternative 1 BMP Concept

The preferred alternative consists of new stormwater conveyance, conversion of existing open channel ditch to a box culvert, new bypass box culvert flowing south, a backflow preventor near the Seminole Bypass Canal, and other stormwater upgrades. The following figure, **Figure 3**, summarizes the proposed improvements and displays the 25-year, 24-hour floodplain model results for the existing and proposed improvements.

Figure 3*: Lake Pearl BMP Concept Summary*

Improvements:

- New stormwater conveyance system running north to south along 90th Way. Pipe sizes increase from 48 inches to 54 inches which discharges into Lake Pearl.
- Conversion of open channel ditch to 5x8 ft box culvert from the outfall of Lake Pearl to Garden Dr. All channel model segments were converted to box culvert links, thus

accounting for lateral flows. Approaches including inlet grates above box culverts should be explored during design.

- Additional 5x8 ft box culvert continuing south at Garden Dr to Long Bayou.
- Upsizing of a 36-inch pipe to 48-inch running south down 92nd Street.

6.1.2 Alternative 1 BMP Evaluation

- ***Resource and Measurable Benefit***
    - Approximately 100 acres of contributing area.
    - Flood reduction benefits seen through the 100-year event.
    - Improvements to FPLOS rankings for streets and structures.
- ***Proposed Conditions Modeling Results***
    - Based on the inclusion of the proposed improvements, structure and street flooding is improved in the Lake Pearl area. Street flooding depths for the 25-year, 24-hour event decreased by approximately 1 foot, with some streets showing even greater improvement. No stages were shown to increase due to the site improvements. See supporting electronic deliverables for all node peak stages for existing and proposed events.
- ***Water Quality Evaluation***
    - The project does not include any substantial water quality components. The stormwater is still draining to Long Bayou just through a slightly different avenue (currently over the Lake Seminole Bypass canal weir versus the proposed bypass box culvert). Conversion of the existing open ditch to a box culvert may have impacts on water quality for the receiving water bodies. Modeling efforts replaced existing channel segments with box culverts, thus accounting for localized, lateral flows. Approaches including vegetated swales with grates above box culverts should be explored during design to help improve water quality of the system.
- ***Environmental Considerations***
    - The National Wetland Inventory (NWI) and 2020 SWFWMD landuse designations do not indicate any wetlands within the project vicinity. Open water features, like Lake Pearl, are designated as Freshwater Ponds by the NWI. Stormwater discharging to Long Bayou is shown to by approximately 6% across all design storms based on the proposed bypass system. Further water quality and environmental analysis is recommended to better understand the Long Bayou system.
- ***Geotechnical Considerations***
    - Soils in the surrounding area are mostly characterized as dual hydrologic soil group A/D (EauGallie and Myakka). Type B and B/D soils are also present.

  - Due to proposed improvements along existing streets and the replacement of the open ditch with a box culvert system, geotechnical investigation related to seasonal high water table and specific soil properties is recommended.

- ***Permitting Requirements***
  - A new individual SWERP application would be needed to demonstrate no-rise condition for offsite peak flood stages via storage modeling for 2.33-yr, 10-yr, 25-yr, and 100-yr storm events.
  - Coordination with Pinellas County/FDOT for box culvert under neath Park Blvd.
- ***Public Acceptance and Availability***
  - Flood protection improvements in smaller storm events as well as some improvement with larger events although not completely solved for the 100-year storm.
  - Reduced maintenance for converting open ditch to box culvert system. Currently, the City does not have access to these areas due to lack of easements. This factor was included in the BMP ranking methodology in the form of construction complexity. It is technically on the residents to maintain the portion of creek segment associated with their property – an activity with seemingly limited participation. It is anticipated that developing agreements and coordination with the local community will be a large component of this project.
- ***Opinion of Probable Construction Cost***
  - The proposed construction cost for BMP 1 was estimated to be approximately $5,550,000. Refer to **APPENDIX C – OPINION ON PROBABLE COST** for detailed cost breakdown.
- ***Cost Benefit Analysis***

The following figure, **Figure 4**, compares the existing and proposed flooding costs based on the SWFWMD BCA evaluation methodology. The proposed project estimates an annual savings of around $725,000 and a present value of future benefits of $9,000,000. The analysis assumes a 7% discount rate over a 30-year project useful life.

Based on the present value of future benefits and the estimated construction cost, the proposed project achieves a Benefit/Cost Ratio of 1.62.

Existing Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$176,278	$410,695	$899,838	$2,326,537	$3,979,355	$6,693,037
Roadway Repair Damage ($)	0.000	$964,850	$1,790,550	$2,566,350	$3,778,250	$5,364,350	$7,060,750
Roadway Service Damage ($)	0.000	$49,230	$56,964	$72,816	$120,076	$184,348	$479,775
Total Damage ($)	0.000	$1,190,357	$2,258,209	$3,539,004	$6,224,863	$9,528,053	$14,233,562
EAD Existing ($)				$1,737,286			
# Structures within 1 ft of Flooding	0	1	2	8	31	58	98
Length Street Flooding, ft	0	4160	7750	11120	16135	22710	29620
Existing Annual Structures				4.95			
Existing Annual Steet Length				5263			
Proposed Conditions	**1-year**	**2.33-year**	**5-year**	**10-year**	**25-year**	**50-year**	**100-year**
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$139,923	$261,858	$513,846	$1,329,334	$2,395,421	$4,710,774
Roadway Related Damage ($)	0.000	$391,000	$888,950	$1,414,050	$2,773,150	$4,365,000	$6,125,800
Roadway Service Damage ($)	0.000	$30,387	$32,620	$37,020	$51,542	$101,065	$228,101
Total Damage ($)	0.000	$561,309	$1,183,428	$1,964,916	$4,154,026	$6,861,486	$11,064,675
EAD Proposed ($)				$1,012,036			
# Structures within 1 ft of Flooding	0	0	1	5	9	20	71
Length Street Flooding, ft	0	1665	3830	6110	11765	18365	25800
Proposed Annual Structures				2.29			
Proposed Annual Steet Length				2920			

Expected Annual Damage Without Project [(1)]	$1,737,286
Expected Annual Damage With Project [(1)]	$1,012,036
Expected Annual Damage Benefit (a) – (b)	$725,251
Discount Rate	7.0%
Project Useful Life (# years)	30
Total Present Value of Future Benefits	$8,999,663
Total Project Cost	$5,551,519
Benefit/Cost Ratio	**1.62**

BMP 1, Lake Pearl Flooding
- max construction cost of around 9 million would correspond to a BCA of 1

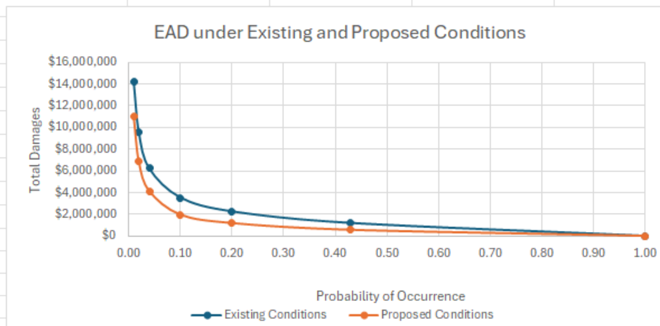


***Figure 4**: BCA Summary, Lake Pearl*

- ***Sea Level Rise Considerations***

The proposed condition model for Lake Pearl was updated with the established 2070 Intermediate High tidal boundary condition, 4.16 NAVD88-ft, see **Table 2**. All design storms were simulated, and the model results were evaluated with the SWFWMD BCA evaluation methodology, see **Figure 5** below.

Existing Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$176,278	$410,695	$899,838	$2,326,537	$3,979,355	$6,693,037
Roadway Repair Damage ($)	0.000	$964,850	$1,790,550	$2,566,350	$3,778,250	$5,364,350	$7,060,750
Roadway Service Damage ($)	0.000	$49,230	$56,964	$72,816	$120,076	$184,348	$479,775
Total Damage ($)	0.000	$1,190,357	$2,258,209	$3,539,004	$6,224,863	$9,528,053	$14,233,562
EAD Existing ($)				$1,737,286			

Proposed Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$136,306	$267,150	$502,510	$1,426,213	$2,748,001	$5,573,542
Roadway Related Damage ($)	0.000	$554,300	$1,111,250	$1,914,300	$3,403,200	$5,097,100	$6,787,500
Roadway Service Damage ($)	0.000	$45,798	$49,162	$54,119	$72,904	$135,357	$328,747
Total Damage ($)	0.000	$736,404	$1,427,563	$2,470,929	$4,902,316	$7,980,458	$12,689,789
EAD Proposed ($)				$1,233,930			

Expected Annual Damage Without Project (1)	$1,737,286
Expected Annual Damage With Project (1)	$1,233,930
Expected Annual Damage Benefit (a) – (b)	$503,356
Discount Rate	7.0%
Project Useful Life (# years)	30
Total Present Value of Future Benefits	$6,246,169
Total Project Cost	$5,551,519
Benefit/Cost Ratio	1.13

BMP 1, Lake Pearl Flooding
- max construction cost of around 6.25 million would correspond to a BCA of 1

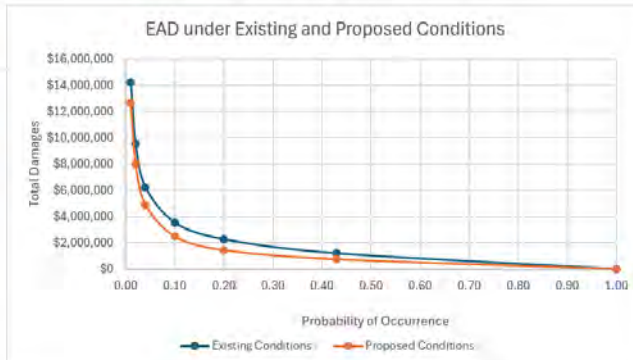


***Figure 5**: BCA Summary, Lake Pearl with Sea Level Rise Considerations*

The analysis quantifies flooding impacts to streets and structures in monetary terms across all design storm events. Under future tidal conditions, the proposed alternative shows a reduction in Expected Annual Damage (EAD) benefits of around $125,000 (original EAD benefits = $725,000; Sea Level Rise EAD benefits = $500,000), which corresponds to future benefit of $6.25 million. This represents a 30% reduction in project benefits due to future elevated tidal conditions; however, the project remains beneficial considering the benefit cost ratio. Under future conditions, the benefit cost ratio was calculated at 1.13 compared to 1.62 under existing conditions.

6.1.3 Alternative 1 BMP Additional Considerations

The City should also consider opportunities for channel improvements in lieu of box culvert conversion. Techniques involving channel fortification with Fabriform materials and bank stabilization should be considered, if more desirable by the community. Additionally, there is the potential ability to connect to other pipe networks within the area. These pipe features are currently running behind resident homes which may prove difficult to directly replace/upsize.

6.2 Alternative 2 – Lake Seminole Bypass Canal Improvements

Flooding occurs just west of the Seminole Bypass canal during significant rainfall events and tidal surges. Recent storm surge events were documented from Hurricane Idalia on 8/30/2023 and an unnamed event on 12/17/2023. Tidal elevations were between 3.97 and 4.54 NAVD88-ft. **Figure 6** and **Figure 7** display the two most recent tidal events that impacted this area.

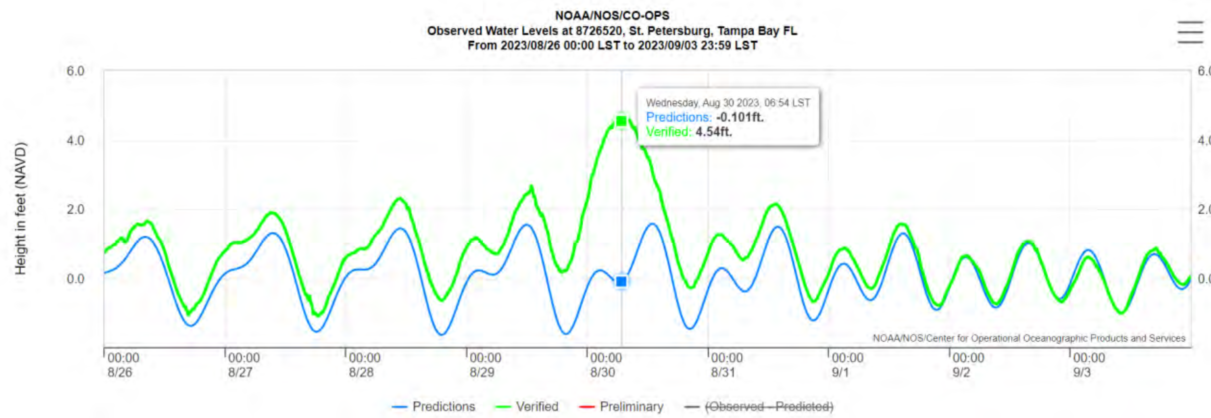


***Figure 6**: St Petersburg Tide Gauge, 8/30/2023 - Hurricane Idalia*

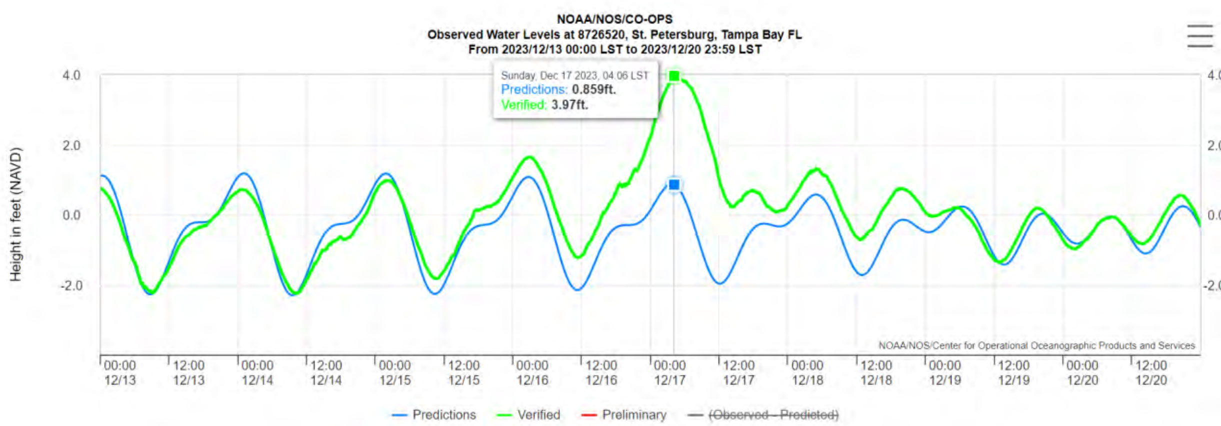


***Figure 7**: St Petersburg Tide Gauge, 12/17/2023 – low pressure weather system event*

Existing stormwater management features are sensitive to elevated tidal conditions in this area. Outfall pipe inverts are often much lower than normal tidal fluctuations with invert elevations from -0.5 to 2.5 NAVD88-ft. During high tide conditions, tidal waters can backflow into neighborhoods causing flooding without any additional rainfall.

6.2.1 Alternative 2 BMP Concept

In addition to recent storm surge events, stormwater modeling was shown to cause flooding impacts to the area. Rainfall based surface modeling from the previously developed ICPR4 model shows substantial flooding in this low-lying area. LOS deficiencies related to streets and structures were identified.

After additional review of the site area and model configuration, it was determined that potential upgrades to the Seminole Bypass outfall system could result in improved conditions upstream in the flooding area. Currently, the outfall system consists of a large rectangular structural weir that discharges under Park Blvd through 4, 7x12 ft concrete box culverts. Head loss between the box culverts and the static tidal boundary condition was notable, with about 3.8 feet of head loss identified during the 25 Year, 24 Hour storm event. By increasing the size of the box culvert system, one could reduce head loss and upstream stages.

To test this approach, Applied Sciences needed to update the type of boundary condition used in the original model. The original model contained a time-stage boundary condition at the northern end of the model domain – Node BNDY_0010. Time-stage information was extracted from the Starkey WMP model that was developed around 2013. This approach is fine for evaluating existing conditions; however, when developing alternatives focused on downstream features, one must update the time-stage information to time-flow. Under time-stage conditions, the model will keep stages in the canal consistent with existing conditions, thus incorrectly representing the impact of downstream improvements. Applied Sciences extracted time-flow information from the 2013 Starkey model for all design storm conditions.

The time-flow boundary condition model was updated with several improvements to the Seminole Bypass outfall structures. The following figure, **Figure 8**, summarizes the proposed improvements and displays 25-year, 24-hour floodplain model results for the existing and proposed improvements.

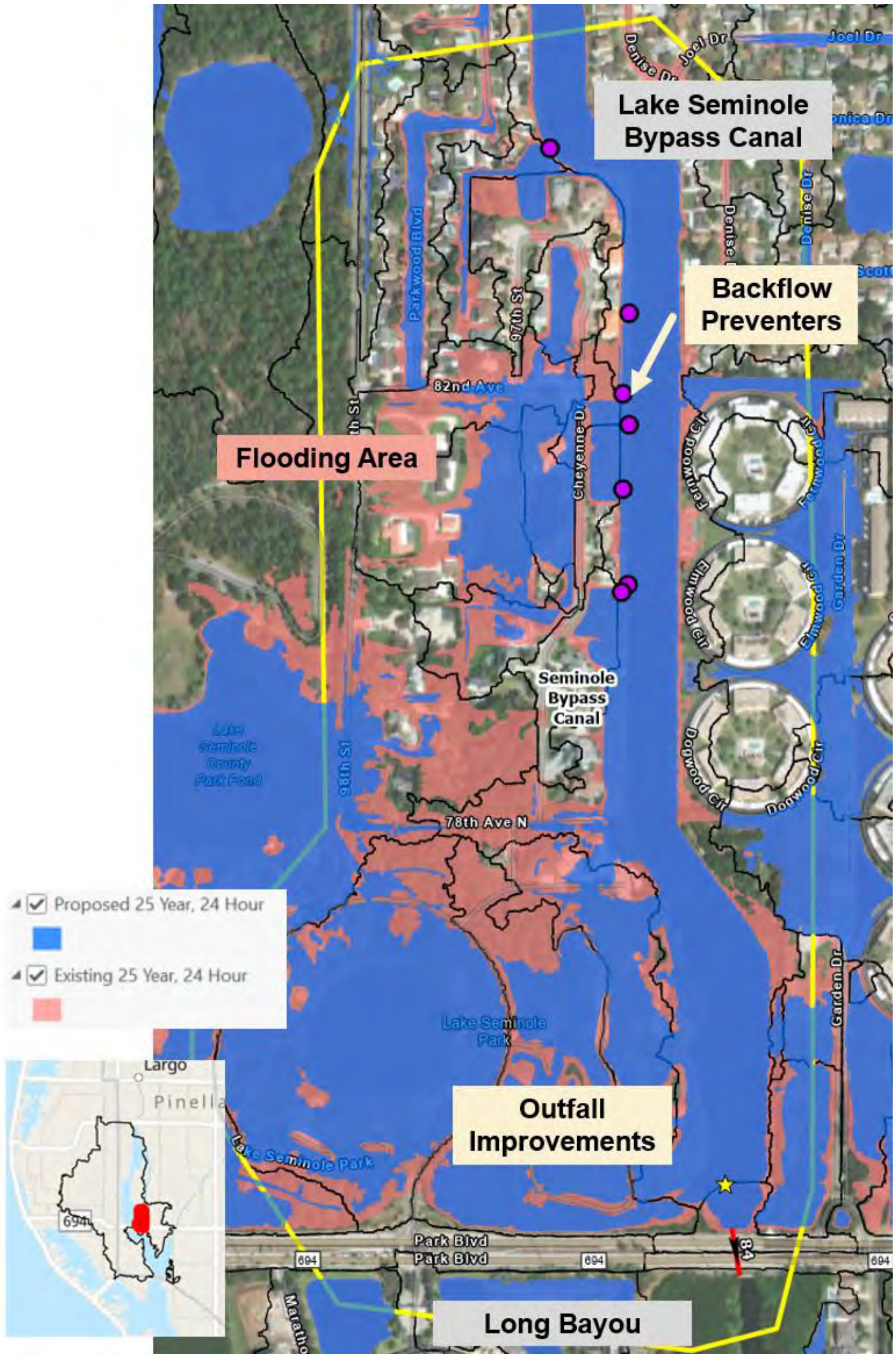


***Figure 8**: Seminole Bypass BMP Concept Summary*

Improvements:

- Increased outfall capacity by 3 box culverts of 7x12 ft size; additional 252 ft^2 of flow area.
    - Potentially consider traditional span bridge design of equivalent cross-sectional area
- Addition of 50 feet of length to outfall weir; from 182 feet to 232 feet; western side of canal.
- Backflow preventers on various stormwater pipes discharging to bypass canal in impacted neighborhood to the northwest of outfall structure.

6.2.2 Alternative 2 BMP Evaluation

- ***Resource and Measurable Benefit***
    - Improvement of flooding conditions for approximately 330 acres.
    - Flood reduction benefits seen through 100-year event. Lesser impact on smaller events.
    - Improvements to LOS rankings for streets and structures.
- ***Proposed Conditions Modeling Results***
    - Based on the inclusion of the proposed improvements, structure and street flooding is improved in the area just west of the Seminole Bypass Canal. Additional flood reduction is shown on the east side of the canal in the Lake Pearl area. Flooding depths for the 25-year, 24-hour event decreased by approximately 1 foot, with some streets showing even greater improvement. No stages were shown to increase due to the site improvements. See supporting electronic deliverables for all node peak stages for existing and proposed events.
- ***Water Quality Evaluation***
    - The project does not include any substantial water quality components. The stormwater is still draining to Long Bayou, just more efficiently. Long Bayou was shown to be impacted by Enterococci and a trend in total nitrogen based on the water quality summary, see **APPENDIX A – WATER QUALITY SUMMARY**. Long Bayou does not have an established Total Maximum Daily Load (TMDL); however, it is recommended to enhance monitoring and perform regular inspections in the area to ensure the health of the receiving waters.
- ***Environmental Considerations***
    - The National Wetland Inventory (NWI) and 2020 SWFWMD landuse designations do not indicate any wetlands within the project vicinity. Open water features, like the Seminole Bypass Canal, are designated as Riverine by the NWI. Stormwater discharging to Long Bayou is shown to increase for the 50-year and 100-year

events, all lesser storms show similar flow rates. Further water quality and environmental analysis is recommended to better understand the Long Bayou system.

- ***Geotechnical Considerations***
    - Soils in the surrounding area are mostly characterized as dual hydrologic soil group A/D (EauGallie and Wulfert muck). Type B and B/D soils are also present further upstream to the west.
    - No geotechnical investigation appears to be required for upsizing the Seminole Bypass outfall system.
- ***Permitting Requirements***
    - Requires coordination with Pinellas County for Bypass Canal activities and Park Blvd right-of-way intervention.
    - No new impervious areas proposed.
    - A new individual SWERP application needed to demonstrate no-rise condition for offsite peak flood stages via storage modeling for 2.33-yr, 10-yr, 25-yr, and 100-yr storm events.
- ***Public Acceptance and Availability***
    - Flood protection improvements for smaller storm events as well as helping with larger events although not completely solved.
    - Backflow preventers for moderate storm surge events.
    - Potential traffic delays due to expansion of box culvert system underneath Park Blvd.
- ***Opinion of Probable Construction Cost***
    - The proposed construction cost for BMP 2 was estimated to be approximately $1,696,000. Refer to **APPENDIX C – OPINION ON PROBABLE COST** for detailed cost breakdown.
- ***Cost Benefit Analysis***

The following figure, **Figure 9**, compares the existing and proposed flooding costs based on the SWFWMD BCA evaluation methodology. The proposed project estimates an annual savings of around $435,000 and a present value of future benefits of $5,400,000. The analysis assumes a 7% discount rate over a 30-year project useful life.

Based on the present value of future benefits and the estimated construction cost, the proposed project achieves a Benefit/Cost Ratio of 3.19.

Existing Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$394,103	$769,304	$1,631,013	$3,882,134	$6,229,375	$9,742,851
Roadway Repair Damage ($)	0.000	$1,277,650	$2,263,200	$3,254,050	$4,917,100	$7,007,150	$9,322,450
Roadway Service Damage ($)	0.000	$51,082	$61,867	$101,522	$178,850	$293,722	$811,673
Total Damage ($)	0.000	$1,722,835	$3,094,371	$4,986,585	$8,978,084	$13,530,247	$19,876,975
EAD Existing ($)	$2,458,864						
# Structures within 1 ft of Flooding	0	4	8	17	47	90	151
Length Street Flooding, ft	0	5520	9805	14110	20980	29425	38755
Existing Annual Structures	9.775						
Existing Annual Steet Length	6817						

Proposed Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$315,434	$603,823	$1,116,587	$2,456,801	$4,256,930	$6,859,895
Roadway Related Damage ($)	0.000	$1,227,850	$2,034,350	$2,731,250	$4,055,850	$5,544,450	$7,416,150
Roadway Service Damage ($)	0.000	$34,841	$42,806	$55,171	$91,361	$187,821	$626,433
Total Damage ($)	0.000	$1,578,125	$2,680,979	$3,903,008	$6,604,012	$9,989,202	$14,902,478
EAD Proposed ($)	$2,023,388						
# Structures within 1 ft of Flooding	0	3	4	8	30	59	99
Length Street Flooding, ft	0	5305	8810	11840	17240	23070	30485
Proposed Annual Structures	6.07						
Proposed Annual Steet Length	6016						

Expected Annual Damage Without Project (1)	$2,458,864
Expected Annual Damage With Project (1)	$2,023,388
Expected Annual Damage Benefit (a) – (b)	$435,476
Discount Rate	7.0%
Project Useful Life (# years)	30
Total Present Value of Future Benefits	$5,403,836
Total Project Cost	$1,696,203
Benefit/Cost Ratio	3.19

BMP 2, Seminole Bypass Canal Improvements
- max construction cost of around 5.4 million would correspond to a BCA of 1

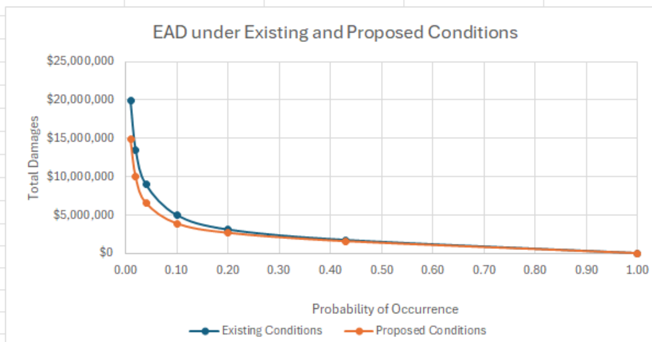


***Figure 9**: BCA Summary, Seminole Bypass Canal*

- ***Sea Level Rise Considerations***

The proposed condition model for the Seminole Bypass Canal project was updated with the established 2070 Intermediate High tidal boundary condition, 4.16 NAVD88-ft, see **Table 2**. All design storms were simulated, and the model results were evaluated with the SWFWMD BCA evaluation methodology, see **Figure 10** below.

Existing Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$394,103	$769,304	$1,631,013	$3,882,134	$6,229,375	$9,742,851
Roadway Repair Damage ($)	0.000	$1,277,650	$2,263,200	$3,254,050	$4,917,100	$7,007,150	$9,322,450
Roadway Service Damage ($)	0.000	$51,082	$61,867	$101,522	$178,850	$293,722	$811,673
Total Damage ($)	0.000	$1,722,835	$3,094,371	$4,986,585	$8,978,084	$13,530,247	$19,876,975
EAD Existing ($)				$2,458,864			

Proposed Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$594,019	$1,070,070	$1,792,209	$3,402,964	$5,427,866	$8,088,011
Roadway Related Damage ($)	0.000	$1,842,300	$2,710,900	$3,436,900	$4,765,950	$6,362,600	$8,067,100
Roadway Service Damage ($)	0.000	$59,797	$82,239	$116,925	$173,349	$284,496	$743,329
Total Damage ($)	0.000	$2,496,116	$3,863,209	$5,346,034	$8,342,263	$12,074,961	$16,898,439
EAD Proposed ($)				$2,831,850			

Expected Annual Damage Without Project (1)	$2,458,864
Expected Annual Damage With Project (1)	$2,831,850
Expected Annual Damage Benefit (a) – (b)	($372,987)
Discount Rate	7.0%
Project Useful Life (# years)	30
Total Present Value of Future Benefits	-$4,628,406
Total Project Cost	$1,696,203
Benefit/Cost Ratio	(2.73)

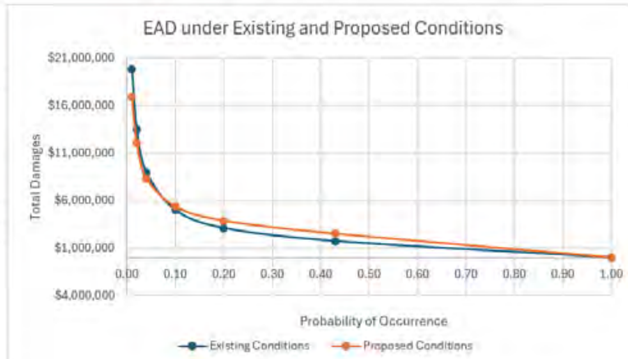


***Figure 10**: BCA Summary, Seminole Bypass Canal with Sea Level Rise Considerations*

The analysis quantifies flooding impacts to streets and structures in monetary terms across all design storm events. Under future tidal conditions, the proposed alternative shows **negative** benefits on an annual basis, indicating the impact of elevated tides. Damages in the smaller storm events are seen to increase under future conditions even with the proposed project in place. The project still shows some effectiveness during larger events like the 25-, 50-, and 100-year events. Since the Expected Annual Damages (EAD) methodology weighs the smaller storm events with greater importance, the overall project benefit appears unfavorable. Additional evaluation for this project concept should be considered to better address future sea level rise.

6.2.3 Alternative 2 BMP Additional Considerations

Applied Sciences performed an additional analysis related to elevated tidal conditions in this area. An area of interest was created from the underlying model basins. Along this perimeter, terrain elevations were assigned every 5 feet. The following graphic, **Figure 11**, displays these results with the lowest, overtopping points labeled:

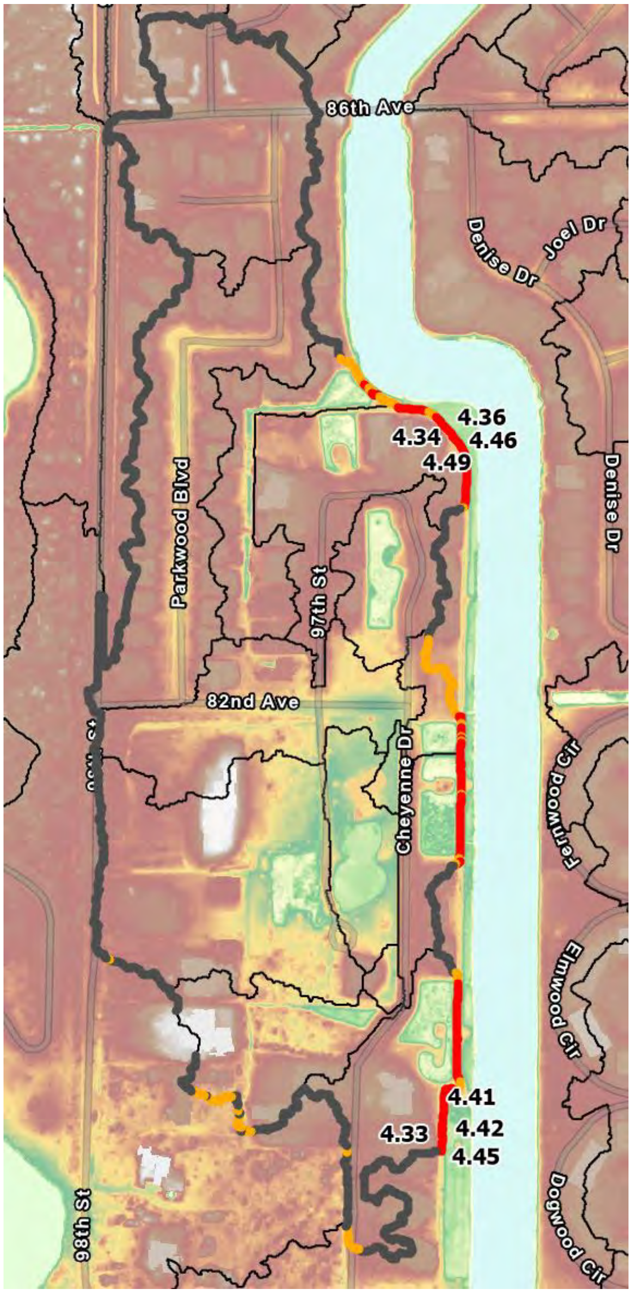


***Figure 11**: Low Points of Entry, Seminole Bypass Canal*

From this analysis, it was found that the lowest point of entry from the bypass canal to the neighborhood was around 4.3 NAVD88-ft. This indicates that even with backflow preventers on the stormwater pipes, tidal elevations around 4.3 NAVD88-ft could overtop the earthen areas and flow overland causing flooding issues. This elevation is slightly above the projected MHHW 2070 tidal value of 4.16 NAVD88-ft. Around 2070, this area is expected to see high tides around the elevations of the current earthen boundary. The City may start thinking of elevating seawalls along the eastern bank of the bypass canal prior to 2070.

6.3 Alternative 3 – 70th Ave Commercial Site

A commercial site on the south side of 70th Ave was identified through stormwater modeling and public comment as an area of concern. The site was developed in the 1960s and does not include any stormwater management infrastructure. Additionally, no intermediate or regional stormwater systems exist near the property to tie into. The following figure, **Figure 12**, shows imagery from 1970 and 2023 for the site and surrounding area.

1970 Imagery *2023 Imagery*

***Figure 12**: Historical Imagery, 70th Ave Commercial Site*

The site is currently characterized as highly impervious with very limited storage and no stormwater management. During minor storm events, flooding occurs throughout the site, connecting through overland flow to eventually move offsite. Flooding is observed throughout the entire design storm suite and supported through conversations with long term residents.

Since flooding is observed in the more frequent design storm events (mean annual and 5-year storms) the expected annual damages are quite high, affecting building structures and business operations. By alleviating flooding in the more frequent design storms, one can expect a more beneficial project from an annual damage perspective.

6.3.1 Alternative 3 BMP Concept

The commercial site just south of 70th Ave experiences regular flooding during small storm events. Without an existing stormwater management system, runoff must be routed to a new conveyance/outfall system and/or a new stormwater storage facility. No existing stormwater infrastructure is available along 70th Ave to discharge into. Any attempts to route water south into existing systems would potentially cause offsite impacts which violates current Environmental Resource Permit (ERP) requirements. Alternative 3 is contingent on no construction of Alternative 4. Alternative 3 might be replaced by direct connection to Alternative 4 if approved and constructed. See Alternative 4 for more information.

The preferred alternative recommends the creation of a new stormwater conveyance system from the commercial site. The network routes underneath Pinellas Trail and into three, linear storage features on the south side of the trail. Each pond can be described as a trapezoidal channel separated by rectangular ditch block weirs to promote retention and water quality treatment. The channel is generally positioned between the edge of the trail and the neighboring residential area with adequate distance between each existing feature. Each pond has a 4:1 side slope and is approximately 250 feet long. The final outfall weir discharges into an existing stormwater conveyance system associated with Seminole Blvd. Through appropriate design and adequate storage represented by the rain garden type systems, it is believed that proposed system can operate without substantially impacting the existing downstream stormwater system. **Figure 13**, displays the conceptual BMP below.

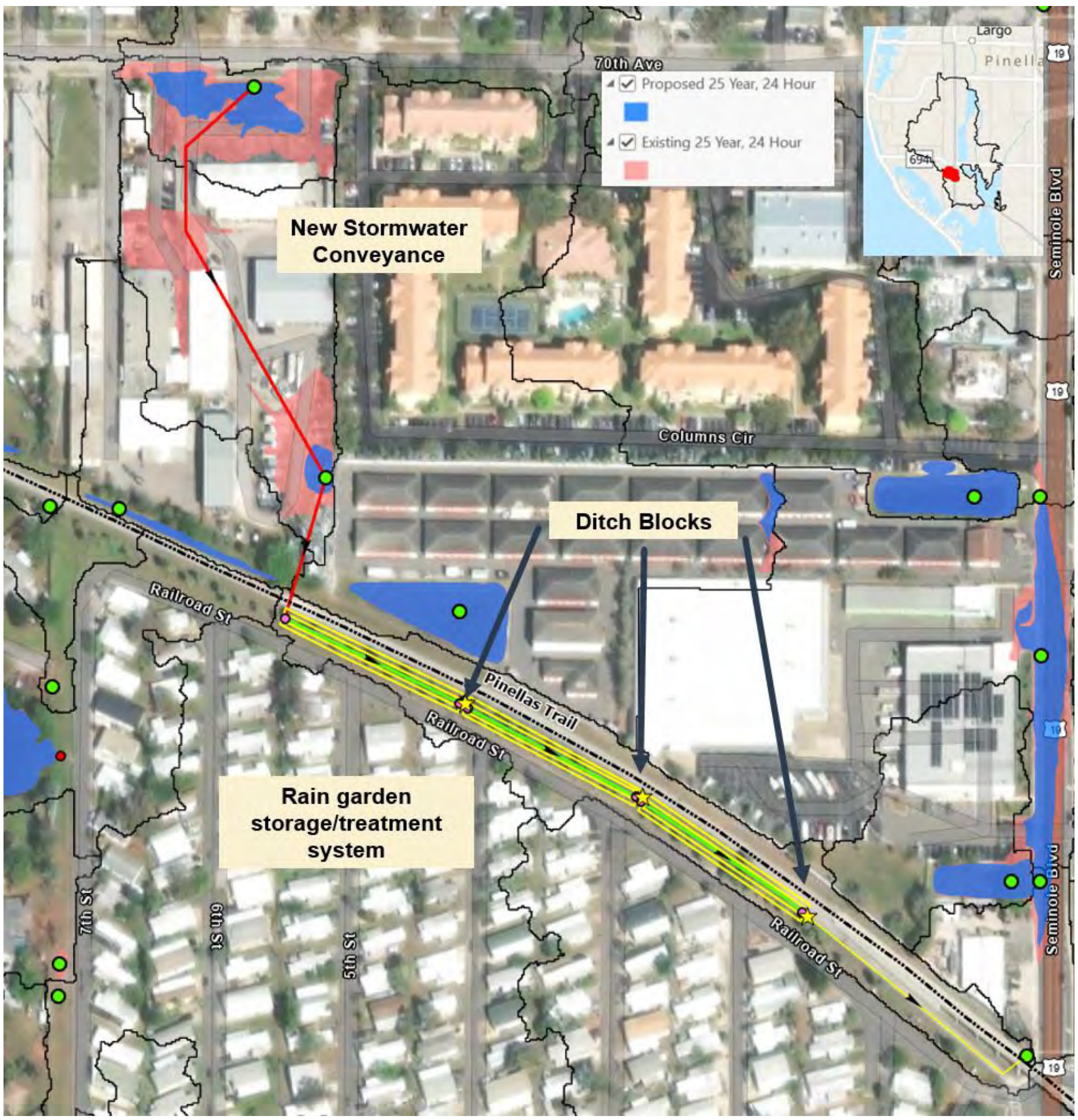


***Figure 13**: 70th Ave Commercial Site BMP Concept Summary*

Improvements:

- New stormwater system at commercial site consisting of small concrete pipes and inlet grates. Pipes are around 12 to 15 inches in diameter.
- Three, 250-foot-long linear ponds with 4:1 side slope, separated by concrete rectangular weirs for attenuation and controlled discharge. Approximately 0.8 ac-ft of total excavation.
    - Concrete ditch block weirs are between 10 and 15 feet wide and consist of rectangular geometry.

6.3.2 Alternative 3 BMP Evaluation

- ***Resource and Measurable Benefit***
    - Acres treated – 3.25 acres, small contributing area.
    - Flood protection benefits seen through 25-year event; some minor flooding still observed, but the runoff is now able to drain off site. Greater improvements for smaller events.
- ***Proposed Conditions Modeling Results***
    - Based on the inclusion of the proposed improvements, flooding and drainage at the commercial site was improved. Flooding depths for the 25-year, 24-hour event decreased by approximately 0.5 feet. Minor flood stage increases are seen at the downstream receiving node during the 100-year, 24-hour event. This could potentially be mitigated through further design and modeling of pond system. Accurate information on the seasonal high water table will be essential for determining the maximum depth of each linear pond component. See supporting electronic deliverables for all node peak stages for existing and proposed events.
- ***Water Quality Evaluation***

For water quality calculations, BMP Trains was used to quantify the average annual water quality benefit of the three swale ponds for nitrogen and phosphorous. Site specific information for the 3.25-acre contributing area was added to BMP Trains including the following details.

Landuse	Light Industrial: TN=1.200 TP=0.260
Area (acres)	3.25
Rational Coefficient (0-1)	0.69
Non DCIA Curve Number	81
DCIA Percent (0-100)	80
Nitrogen EMC (mg/l)	1.2
Phosphorus EMC (mg/l)	0.26
Runoff Volume (ac-ft/yr)	9.664

Groundwater N (kg/yr)	0
Groundwater P (kg/yr)	0
Nitrogen Loading (kg/yr)	14.299
Phosphorus Loading (kg/yr)	3.098

The swale BMP was implemented as a single feature with three swale blocks representing the three weirs used in the proposed alternative. The following table, **Table 3** describes the swale BMP in BMP Trains.

***Table 3**: Swale BMP Design, BMP Trains*

Swale Top Width for Flood Conditions - W (ft)	25
Swale Bottom Width - B (ft)	9
Swale Length - L (ft)	750
Average Impervious Length (ft)	0
Average Impervious Width (ft)	0
Average Pervious Width (ft)	28
Swale Slope (foot drop/foot length) - S	0.005
Mannings N	0.015
Soil Infiltration Rate (in/hr)*	5
Side Slope of Swale horizontal/vertical - Z	4
Average Height of Swale Block - H	1
Length of Berm Upstream of Crest - Lb	0
Runoff Area (acres)	0
Number of Swale Blocks	3

* Infiltration rate estimated from underlying Green-Ampt soil data for Tavares Fine Sand (13 ft/day or 6 in/hr); 5 in/hr used in the analysis for conservative estimation

The swale BMP was shown to provide extensive treatment for both nitrogen and phosphorous, with removal efficiencies nearing 97%. The provided nitrogen discharge load was shown to be 0.43 kg/year (reduced from 14.299 kg/year), while the provided phosphorous discharge load was calculated at 0.094 kg/year (reduced from 3.098 kg/year). Overall, the proposed project is expected to remove approximately 30.58 lb/yr of nitrogen and 6.63 lb/year of phosphorous.

- ***Environmental Considerations***
    - The National Wetland Inventory (NWI) and 2020 SWFWMD landuse designations do not indicate any wetlands within the project vicinity.

- ***Geotechnical Considerations***
    - Soils in the surrounding area are mostly characterized as hydrologic soil group A (Astatula, Tavares, and Adamsville sands), indicating high conductivity and deeper water tables.
    - Geotechnical investigation is recommended to better understand the seasonal high water table and specific conductivity values at the locations of the proposed ponds.
- ***Permitting Requirements***
    - Based on the ERP meeting with SWFWMD staff the project may qualify as a retrofit activity. The alternative is likely feasible for a General Permit under Rule 62-330.451.
- ***Public Acceptance and Availability***
    - Flood protection improvement for small commercial site that currently lacks any stormwater management.
    - Potential aesthetic and educational opportunities for linear pond system along Pinellas Trail. Incorporation of native plant landscaping, decorative rocks/stones, and seating areas.
    - Water quality improvements through tiered pond system.
- ***Opinion of Probable Construction Cost***
    - The proposed construction cost for BMP 3 was estimated to be approximately $374,000. Refer to **APPENDIX C – OPINION ON PROBABLE COST** for detailed cost breakdown.
- ***Cost Benefit Analysis***

The following figure, **Figure 14**, compares the existing and proposed flooding costs based on the SWFWMD BCA evaluation methodology. The proposed project estimates an annual savings of around $244,000 and a present value of future benefits of $3,000,000. The analysis assumes a 7% discount rate over a 30-year project useful life.

Based on the present value of future benefits and the estimated construction cost, the proposed project achieves a Benefit/Cost Ratio of 8.09.

Existing Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$297,657	$621,701	$692,318	$896,304	$1,209,663	$1,548,600
Roadway Repair Damage ($)	0.000	$0	$48,300	$62,100	$845,350	$1,199,250	$1,615,300
Roadway Service Damage ($)	0.000	$0	$0	$0	$36,760	$71,278	$124,149
Total Damage ($)	0.000	$297,657	$670,001	$754,418	$1,778,414	$2,480,191	$3,288,049
EAD Existing ($)				$447,627			
# Structures within 1 ft of Flooding	0	3	5	5	7	15	20
Length Street Flooding, ft	0	0	210	270	2945	4260	5760
Existing Annual Structures				3.23			
Existing Annual Steet Length				324			

Proposed Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$47,344	$87,713	$309,353	$694,066	$988,201	$1,402,499
Roadway Related Damage ($)	0.000	$0	$48,300	$62,100	$667,550	$1,066,250	$1,549,300
Roadway Service Damage ($)	0.000	$0	$0	$0	$9,176	$55,984	$102,683
Total Damage ($)	0.000	$47,344	$136,013	$371,453	$1,370,792	$2,110,435	$3,054,481
EAD Proposed ($)				$203,402			
# Structures within 1 ft of Flooding	0	0	0	1	4	11	18
Length Street Flooding, ft	0	0	210	270	2350	3805	5535
Proposed Annual Structures				0.675			
Proposed Annual Steet Length				290			

Expected Annual Damage Without Project [1]	$447,627
Expected Annual Damage With Project [1]	$203,402
Expected Annual Damage Benefit (a) – (b)	$244,225
Discount Rate	7.0%
Project Useful Life (# years)	30
Total Present Value of Future Benefits	$3,030,599
Total Project Cost	$374,620
Benefit/Cost Ratio	8.09

BMP 3, 70th Ave Commercial Site
- max construction cost of around 3 million would correspond to a BCA of 1

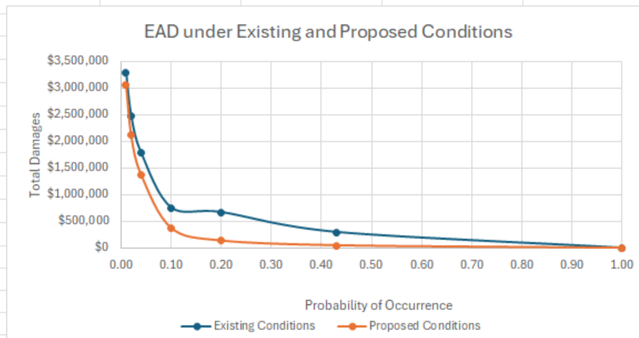


***Figure 14**: BCA Summary, 70th Ave Commercial Site*

- ***Sea Level Rise Considerations***
  - No SLR consideration for this location due to distance from SLR influences.

6.3.3 Alternative 3 BMP Additional Considerations

- Coordination with Pinellas County to achieve this project. Pinellas Trail site is owned by the County.
- Potentially greater benefits through incorporating percolation modeling or other high-infiltration techniques in the proposed pond areas. Geotechnical investigations are required to determine these limits.
- Introduction of more aesthetic properties like unique vegetation and other structural materials. Educational opportunities are possible throughout the site for patrons of Pinellas Trail to read/learn and understand more about stormwater management in the community.
- Potential inclusion of designed treatment materials like *Bold and Gold* for additional water quality improvement.

- Connection to Alternative 4, if Alternative 4 is constructed, the commercial site can be tied in more easily, no need for more complicated storage treatment along Pinellas Trail.

6.4 Alternative 4 – 112th St North Flooding

Alternative 4 focuses on a flooding area just northwest of the previously discussed 70th Ave Commercial Site. Alternative 3 might be replaced with direct connection to Alternative 4, if approved and constructed. The area was developed around the 1960s prior to detailed stormwater management regulations. The open water ponds and underlying stormwater infrastructure are inadequate to service the existing development. The following figure, **Figure 15**, displays historical aerial imagery from 1970 and current imagery from 2023.

1970 Imagery *2023 Imagery*

***Figure 15**: Historical Imagery, 112th St North*

Based on existing condition ICPR4 model results, this area experiences street flooding during the 25-year storm and larger events. Residential buildings are at risk of inundation during the 100-year storm event with peak stages within inches of finished floor elevations. The area is characterized with high density residential, commercial, and institutional land uses. Soils in the area are designated as hydrologic soil group A/D, indicating increased runoff potential under saturated conditions. The system outfalls into County Road 321 (113th St) and heads north to a large pond associated with Seminole Garden Apartments. The pond at Seminole Garden Apartments ultimately discharges into Lake Seminole through a control weir and 72-inch concrete pipe.

6.4.1 Alternative 4 BMP Concept

The proposed alternative specifies a new outfall at 112th St North, just north of 73rd Ave. The alternative recommends a 48-inch concrete pipe connecting to the existing wet ponds, first flowing south down 112th St North and then west along 73rd Ave. The outfall system then reroutes a portion of 113th St runoff south, and then east down 70th Ave. The pipe evolves to a 54-inch section crossing State Road 595 (Seminole Blvd), and eventually to a tidal outfall. The project incorporates a baffle box to aid in pollutant /water quality treatment before discharging into Long Bayou. This project can also be associated with BMP 3. If constructed, the 70th Ave site can discharge to the new truckline/outfall. Final downstream improvements at Long Bayou are also included in the proposed project. **Figure 16**, seen below, presents the proposed alternative.

***Figure 16**: 112th St North BMP Concept Summary*

Improvements:

- New 48-inch outfall pipe at 112th St heading south, then west to connect with 113th St.
- Rerouting and upsizing of existing stormwater pipes along the east side of 113th St.
- New 54-inch outfall pipe collecting 113th St runoff and routing east down 70th Ave towards Seminole Blvd.
- Construction of in-line baffle box near the City of Seminole public works location. The proposed baffle box is approximately 8 feet wide, and the existing street plus assumed right of way is around 40 feet, ensuring enough space for potential construction.
- Construct small pipe system from previous commercial site to tie into new 54-inch outfall pipe.
- Crossing Seminole Blvd and increasing pipe size to connect with existing drainage system.
- Final outfall improvements prior to discharging into Long Bayou.

6.4.2 Alternative 4 BMP Evaluation

- ***Resource and Measurable Benefit***
  - Approximately 142 acres of contributing area are associated with the proposed alternative.
  - Flood reduction benefits seen through 100-year event. Lesser impact on smaller events.
  - Improvements to LOS rankings for streets and structures.
- ***Proposed Conditions Modeling Results***
  - Based on the inclusion of the proposed improvements, structure and street flooding is improved in the area near 112th St. Flooding depths for the 25-year, 24-hour event decreased by more than 1 foot. A downstream node was shown to increase in stage during the larger storm events, but the peak stage was contained within the stormwater system (below natural grade). See supporting electronic deliverables for all node peak stages for existing and proposed events.
- ***Water Quality Evaluation***

For water quality calculations, BMP Trains was used to quantify the average annual water quality benefit by adding an in-line Nutrient Separating Baffle Box (NSBB) structure to the new outfall system. Nitrogen and phosphorous were examined with BMP trains by generalizing the overall contributing area. The catchment description between existing and proposed was the same for this project – no increase in impervious area or dramatic landuse changes. Site specific information for the 28-acre contributing area (predominately single-family homes) was added to BMP Trains including the following details.

Landuse	Single-Family: TN=2.070 TP=0.327
Area (acres)	28
Rational Coefficient (0-1)	0.41
Non DCIA Curve Number	68
DCIA Percent (0-100)	45
Nitrogen EMC (mg/l)	2.07
Phosphorus EMC (mg/l)	0.327
Runoff Volume (ac-ft/yr)	49.261
Groundwater N (kg/yr)	0
Groundwater P (kg/yr)	0
Nitrogen Loading (kg/yr)	125.73
Phosphorus Loading (kg/yr)	19.862

Applied Sciences referenced recent presentations from Ferguson Waterworks related to incorporating NSBB type BMPs into BMP Trains. Baffle boxes are not directly included as treatment options in BMP Trains. A user defined BMP is required. Based on Ferguson documentation, a typical NSBB can provide nitrogen and phosphorous removal efficiencies of 19% and 16%, respectively (Ferguson, 2023). These removal efficiencies do not include any additional treatment media, thus providing a conservative estimate. With the introduction of filter media, such as Bold and Gold, Ferguson estimates removal efficiencies up to 67% and 79% for nitrogen and phosphorous, respectively. The following table, **Table 4** describes the user defined baffle box removal efficiencies which were added to BMP Trains.

Table 4*: User Defined Baffle Box Parameters for BMP Trains*

User Defined BMP Design	Values
Catchment Area (ac)	28
Provided Nitrogen Treatment Efficiency (%)	19
Provided Phosphorus Treatment Efficiency (%)	16
Provided N Discharge Load (kg/year)	101.78
Provided P Discharge Load (kg/year)	16.783

The user defined baffle box provided minor benefits to the concentrations of nitrogen and phosphorus leaving the site. Approximately 52.81 lb/yr of nitrogen and 6.79 lb/year of phosphorous were removed from the stormwater runoff due to the introduction of the baffle box.

According to Ferguson documentation and the anticipated baffle box implementation location, model number NSBB 816 would be sufficient for this project. This baffle box is approximately 8 ft x 16 ft and can accommodate up to a 48-inch pipe. This pipe size aligns with the proposed alternative. Additionally, the proposed alternative model simulation results estimate peak flows below the max peak flow rate for the NSBB 816 product. The max flow rate for the NSBB is reported as 94 cfs, while the max flow rate from the 100-year, 24-hour event was around 98 cfs.

- ***Environmental Considerations***
  - The National Wetland Inventory (NWI) and 2020 SWFWMD landuse designations do not indicate any wetlands within the project vicinity. A few open water features are designated as Freshwater Ponds by the NWI.
- ***Geotechnical Considerations***
  - Soils surrounding the 112th Street area are mostly characterized as dual hydrologic soil group A/D (Immokalee and Myakka). East of the 112th Street location, soils are mostly characterized by hydrologic soil group A (Astatula, Tavares, and Adamsville sands).

   - Due to proposed improvements along existing streets, geotechnical investigation related to seasonal high water table and specific soil properties is recommended.
   - Potential pavement borings along 70th Ave to understand existing pavement for large pipe construction.

- ***Permitting Requirements***
   - A new individual SWERP application needed to demonstrate no-rise condition for offsite peak flood stages via storage modeling for 2.33-yr, 10-yr, 25-yr, and 100-yr storm events.

- ***Public Acceptance and Availability***
   - Flood protection improvements for smaller storm events as well as helping with larger events although not completely solved.
   - Construction limited to existing streets/right of way.
   - Coordination with FDOT for Seminole Blvd road crossing.

- ***Opinion of Probable Construction Cost***
   - The proposed construction cost for BMP 4 was estimated to be approximately $6,371,000. Refer to **APPENDIX C – OPINION ON PROBABLE COST** for detailed cost breakdown.
   - The proposed baffle box system is expected to be cleaned and inspected quarterly.

- ***Cost Benefit Analysis***

The following figure, **Figure 17**, compares the existing and proposed flooding costs based on the SWFWMD BCA evaluation methodology. The proposed project estimates an annual savings of around $525,000 and a present value of future benefits of $6,500,000. The analysis assumes a 7% discount rate over a 30-year project useful life.

Based on the present value of future benefits and the estimated construction cost, the proposed project achieves a Benefit/Cost Ratio of 1.02.

Existing Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$1,650,297	$2,528,340	$3,619,431	$5,349,433	$7,799,687	$11,220,524
Roadway Repair Damage ($)	0.000	$289,350	$569,600	$1,578,450	$5,156,550	$8,866,400	$12,747,725
Roadway Service Damage ($)	0.000	$15,633	$16,559	$25,040	$126,545	$418,709	$1,075,059
Total Damage ($)	0.000	$1,955,281	$3,114,499	$5,222,921	$10,632,529	$17,084,796	$25,043,308
EAD Existing ($)	$2,771,061						
# Structures within 1 ft of Flooding	0	9	17	20	33	87	136
Length Street Flooding, ft	0	1185	2305	6255	19145	32430	46250
Existing Annual Structures	12.67						
Existing Annual Steet Length	3301						

Proposed Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$1,351,744	$1,869,779	$3,122,614	$4,748,980	$6,683,085	$9,785,731
Roadway Related Damage ($)	0.000	$245,200	$490,050	$1,173,650	$3,445,650	$6,960,200	$11,585,775
Roadway Service Damage ($)	0.000	$10,295	$11,112	$12,055	$58,293	$209,367	$587,163
Total Damage ($)	0.000	$1,607,239	$2,370,941	$4,308,319	$8,252,923	$13,852,652	$21,958,670
EAD Proposed ($)	$2,246,053						
# Structures within 1 ft of Flooding	0	6	8	17	33	63	99
Length Street Flooding, ft	0	1025	2020	4740	12945	25635	42110
Proposed Annual Structures	8.83						
Proposed Annual Steet Length	2656						

Expected Annual Damage Without Project (1)	$2,771,061
Expected Annual Damage With Project (1)	$2,246,053
Expected Annual Damage Benefit (a) – (b)	$525,008
Discount Rate	7.0%
Project Useful Life (# years)	30
Total Present Value of Future Benefits	$6,514,845
Total Project Cost	$6,371,379
Benefit/Cost Ratio	1.02

BMP 4, 112th St North Flooding
- max construction cost of around 6.5 million would correspond to a BCA of 1

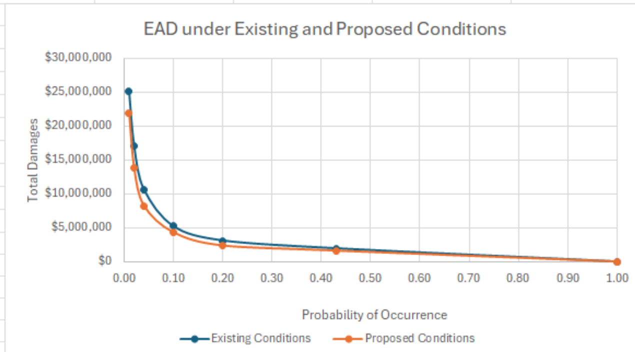


***Figure 17**: BCA Summary, 112th St North*

- ***Sea Level Rise Considerations***

The proposed condition model for 112th St North was updated with the established 2070 Intermediate High tidal boundary condition, 4.16 NAVD88-ft, see **Table 2**. All design storms were simulated, and the model results were evaluated with the SWFWMD BCA evaluation methodology, see **Figure 18** below.

Existing Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$1,650,297	$2,528,340	$3,619,431	$5,349,433	$7,799,687	$11,220,524
Roadway Repair Damage ($)	0.000	$289,350	$569,600	$1,578,450	$5,156,550	$8,866,400	$12,747,725
Roadway Service Damage ($)	0.000	$15,633	$16,559	$25,040	$126,545	$418,709	$1,075,059
Total Damage ($)	0.000	$1,955,281	$3,114,499	$5,222,921	$10,632,529	$17,084,796	$25,043,308
EAD Existing ($)				$2,771,061			

Proposed Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$1,363,177	$1,886,447	$3,142,004	$4,767,902	$6,764,301	$9,989,127
Roadway Related Damage ($)	0.000	$246,350	$490,050	$1,187,450	$3,475,550	$6,968,250	$11,582,425
Roadway Service Damage ($)	0.000	$15,633	$16,341	$17,284	$63,631	$214,705	$592,665
Total Damage ($)	0.000	$1,625,161	$2,392,838	$4,346,738	$8,307,083	$13,947,256	$22,164,217
EAD Proposed ($)				$2,266,577			

Expected Annual Damage Without Project (1)	$2,771,061
Expected Annual Damage With Project (1)	$2,266,577
Expected Annual Damage Benefit (a) – (b)	$504,484
Discount Rate	7.0%
Project Useful Life (# years)	30
Total Present Value of Future Benefits	$6,260,162
Total Project Cost	$6,371,379
Benefit/Cost Ratio	0.98

BMP 4, 112th St North Flooding
- max construction cost of around 6.26 million would correspond to a BCA of 1

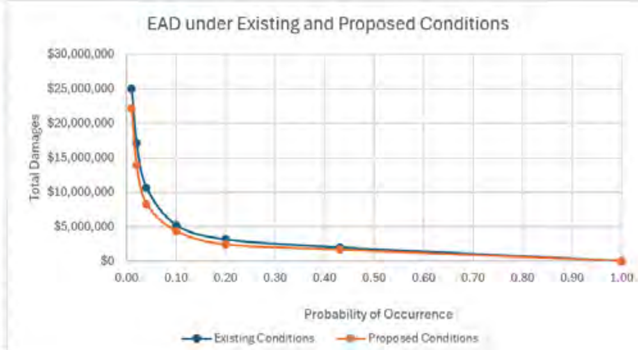


***Figure 18**: BCA Summary, 112th St North with Sea Level Rise Considerations*

The analysis quantifies flooding impacts to streets and structures in monetary terms across all design storm events. Under future tidal conditions, the proposed alternative shows a very small reduction in Expected Annual Damage (EAD) benefits of around $20,000, which corresponds to future benefit of $6.26 million. This represents a 4% reduction in project benefits due to future elevated tidal conditions. Although the proposed outfall pipe is tidally connected, most of the improvements are observed approximately 1 mile upstream. Because of this, it is not surprising that the original proposed benefits are mostly preserved, even under elevated tidal conditions.

6.4.3 Alternative 4 BMP Additional Considerations

- Creation of large box culvert system just east of Seminole Blvd, incorporating both systems (new system and existing systems draining Seminole Blvd).
- Connection of any additional systems or optimization of proposed pipe diameters through additional iterative modeling.
- Potential incorporation of additional in-line water quality treatment; additional baffle box structures.

6.5 Alternative 5 – Walsingham Park East

Walsingham Park East is located in the northwest corner of the City and just east of McKay Creek. The area is characterized by high density residential development and a few open water ponds. Based on a review of historical imagery and housing development records, the community was built around 1980, prior to stormwater management regulations. The existing stormwater management system consists of three historic wet ponds and corrugated metal pipe conveyance. The system collects street runoff to the wet ponds and discharges west, through Walsingham Park Ponds.

Soils in the area include both hydrologic group A and A/D. Most of the area consists of the dual classification (A/D) group, which can have higher runoff potential once saturated. Based on existing condition ICPR4 model results, this area experiences some street flooding during the mean annual storm and larger events. Building structures are likely to see some flooding impact during the 100-year storm.

Around 1990, the Walsingham Reservoir area was developed for restoration purposes and park development by Pinellas County. The project was permitted by SWFWMD under permit number 8744. Two relevant revisions (ERP_008744_000 and ERP_008744_001) were downloaded by Applied Sciences for additional review. The recommended BMP alternative for this area discharges directly into existing features found within the Walsingham project area. The following provides a brief review of the permit drawings and connection to the preferred alternative.

6.5.1 Review of Past Permitting – Walsingham Reservoir

Applied Sciences reviewed revision 0 and 1 related to ERP 8744 – Walsingham Reservoir Improvements and Park Design. The plans capture the general areas draining to a newly created wet detention area called Detention Area B. The stormwater system under investigation for this BMP alternative ultimately discharges into Detention Area B. All plan elevations are referenced to the NGVD29 vertical datum and would need conversion to NAVD88 for modeling purposes. The following figure, **Figure 19**, demonstrates the originally permitted phased approach to construction, location of Detention Area B, and contributing area to this system.

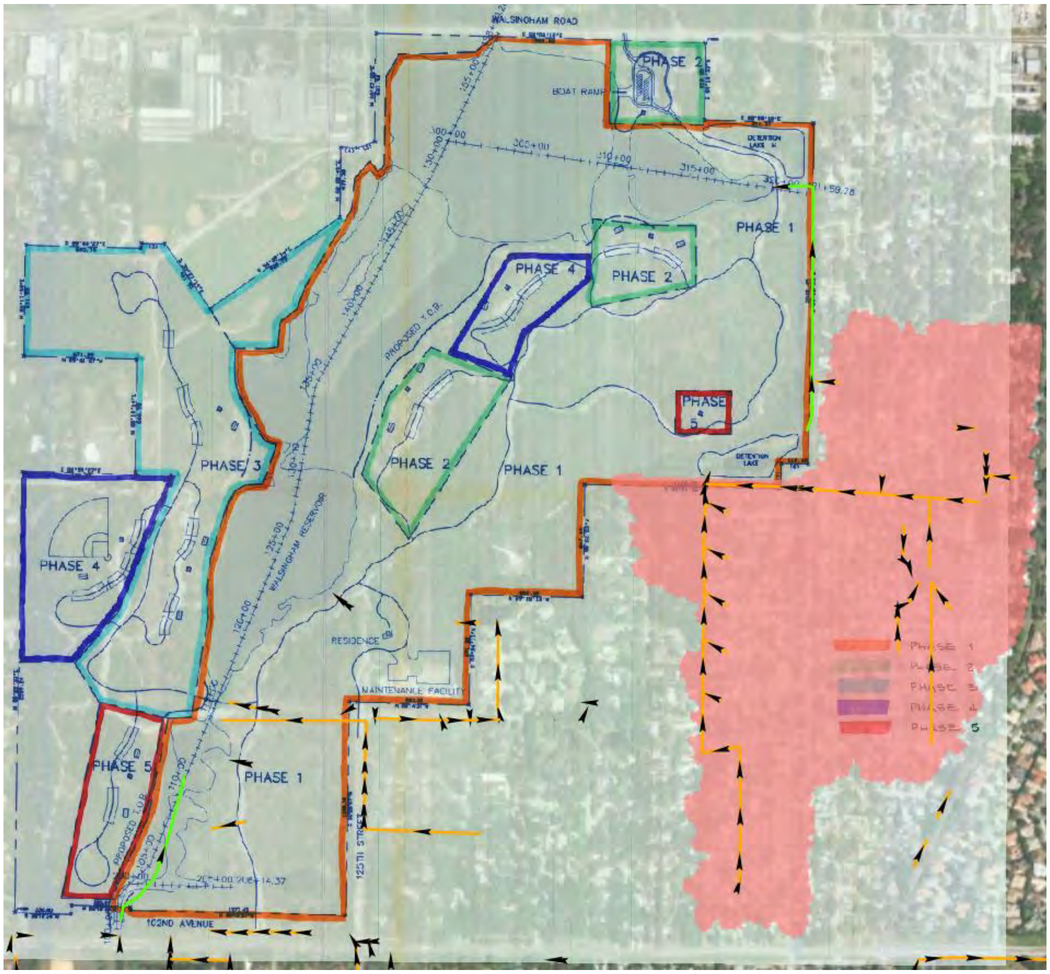


***Figure 19**: ERP 8744 Walsingham Reservoir, Phased Construction Approach*

The detention pond collects runoff from the contributing areas (approximately 118 acres) from the south and east. The pond then discharges north through a series of outfall weirs and channel system to Walsingham Reservoir.

Permitted contour lines for the existing wet detention pond appear below in **Figure 20**.

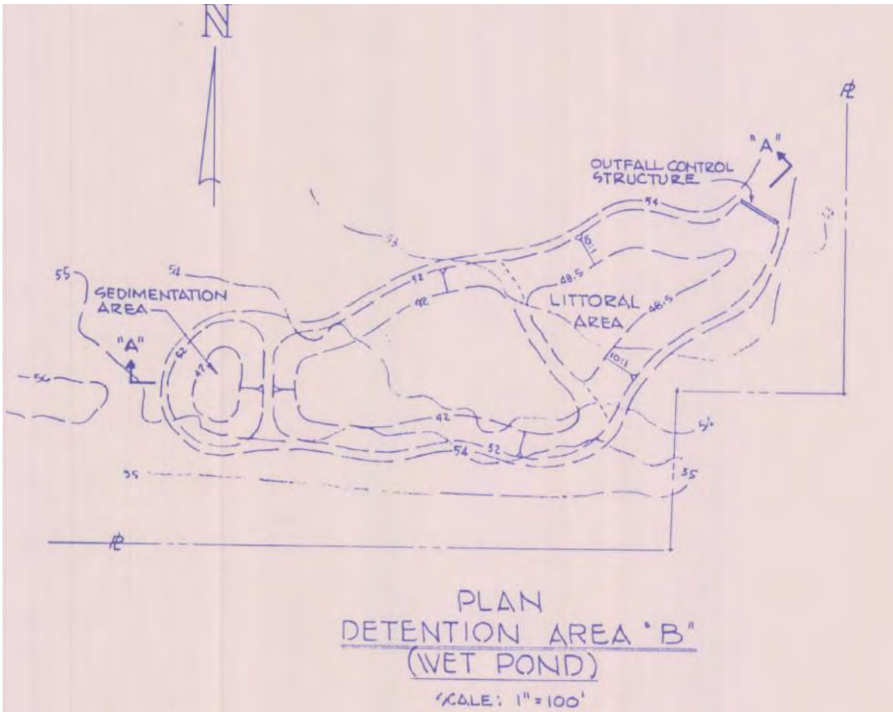


Figure 20*: ERP 8744 Walsingham Reservoir, Detention Area B Existing Contours*

The structural weir discharging from the northern portion of Detention Area B is described below in **Figure 21**.

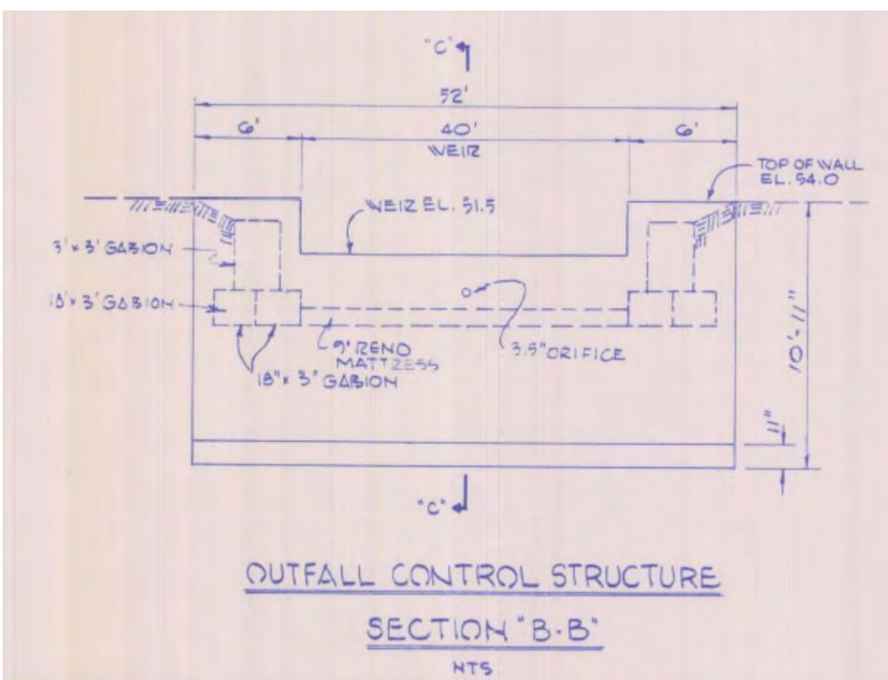


Figure 21*: ERP 8744 Walsingham Reservoir, Detention Area B Outfall Control Structure*

Finally, a typical channel section of the outfall ditch is shown in the following figure, **Figure 22**.

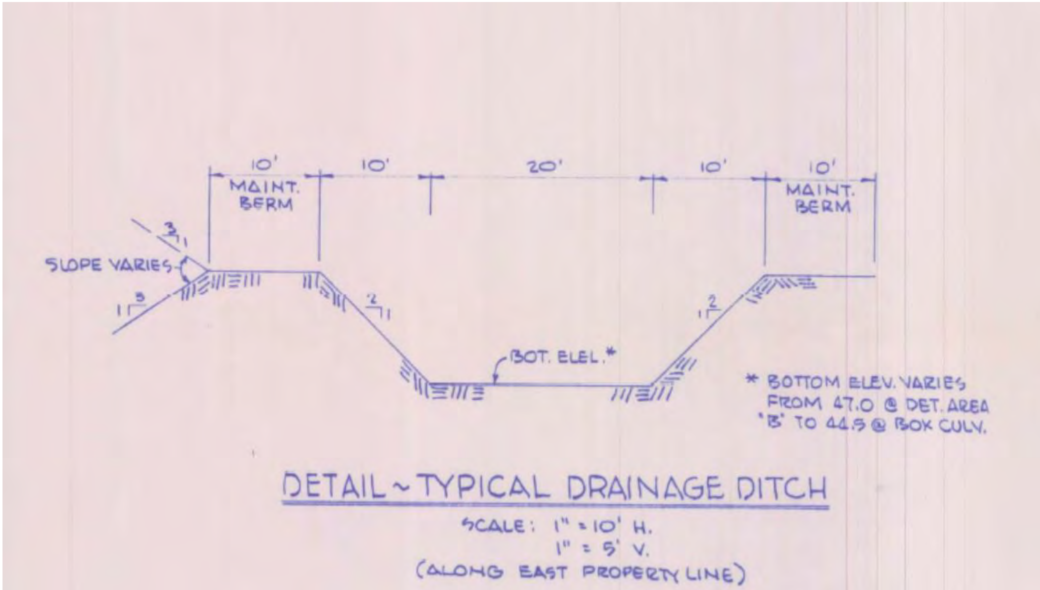


Figure 22*: ERP 8744 Walsingham Reservoir, Outfall Channel Typical Section*

In addition to proposed stormwater conveyance improvements found within the contributing area, the recommended alternative proposes modifications/expansions of the existing Pinellas County owned wet detention area infrastructure. Both storage and conveyance improvements are recommended.

6.5.2 Alternative 5 BMP Concept

The proposed concept for BMP site 5 involves the creation of a new outfall system for the neighborhood just east of the Walsingham Reservoir area. The proposed conveyance reduces the difficulty of managing stormwater systems that run behind and potentially below existing residential properties. The new outfall system directs street runoff south down 117th Way and west along 110th Terrace. The stormwater system continues south down 117th Way and then turns west along 108th Court. Existing drainage systems are connected to the new outfall near 117th Lane moving west along 108th Court. The system turns north at 118th St and connects to newly proposed pipes along 110th Terrace. The proposed concept then specifies upsizing existing pipes that discharge into Walsingham Park Ponds (previously called Detention Area B). Additionally, improvements are recommended for Walsingham Park Ponds, including pond expansion, outfall weir upgrades, and outfall channel upgrades. Any improvements to the existing Walsingham Park Ponds would require a permit modification to ERP 8744 in coordination with SWFWMD requirements. **Figure 23**, seen below, provides a visualization of the BMP concept for Walsingham Park East.

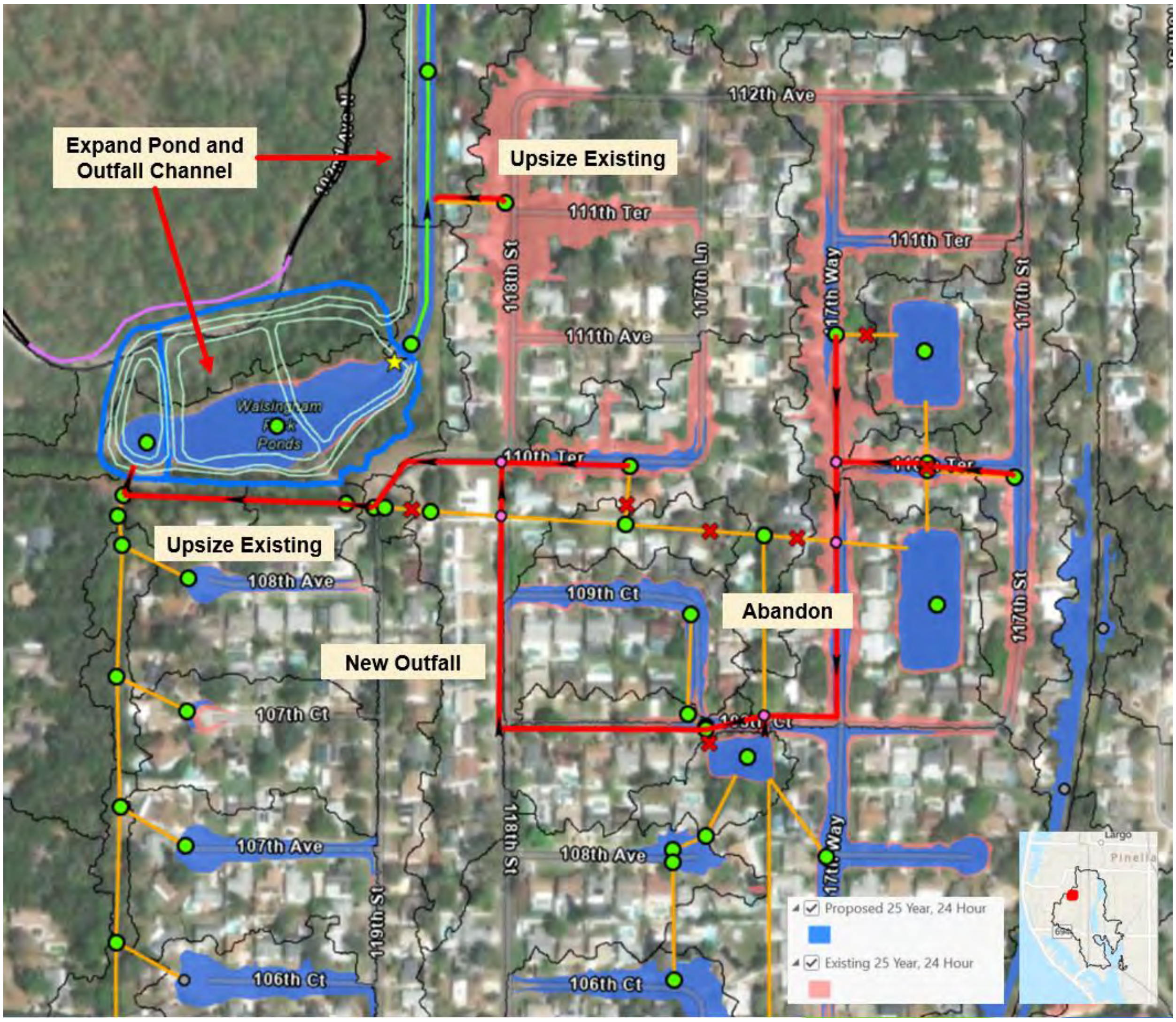


***Figure 23**: Walsingham Park East BMP Concept Summary*

Improvements:

- **New Outfall Corridor**
  - 3,700 ft of new concrete pipes. Sizes ranging from 36 inches to 72 inches at the outfall pond.
- **Pond Expansion**
  - Increase Walsingham Park Pond sizes by approximately 50 percent
    - Original small sediment basin was 0.47 acres; proposed area of around 0.75 acres
    - Original larger basin was 2.49 acres; proposed area of around 4 acres
  - Approximately 10 ac-ft of pond expansion.

  - Rerouting existing park trail, approximately 600 feet.
- **Sediment Weir**
  - Lower invert to 49.5 feet from 50.8 feet (NAVD88)
  - Weir length increased by approximately 100 feet due to pond expansion
- **Final Outfall Weir**
  - Lower weir invert to 48.75 ft from 50.66 NAVD88-ft
  - Double size of outfall weir, 40 to 80 feet
- **Channel Improvements**
  - Expand bottom width of channel by 15 feet as seen in **Figure 24** below.
  - Equivalent to 3.5 ac-ft of channel excavation.

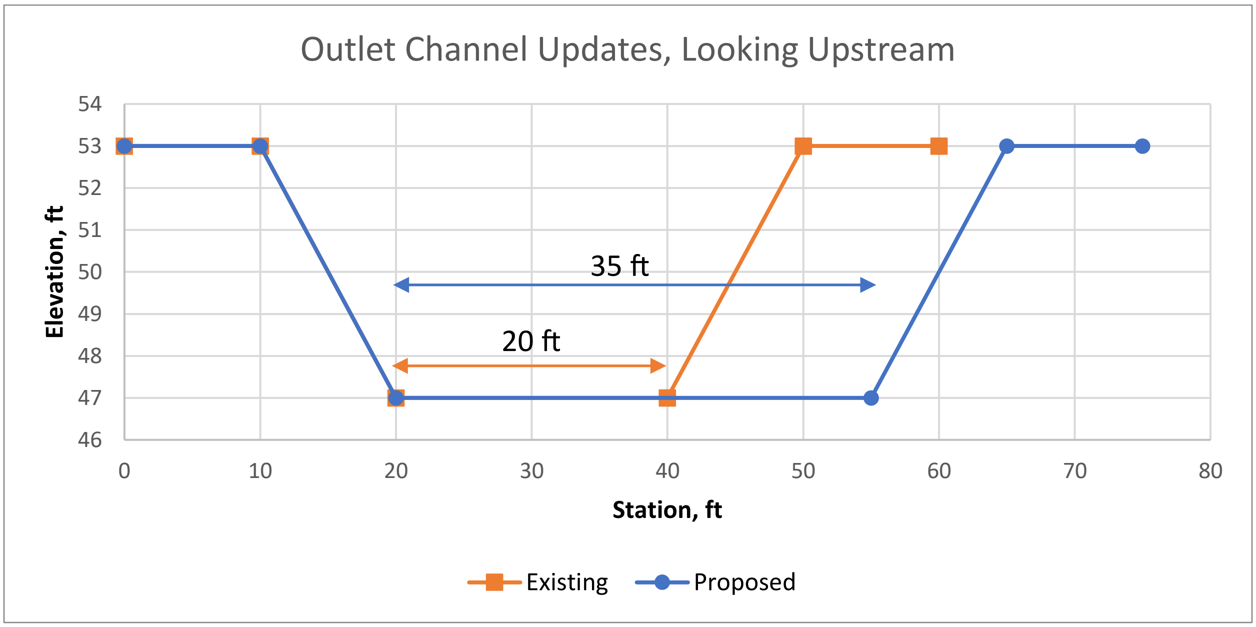


***Figure 24**: Expansion of Outfall Ditch*

6.5.3 Alternative 5 BMP Evaluation

- ***Resource and Measurable Benefit***
  - Acres treated – around 118 acres
  - Flood reduction benefits seen through 100-year event.
  - Improvements to LOS rankings for streets and structures.

- ***Proposed Conditions Modeling Results***
  - Through proposed condition stormwater modeling, flood stages are shown to decrease throughout the suite of design storms. Reduction in street flooding is shown for the 25-year, 24-hour event along 117th Way, 110th Terrace, and 118th St.
  - The following tables (**Table 5** and **Table 6**) contain peak stage and flow comparisons for the Walsingham Ponds. Nodes D18N0100 and D18N0110 and final outfall channel link D18C0120 are reviewed.

Table 5*: Peak Stage Comparison for Walsingham Pond Nodes*

Condition	Existing Stage (ft), 24 Hour Event			Proposed Stage (ft), 24 Hour Event		
Simulation	10 Year	25 Year	100 Year	10 Year	25 Year	100 Year
D18N0100	51.52	51.57	51.94	50.03	50.07	50.2
D18N0110	51.42	51.5	51.93	49.36	49.51	50.16

Table 6*: Peak Flow Comparison for the Outfall Channel Associated with Walsingham Ponds*

Condition	Existing Flow (cfs), 24 Hour Event			Proposed Flow (cfs), 24 Hour Event		
Simulation	10 Year	25 Year	100 Year	10 Year	25 Year	100 Year
D18C0120	86	100	181	122	154	205

  - No significant increase in stage for all events. The downstream channel achieves greater flows due to increased channel geometry; however, the stages and flows remain well within the channel banks. See supporting electronic deliverables for all node peak stages for existing and proposed events.

- ***Water Quality Evaluation***

  For water quality calculations, BMP Trains was used to quantify the average annual water quality benefit by expanding the existing wet detention ponds. Nitrogen and phosphorous were examined with BMP trains by generalizing the overall contributing area. Water quality improvements were evaluated by comparing the existing condition permanent pool volumes to the proposed permanent pool volumes. The catchment description between existing and proposed was the same for this project – no increase in impervious area or dramatic landuse changes. Site specific information for the 107-acre contributing area was added to BMP Trains including the following details.

Landuse	Single-Family: TN=2.070 TP=0.327
Area (acres)	107
Rational Coefficient (0-1)	0.43
Non DCIA Curve Number	74
DCIA Percent (0-100)	47
Nitrogen EMC (mg/l)	2.07
Phosphorus EMC (mg/l)	0.327
Runoff Volume (ac-ft/yr)	201.639
Groundwater N (kg/yr)	0
Groundwater P (kg/yr)	0
Nitrogen Loading (kg/yr)	514.646
Phosphorus Loading (kg/yr)	81.299

Permanent pool volumes were calculated based on stage storage information from the existing condition and proposed pond expansion. Additionally, pool volumes were related to the existing and proposed weir inverts of the pond outfall system. The following table, **Table 7** describes the wet detention ponds in BMP Trains.

Table 7*: Wet Detention Characteristics, BMP 5*

Wet Detention Design	Existing	Proposed
Permanent Pool Volume (ac-ft)	4.29	8.15
Permanent Pool Volume (ac-ft) for 31 days residence	16.929	16.929
Annual Residence Time (days)	8	15
Provided N Discharge Load (kg/year)	365.83	336.66
Provided P Discharge Load (kg/year)	36.832	33.022
Provided TN Treatment Efficiency (%)	28	34
Provided TP Treatment Efficiency (%)	54	59

By increasing the size of the wet detention system, a small benefit in the concentrations of nitrogen and phosphorus leaving the site was observed. The net increase in nitrogen and phosphorus removal was around 5%. This equates to an additional 64.33 lb/yr of nitrogen and 8.4 lb/year of phosphorus.

- ***Environmental Considerations***
    - The National Wetland Inventory (NWI) and 2020 SWFWMD landuse designations do not indicate any wetlands within the direct project area. The current open water ponds are classified as Reservoirs (FLUCCSCODE = 5300) and the surrounding area is Recreational (FLUCCSCODE = 1800) and Residential High Density (FLUCCSCODE = 1300). The NWI index indicates there is a wetland area to

the northwest on the Walsingham Reservoir property. This location should be sufficiently far away from proposed improvements; however, wetland boundaries should be delineated by an environmental scientist to ensure compliance. The formal design should ensure wetlands are not impacted.

- ***Geotechnical Considerations***
  - Soils surrounding the Walsingham East area are mostly characterized as dual hydrologic soil group A/D (Basinger and Myakka). Further east, soils are mostly characterized by hydrologic soil group A (Tavares and Adamsville sands).
  - Due to proposed improvements along existing streets, geotechnical investigation related to seasonal high water table and specific soil properties is recommended.
  - Potential pavement borings along the proposed outfall corridor are recommended to understand the existing pavement characteristics for large pipe construction.
- ***Permitting Requirements***
  - Based on permitting meeting with SWFWMD, the proposed project most likely needs a SWERP Permit modification considering construction was authorized under Permit No. 8744 (revisions 0, 1, and 2).
- ***Public Acceptance and Availability***
  - Flood protection improvements for smaller storm events as well as improving model results for larger events, although not completely solved.
  - Construction mostly limited to existing streets/right of way
  - No property acquisition
  - Potential for park improvements in cooperation with Pinellas County
    - Boardwalks, piers/platforms extending over the lake/pond features
- ***Opinion of Probable Construction Cost***
  - The proposed construction cost for BMP 5 was estimated to be approximately $5,940,000. Refer to **APPENDIX C – OPINION ON PROBABLE COST** for detailed cost breakdown.
- ***Cost Benefit Analysis***

The following figure, **Figure 25**, compares the existing and proposed flooding costs based on the SWFWMD BCA evaluation methodology. The proposed project estimates an annual savings of around $658,000 and a present value of future benefits of $8,200,000. The analysis assumes a 7% discount rate over a 30-year project useful life.

Based on the present value of future benefits and the estimated construction cost, the proposed project achieves a Benefit/Cost Ratio of 1.38.

Existing Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$159,466	$544,384	$1,007,453	$1,915,154	$2,630,892	$3,369,118
Roadway Repair Damage ($)	0.000	$696,900	$1,319,050	$1,869,900	$2,774,950	$3,145,250	$3,312,000
Roadway Service Damage ($)	0.000	$2,506	$8,062	$14,054	$22,551	$30,994	$36,823
Total Damage ($)	0.000	$858,872	$1,871,496	$2,891,406	$4,712,655	$5,807,137	$6,717,940
EAD Existing ($)				$1,260,040			
# Structures within 1 ft of Flooding	0	0	2	14	37	55	77
Length Street Flooding, ft	0	3030	5735	8130	12065	13675	14400
Existing Annual Structures				4.91			
Existing Annual Steet Length				3712			

Proposed Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$83,341	$261,571	$523,158	$871,306	$1,463,143	$2,614,713
Roadway Related Damage ($)	0.000	$181,700	$493,350	$917,700	$1,831,950	$2,590,950	$3,098,100
Roadway Service Damage ($)	0.000	$163	$1,035	$3,105	$6,537	$12,311	$18,684
Total Damage ($)	0.000	$265,204	$755,956	$1,443,963	$2,709,792	$4,066,404	$5,731,497
EAD Proposed ($)				$601,692			
# Structures within 1 ft of Flooding	0	0	2	9	14	21	54
Length Street Flooding, ft	0	790	2145	3990	7965	11265	13470
Proposed Annual Structures				2.735			
Proposed Annual Steet Length				1679			

Expected Annual Damage Without Project (1)	$1,260,040
Expected Annual Damage With Project (1)	$601,692
Expected Annual Damage Benefit (a) – (b)	$658,349
Discount Rate	7.0%
Project Useful Life (# years)	30
Total Present Value of Future Benefits	$8,169,475
Total Project Cost	$5,939,816
Benefit/Cost Ratio	1.38

BMP 5, Walsingham Park East
- max construction cost of around 8 million would correspond to a BCA of 1

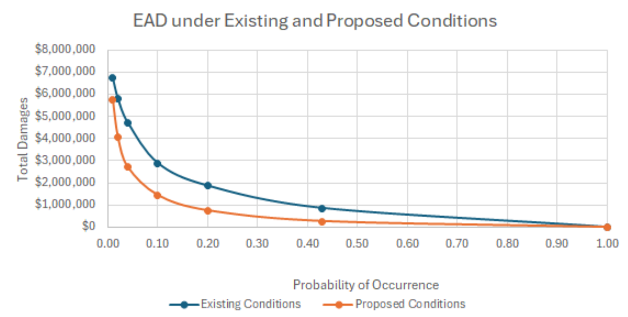


***Figure 25**: BCA Summary, Walsingham Park East*

- ***Sea Level Rise Considerations***
    - No sea level rise considerations for this site, sufficiently far from tidal influences.

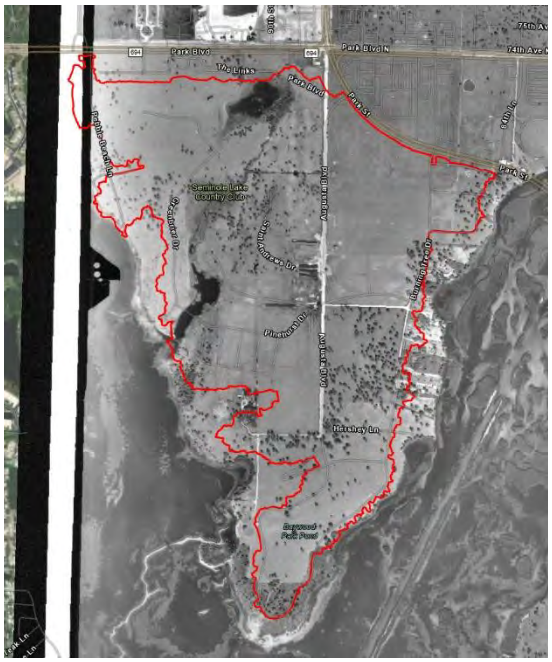
6.5.4 Alternative 5 BMP Additional Considerations

- Potential to keep more of the existing pipes in place. This could potentially reduce pipe sizes throughout the main conveyance paths and ultimately reduce the overall cost.
- Purchasing of properties surrounding existing lakes. The average just value as of 2023 is around $350,000/home, market rates might be even higher, possibly around $425,000. There are approximately 30 parcels that surround the three existing open water ponds in this neighborhood. Estimated purchase price of just the homes, not including demolition/expansion of ponds is around $ 10M to $13M (using just value market value as of 2023, respectively).

6.6 Alternative 6 – Seminole Lake Country Club

The Seminole Lake Country Club is located on a peninsula just south of Park Blvd and between the Cross Bayou Canal to the east and the outfall locations of Lake Seminole and the Lake Seminole Bypass Canal to the west. The property was originally purchased in the early 1930s and was used as a working cattle ranch for many years. By the early 1960s, the property was developed for residential housing and establishment of a country club. Currently, the 300-acre triangular peninsula contains approximately 450 residential homes and an 18-hole golf course.

The following figure, **Figure 26**, displays different aerial imagery from 1957, 1970 and 2023.



1957 Imagery

1970 Imagery

2023 Imagery

***Figure 26**: Historical Imagery, Seminole Lake Country Club*

From **Figure 26**, we can see the conversion of pastureland to residential neighborhoods, as well as the creation of several open water surface ponds. Current terrain elevations based on 2018 LiDAR data show maximum elevations around 16.5 feet, while minimum elevations are around 0.8 feet (sea level). Elevations are referenced to the NAVD88 vertical datum.

During the development of the Watershed Management Plan (WMP), the City hosted an in-person open house to discuss the preliminary model results and solicit comments/feedback from residents. Many comments were received from residents within the Seminole Lake Country Club relating to nuisance flooding issues due to rainfall and tidal surge and other stormwater maintenance activities. **Figure 27**, seen below, captures the locations of public comments along with proposed projects developed by the City through a separate task work assignment.

***Figure 27**: WMP Open House Comments and Planned City Improvements*

Based on the existing ICPR4 model results, only minor flooding was observed within the Seminole Lake Country Club area. The current design storm simulations do not appear to capture some of the local issues expressed by residents. To provide additional understanding of this area, Applied Sciences developed unique modeling scenarios focused on simulating elevated tidal and soil saturation dynamics. These compound flooding scenarios are expected to better capture the specific hydrological characteristics affecting this area.

6.6.1 Alternative 6 Analysis

Applied Sciences focused on two specific model components for this analysis: elevated tidal conditions and reduction in soil storage. These parameters can be adjusted in the underlying model schematic through manipulation of time stage boundary conditions and Green-Ampt soil properties. **Table 8** contains the specific parameter adjustments that were added to better understand the impact on flooding for the 25-year, 24-hour storm event.

***Table 8**: Alternative 6 Model Simulation Parameters*

Simulation #	Tidal Elevation (NAVD88-ft)	Water Table Depth Reduction (ft)	Design Storm
1	2.0	0.5	25 Year, 24 Hour (9.32 inches)
2	3.0	0.5	
3	4.0	1.0	
4	5.0	1.0	
5	6.0	1.5	

As a reminder, the original existing conditions modeling was performed assuming a static tidal boundary condition of 1.5 NAVD88-ft. All elevations from **Table 8** exceed this value, representing potential future elevated tidal levels. Additionally, the range of tidal elevations from **Table 8** encompasses future tidal projections as defined by NOAA (see **Table 2** from the project Sea Level Rise discussion). The project specific 2070 Intermediate High projection specifies a tidal boundary of 4.16 NAVD88-ft. Additionally, recent storm events (Hurricane Idalia, **Figure 6**, and unnamed December 2023 event, **Figure 7**) produced recorded tidal conditions around 4 NAVD88-ft.

Soil storage reduction was estimated, but conceptually correlates to elevated tidal conditions. As tidal elevations increase, it is assumed that inland soil storage would decrease. For modeling purposes, all soil types within the project focus area were updated – the water table depths were decreased based on the metrics from **Table 8**.

The following figure, **Figure 28**, displays the simulated model results for two of the scenarios described in **Table 8**. Model results were not significantly different between the existing conditions model and the first two simulations from **Table 8**. **Figure 28** presents the existing conditions model results along with model results from simulation 3 and 5; 4 ft and 6 ft tidal boundary elevations, respectively.

***Figure 28**: Elevated Tidal Boundary and Soil Reduction Floodplain Results, 25 Year Storm, Seminole Lake Country Club*

Figure 28 also contains 5 locations of interest that are discussed in the following sections.

Location 1 – Saint Andrews Dr

Minimal flooding is observed for the existing conditions modeling along Saint Andrews Dr. The existing 24x38 inch concrete elliptical pipe appears to adequately convey stormwater runoff to the outfall pond system; however, the City has received flooding complaints from this location in the recent past. In July 2022, the City lined the concrete pipe to improve performance and ensure proper functionality.

Future conditions modeling begins to show larger impacts to streets and structures in this area. With a 4 ft tidal boundary condition, the outfall pipe on Saint Andrews Dr appears to be completely inundated with only about a quarter of a foot head differential compared to the outfall pond. Peak stages continue to rise with the 6 ft tidal boundary, but not by a significant amount. It is anticipated that modifications to the overall outfall structure of the development could improve flooding conditions during future elevated tides.

Location 2 – Grand Blanc Dr

Grand Blanc Dr is shown to experience some minor street inundation during the existing conditions model results. The stormwater system consists of smaller 15-inch pipes that are undersized based on the volume and rate of runoff generated in the area. Head differentials between the existing pipe and the outfall pond system are nearly 1 foot, indicating potential for upsizing and improving flooding conditions along Grand Blanc Dr. The existing pipe appears to run underneath the parcel/home located at 9203 Grand Blanc Dr, which may prove difficult to upsize. The pipe would likely need to be rerouted to avoid existing development and increase the ability to access and maintain. Under future conditions, the ability to upsize and recommend stormwater improvements decreases. The observed head differentials for the 6 ft tidal boundary condition are nearly equalized, indicating less ability to improve flood elevations by increasing pipe diameter.

Location 3 – Burning Tree Dr and Hershey Ln

Minimal flooding is observed for the existing conditions modeling near the intersection of Burning Tree Dr and Hershey Ln. The existing 24-inch concrete pipe appears to adequately convey stormwater runoff east to the tidal outfall; however, the City has received flooding complaints from this location in the recent past. Several comments were received during the open house public meeting that note localized street flooding directly at the intersection. Upon further review, it appears the intersection is a low point with higher elevations to the east, potentially trapping stormwater runoff. Additionally, no stormwater inlets are located at the intersection, only slightly further north to the existing outfall pipe. Street grading or the addition of stormwater inlets is recommended in this area to address localized flooding issues.

Future conditions modeling begins to show larger impacts to streets and structures in this area. With a 4 ft tidal boundary condition, the outfall pipe just north of the intersection demonstrates a large head differential compared to the tidal outfall elevation. Approximately 2.5 feet of head is developed on the upstream end of the 24-inch pipe, indicating opportunities for upsizing. Peak stages continue to rise with the 6 ft tidal boundary, but not by a significant amount. During a tidal surge of 6 feet, it is expected that the existing 24-inch pipe would backflow and cause street flooding, regardless of additional rainfall. The use of backflow preventors for these extreme events should be considered.

Location 4 – Baywood Park Dr

The Baywood Park area appears to be adequately protected during existing condition modeling for the 25-year storm event; however, the southernmost tip of the peninsula starts to show flooding impacts during elevated tidal conditions. The terrain within this area is below 4 feet and would experience flooding during future tidal conditions. As water levels increase to 6 feet, a larger percentage of the area is expected to be inundated. Most building structures appear to be elevated to around 5 or 6 feet, while one home appears to be elevated to around elevation 9 feet. Future tidal conditions may be manageable if elevated seawalls are considered. Seawalls would need to be constructed around the peninsula at elevations greater than the expected tidal impact – potentially between 5 and 6 feet. Based on current NOAA sea level rise projections, these tidal impacts are not expected to regularly be observed until around 2080.

Location 5 – Outfall Structure to Long Bayou

The outfall structure for the Seminole Lake Country Club is located on the western edge of the community just southwest of the Pinehurst Dr bridge crossing. Based on existing condition modeling there appears to be a large head differential between the country club lakes and the tide. This is often indicative of undersized stormwater structures. It is recommended to further investigate the specific components of the outfall structure to potentially refine the existing model. The model refinement will then allow for a better understanding of any future condition model results. It is expected that improvements to the outfall structure will reduce flooding conditions upstream. For future tidal conditions around 6 feet, the City/community might consider the incorporation of an emergency stormwater pump station to mechanically drain the area when natural elevation gradients are not available.

Applied Sciences performed a supplemental analysis related to elevated tidal conditions in this area to gain a better understanding of tidal overland flow. The analysis aims to estimate specific locations along the site perimeter for where tidal waters could cause overland flow, independent of stormwater infrastructure. An area of interest was created from the underlying model basins. Along this perimeter, terrain elevations were assigned every 10 feet. The following graphic, **Figure 29**, displays these results with the lowest, overtopping points labeled:

***Figure 29**: Low Points of Entry, Seminole Lake Country Club*

From this analysis, it was found that the lowest point of entry from Long Bayou to Seminole Lake Country Club was around 3.72 NAVD88-ft. This indicates that even with backflow preventers on the stormwater pipes, tidal elevations around 3.72 NAVD88-ft could overtop the earthen areas and flow overland causing flooding issues. Under these or higher tides, the City may start thinking of elevated seawalls along the more vulnerable parts of the development. Based on current NOAA sea level rise projections, these tidal impacts are not expected to regularly be observed until around 2070.

6.6.2 Alternative 6 Recommendations

- It is expected that since the 1960s the existing stormwater/golf course ponds have accumulated sediments and thus reduced pond storage capacity. It is recommended that an environmental scientist/ecologist perform an investigation to understand the degree of sedimentation in existing open water surface ponds.
- Address local flooding and maintenance issues through construction of new inlets to drain nuisance flooding along streets. The City has currently defined these projects/locations in subsequent project planning, see **Figure 27**.
- Potential stormwater pump station at the existing outfall location. Pumping may be required to mitigate the impact of future tidal and rainfall conditions. Current NOAA projections show potential impacts around the year 2070.
- Consideration for sea walls around most vulnerable points of entry, including the most southern point of Seminole Lake Country Club and additional portions on the west side of the community.
- This area may be explored in more detail during the City's Vulnerability Assessment which focuses on the impacts of future sea level rise/storm surge. The Vulnerability Assessment also will recommend adaptation planning strategies that may contain ideas related to those presented in the above analysis.

6.7 Alternative 7 – Oaks of Seminole Condominium

The Oaks of Seminole Condominium is located on the far western boundary of the City between Park Blvd to the north and 74th Ave to the south. The community was developed around the late 1980s but was not subject to modern stormwater permitting criteria. No Environmental Resource Permits (ERPs) exist in the area. The following figure, **Figure 30**, shows imagery from 1970 and 2023 for the site and surrounding area.

1970 Imagery

2023 Imagery

***Figure 30**: Historical Imagery, Oaks of Seminole Condominium*

The existing stormwater system consists of small drainage ditches, corrugated metal pipes, and a retention pond on the north side of the property. Landuse in the surrounding area is mostly high density residential, whereas the condominium site has a decent percentage of open space and pervious landscapes. Soils consist of hydrologic soil group A with deeper water table depths and higher conductivity values.

Existing condition model results show potential impacts to the condo community as well as the properties to the north and east. Although the predicted model results do not result in substantial flooding impacts, the site is located directly adjacent to a recently acquired property. The City purchased the 5.53-acre parcel directly adjacent to the condominium around 2019. The parcel is labeled in the following figure, **Figure 31**.

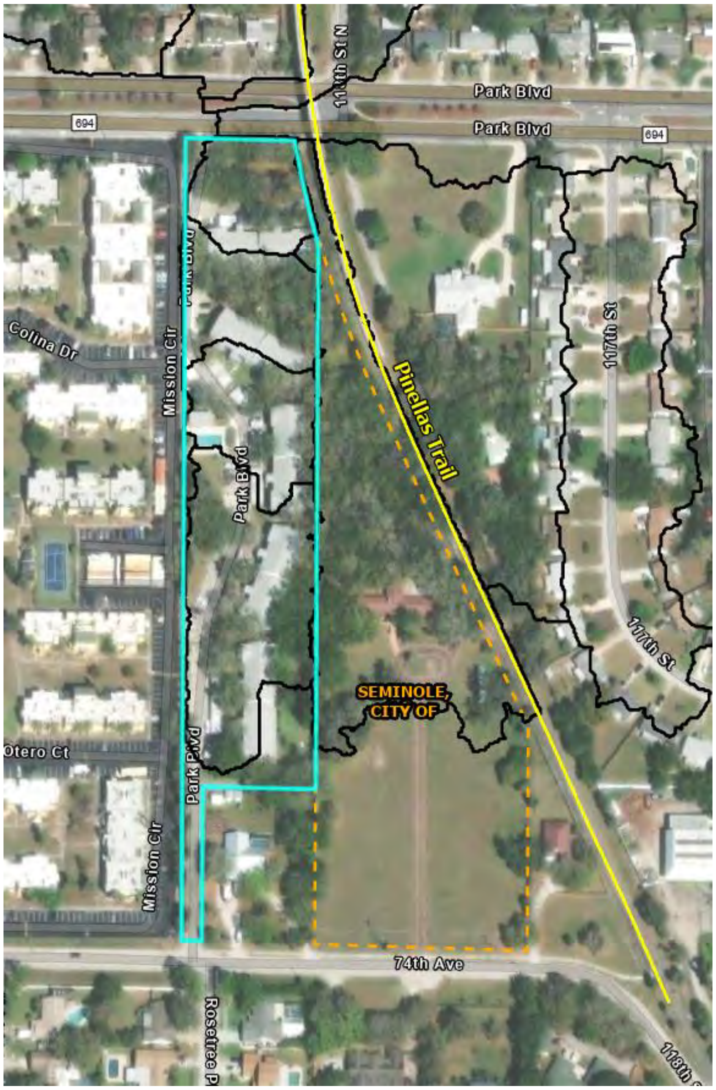


***Figure 31**: Oaks of Seminole Property with Recently Purchased City Parcel*

Another unique feature of this area is the proximity to the Pinellas Trail, which could allow for additional recreational opportunities for the development of the recently purchased City of Seminole property. The City currently does not have specific plans for the parcel; however, the size and location of the property make it desirable for a variety of development purposes. In the proposed concept, the northern portion of the property was reserved for flooding and water quality improvements in the form of a stormwater pond.

6.7.1 Alternative 7 BMP Concept

The proposed alternative includes the expansion of an existing storage area located on the City owned parcel to construct a new stormwater pond. Stormwater in the area is directed towards the new stormwater pond through the addition of new pipe connections and abandoning existing connections. Runoff from 118th St N is directed west under Pinellas Trail to existing inlets just north of Park Blvd. The alternative proposes upgrades to the existing pipes running south under

Park Blvd. It is assumed that the existing pipes can be replaced through jack and bore techniques. These pipes are upsized from 18 inches to 24 inches. Stormwater then continues to the new stormwater pond. Runoff contained within the Oaks of Seminole Condominium is directed to the new stormwater pond located on the City of Seminole property after traveling to the existing retention pond on the north side of the development. A new connection from the property to the east was added to route additional stormwater to the new pond. A backflow preventor was specified on the downstream end of this pipe. The following figure, **Figure 32**, displays the proposed improvements along with the 25-year, 24-hour modeling results.

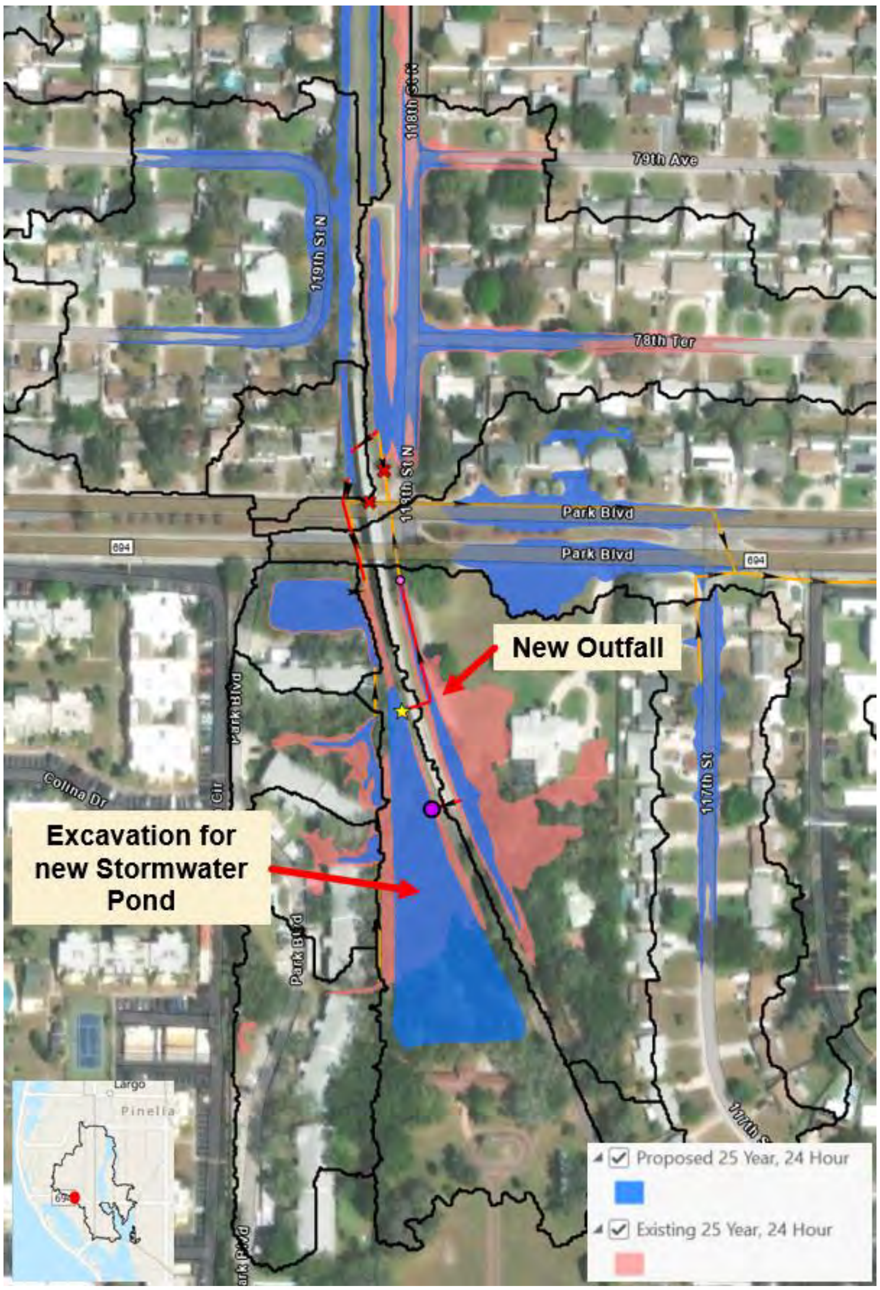


***Figure 32**: Oaks of Seminole BMP Concept Summary*

Improvements:

- Creation of new stormwater pond. Excavation of 5 ac-ft, with top of bank elevation equal to 55 NAVD88-ft. Top of bank area approximately 1.7 acres.
- Creation of new outfall structure and outfall pipe (220 ft) to existing Park Blvd drainage system.
- Upsizing 150 ft of existing stormwater pipes.
- Abandoning existing connections to re-route stormwater flows.
- Addition of new 45 ft 24-inch pipe with backflow preventor.

6.7.2 Alternative 7 BMP Evaluation

- ***Resource and Measurable Benefit***
  - Approximately 28 acre contributing area.
  - Minor improvements to flood protection, greater water quality benefits.
- ***Proposed Conditions Modeling Results***
  - Based on the inclusion of the proposed improvements, flooding and drainage around the Oaks of Seminole Condominium area was improved. Flooding depths for the 25-year, 24-hour event decreased by approximately 0.5 feet. Minor flood stage increases are seen at the downstream receiving node during the 100-year, 24-hour event. The peak stage is still well within the stormwater system. See supporting electronic deliverables for all node peak stages for existing and proposed events.
- ***Water Quality Evaluation***

For water quality calculations, BMP Trains was used to quantify the average annual water quality benefit of newly defined retention pond for nitrogen and phosphorous. Depending on future geotechnical analysis, the pond site may be better suited for wet detention; however, the general surrounding area consists of higher terrain elevations. Additionally, the nearest open water body, located approximately 1,500 feet southeast of the BMP site, shows a LiDAR derived elevation of 43 NAVD88-ft. This elevation is approximately 4 to 5 feet lower than the lowest elevation of the BMP site. A local, accurate understanding of the seasonal high water table would be required to refine the proposed design. Site specific information for the 14-acre water quality contributing area was added to BMP Trains including the following details.

Landuse	Low-Density Residential: TN=1.645 TP= 0.27
Area (acres)	14
Rational Coefficient (0-1)	0.25
Non DCIA Curve Number	58

DCIA Percent (0-100)	27
Nitrogen EMC (mg/l)	1.645
Phosphorus EMC (mg/l)	0.27
Runoff Volume (ac-ft/yr)	15.079
Groundwater N (kg/yr)	0
Groundwater P (kg/yr)	0
Nitrogen Loading (kg/yr)	30.585
Phosphorus Loading (kg/yr)	5.02

A retention pond BMP was described in BMP Trains to quantify water quality benefits from the previously defined catchment. The following table, **Table 9**, describes the retention BMP in BMP Trains.

Table 9*: BMP 7 Retention Pond Details*

Retention Design	**Values**
Retention Depth (in)	1.13
Retention Volume (ac-ft)	1.318
Provided N Discharge Load (kg/year)	3.06
Provided P Discharge Load (kg/year)	0.502
Provided TN Treatment Efficiency (%)	90
Provided TP Treatment Efficiency (%)	90

Due to the large size of the retention pond, the pond provides significant water quality treatment. Around 90% of the nitrogen and phosphorus load is treated through runoff retention. The outfall retention pond weir is sufficiently above the retention volume (1.318 ac-ft). Overall, the proposed project is expected to remove approximately 60.7 lb/yr of nitrogen and 9.96 lb/year of phosphorous. Depending on the specific future development of the City of Seminole property, water quality calculations and overall layout of stormwater management system will need to be re-evaluated.

- ***Environmental Considerations***
    - The 2020 SWFWMD landuse designations do not indicate any wetlands within the project vicinity; however, the National Wetland Inventory (NWI) classifies the existing pond on the north end of the property as a Freshwater Emergent Wetland. Further investigation by an ecologist or environmental scientist might be necessary to evaluate this wetland designation.

- ***Geotechnical Considerations***
  - Soils surrounding the Oaks of Seminole area are mostly characterized as hydrologic soil group A (Tavares and Astatula sands). These soils often have high infiltration capacities and reduced runoff response.
  - Due to the proposed pond, it is recommended to perform a geotechnical investigation to determine the seasonal high water table and more localized soil conductivity parameters. As previously mentioned, local open water bodies indicate an additional 4 to 5 feet of soil column below the proposed pond bottom. The proposed geotechnical data acquisition would further confirm this information and potential adjust the available design parameters (retention versus wet detention).
- ***Permitting Requirements***
  - A new individual SWERP application needed to demonstrate no-rise condition for offsite peak flood stages via storage modeling for 2.33-yr, 10-yr, 25-yr, and 100-yr storm events.
- ***Public Acceptance and Availability***
  - Flood protection improvement along with water quality benefits due to new storage pond. Pond design could incorporate additional uses of the City of Seminole property. The property has yet to be slated for a particular type of development. Any future plans for the City of Seminole property would be subject to the relevant stormwater management requirements. Any new impervious area would potentially require additional treatment and attenuation.
  - Construction is generally limited to the existing City of Seminole property.
  - Potential issues dealing with large existing oaks trees, this may prove problematic for construction of retention pond. Potential to incorporate unique pond design while preserving as many trees as possible to maintain local aesthetics.
- ***Opinion of Probable Construction Cost***
  - The proposed construction cost for BMP 7 was estimated to be approximately $614,000. Refer to **APPENDIX C – OPINION ON PROBABLE COST** for detailed cost breakdown.
- ***Cost Benefit Analysis***

The following figure, **Figure 33**, compares the existing and proposed flooding costs based on the SWFWMD BCA evaluation methodology. The proposed project estimates minor annual savings of around $16,000 and a present value of future benefits of $200,000. The analysis assumes a 7% discount rate over a 30-year project useful life.

Based on the present value of future benefits and the estimated construction cost, the proposed project achieves a Benefit/Cost Ratio of 0.33.

Existing Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$2,909	$36,198	$78,991	$147,928	$213,707	$316,801
Roadway Repair Damage ($)	0.000	$196,500	$309,000	$410,550	$541,200	$604,800	$676,250
Roadway Service Damage ($)	0.000	$838	$3,562	$5,028	$7,752	$9,591	$11,322
Total Damage ($)	0.000	$200,247	$348,760	$494,569	$696,879	$828,098	$1,004,373
EAD Existing ($)				$232,572			
# Structures within 1 ft of Flooding	0	0	0	0	0	2	4
Length Street Flooding, ft	0	655	1030	1400	1895	2195	2510
Existing Annual Structures				0.09			
Existing Annual Steet Length				690			

Proposed Conditions	1-year	2.33-year	5-year	10-year	25-year	50-year	100-year
Probability of Occurrence	1.00	0.43	0.20	0.10	0.04	0.02	0.01
Property Related Damage ($)	0.000	$9,975	$17,410	$39,061	$92,859	$124,481	$168,569
Roadway Related Damage ($)	0.000	$181,500	$309,000	$415,050	$539,950	$593,500	$619,550
Roadway Service Damage ($)	0.000	$419	$3,352	$5,028	$6,914	$7,915	$9,436
Total Damage ($)	0.000	$191,894	$329,762	$459,139	$639,723	$725,896	$797,555
EAD Proposed ($)				$216,340			
# Structures within 1 ft of Flooding	0	0	0	0	1	1	1
Length Street Flooding, ft	0	605	1030	1415	1885	2095	2190
Proposed Annual Structures				0.07			
Proposed Annual Steet Length				665			

Expected Annual Damage Without Project (1)	$232,572
Expected Annual Damage With Project (1)	$216,340
Expected Annual Damage Benefit (a) – (b)	$16,232
Discount Rate	7.0%
Project Useful Life (# years)	30
Total Present Value of Future Benefits	$201,423
Total Project Cost	$614,451
Benefit/Cost Ratio	0.33

BMP 7, Oaks of Seminole Condominum Pond
- max construction cost of around 200,000 would correspond to a BCA of 1

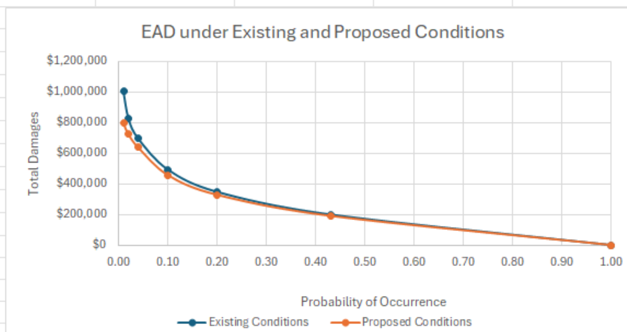


***Figure 33**: BCA Summary, Oaks of Seminole*

- ***Sea Level Rise Considerations***
  - No SLR consideration for this location due to distance from SLR influences.

6.7.3 Alternative 7 BMP Additional Considerations

- City owned property with large potential. Any future development will likely require some form of stormwater management. It would be a great opportunity for the City to strategically integrate the stormwater management features into the future development.
  - Recreation and aesthetics of specially designed stormwater pond/park area. Close to Pinellas Trail and other neighborhoods that would potentially utilize the park/pond area.

7 BMP RANKING RESULTS

City of Seminole Conceptual BMP Project Scoring						
	Lake Pearl Flooding	**Seminole Bypass Improvements**	**70th Ave Commercial**	**112th St North Flooding**	**Walsingham Park East**	**Oaks of Seminole Condominium**
BMP ID	1	2	3	4	5	7
System Scale						
Regional (20)		20		20		
Intermediate (12)	12				12	
Local (5)			5			5
Benefit Cost Ratio						
Greater than 1.10 (20)	20	20	20		20	
Between 0.9 and 1.10 (15)				15		
Between 0.7 and 0.9 (10)						
Between 0.5 and 0.7 (5)						
Lower than 0.5 (0)						0
Structure Impacts (Expected Annual Count)						
Greater than 3.0 (15)			15			
Between 1.5 and 3.0 (10)	10	10			10	
Between 1.0 and 1.5 (5)				5		5
< 1.0 (0)						
Street Impacts (Expected Annual Length)						
Greater than 2.0 (15)					15	
Between 1.26 and 1.9 (10)	10					
Between 1.0 and 1.25 (5)		5	5	5		5
< 1.0 (0)						
Water Quality Improvements, Nitrogen, Cost Per Pound Per Acre						
$0 - $2,000 (10)					10	10
$2,001 - $4,000 (8)						
$4,001 - $6,000 (6)			6	6		
$6,001 - $8,000 (4)						
> $8,000 (2)						
No Water Quality (0)	0	0				
Water Quality Improvements, Phosphorus, Cost Per Pound Per Acre						
$0 - $2,000 (10)						
$2,001 - $4,000 (8)						
$4,001 - $6,000 (6)						6
$6,001 - $8,000 (4)					4	
> $8,000 (2)			2	2		
No Water Quality (0)	0	0				
Opinion of Construction Complexity						
Simple (10)			10			10
Moderate (8)		8				
Complex (4)	4			4	4	
Very Complex (2)						
BMP ID	1	2	3	4	5	7
Total	56	63	63	57	75	41
Ranking	5	3	2	4	1	6

BMP Number	BMP Name	Description	EAD* Existing	EAD* Proposed	Total Future Benefits*	Total Project Cost	Benefit Cost Ratio	Final Score	Final Ranking
1	Lake Pearl Flooding	A new stormwater conveyance system with pipes increasing from 48 to 54 inches runs along 90th Way, discharging into Lake Pearl, and an open channel ditch has been converted to a 5x8 ft box culvert from Lake Pearl to Garden Dr, with inlet grates to be considered in the design. Additionally, a 5x8 ft box culvert extends south from Garden Dr to Long Bayou, and a 36-inch pipe on 92nd Street is being upsized to 48 inches.	$ 1,737,286	$ 1,012,036	$ 8,999,663	$ 5,550,000	1.62	56	5
2	Lake Seminole Bypass Canal Improvements	The Seminole Bypass Outfall capacity is increased by three 7x12 ft box culverts, adding 252 ft^2 of flow area, with the potential consideration of a traditional span bridge design of equivalent area. Additionally, 50 feet are added to the outfall weir on the canal's western side, and backflow preventers are installed on various stormwater pipes in the impacted northwest neighborhood.	$ 2,458,864	$ 2,023,388	$ 5,403,836	$ 1,696,000	3.19	63	3
3	70th Ave Commercial Site	A new stormwater system at a commercial site includes small concrete pipes (12 to 15 inches in diameter) and inlet grates. It also features three 250-foot-long linear ponds along Pinellas Trail with 4:1 side slopes, separated by 10 to 15-foot-wide concrete rectangular weirs for attenuation and controlled discharge, totaling about 0.8 acre-feet of excavation.	$ 447,627	$ 203,402	$ 3,030,599	$ 374,000	8.10	63	2
4	112th St North Flooding	A new 48-inch outfall pipe runs south from 112th St and then west to connect with 113th St, while existing stormwater pipes along the east side of 113th St are rerouted and upsized. Additionally, a 54-inch outfall pipe will collect runoff from 113th St, routing it east down 70th Ave towards Seminole Blvd, and will include an 8-foot wide in-line baffle box near the City of Seminole public works, small pipes from a commercial site, and final outfall improvements before discharging into Long Bayou.	$ 2,771,061	$ 2,246,053	$ 6,514,845	$ 6,371,000	1.02	57	4
5	Walsingham Park East	The project involves constructing 3,700 feet of new concrete pipes ranging from 36 inches to 72 inches in diameter for a new outfall corridor, expanding Walsingham Park Pond by approximately 50 percent with increases in sediment basin areas and a rerouted trail, and improving sediment and outfall weirs while expanding channel width by 15 feet through 3.5 acre-feet of excavation.	$ 1,260,040	$ 601,692	$ 8,169,475	$ 5,940,000	1.38	75	1
7	Oaks of Seminole Condominium	The project includes creating a new stormwater pond with a 5 acre-feet excavation, a top of bank elevation set at 55 NAVD88 feet, covering approximately 1.7 acres. It also involves constructing a new outfall structure and 220 feet of outfall pipe to integrate with the existing Park Blvd drainage system, alongside upsizing 150 feet of existing stormwater pipes, abandoning current connections for rerouting stormwater flows, and installing a new 45-foot long 24-inch pipe with a backflow preventer.	$ 232,572	$ 216,340	$ 201,423	$ 614,000	0.33	41	6

**EAD = Expected Annual Damages*
**Total Future Benefits assumes 7% discount rate over 30 year life cycle*

8 CONCLUSIONS AND RECOMMENDATIONS

Applied Sciences reviewed seven locations throughout the City of Seminole and developed conceptual BMP projects and or analysis to support the further understanding of existing flood risk and the ability to alleviate flooding through implementation projects. The city contains an extensive network of stormwater pipes and features, established over many years to address recurrent flooding and standing water problems. This system functions similarly to a natural creek system, effectively channeling stormwater through an underground network designed to prevent surface flooding. As specific projects were explored, the capacity and efficiency of the existing system were assessed, identifying areas where enhancements or additional BMPs could further alleviate flooding and improve water quality.

Among the evaluated projects, several stood out for their significant positive impacts. As seen in the previous BMP Ranking tables, many projects attained a benefit cost ratio greater than 1.0, indicating a positive return on investment. Both flood protection and water quality benefits were achieved including the reduction of street and structure impacts within the BMP site areas. It is recommended the city move forward with additional analysis in the form of Preliminary Engineering Reports (PERs) and further design phases for the highly ranked BMP projects. Inclusion of future Sea Level Rise (SLR) and other climate related indicators should be included and emphasized in future phases of project development. Additionally, Applied Sciences recommends pursuing grant funding opportunities from local and federal agencies including SWFWMD and FDEP.

Applied Sciences recommends leveraging the detailed stormwater inventory and model data developed throughout this project to enhance the City's asset management system. Rainfall-based vulnerability assessments should be evaluated to better identify and address potential flood risks to key City assets. Additionally, it is recommended to perform future land use analyses to understand the impacts of development on stormwater dynamics, ensuring sustainable growth. An in-depth water quality analysis using the citywide watershed model is also recommended. This effort could further identify pollution sources and the development of targeted mitigation strategies, thereby improving overall water quality and ecosystem health.

9 REFERERENCES

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10 APPENDIX A – WATER QUALITY SUMMARY

DATE: February 20, 2024

TO: Rodney Due (City of Seminole)

FROM: Eesa Ali, PWS (Applied Sciences)

CC: Taylor Lankford, PE (Applied Sciences)
Elie Araj, PE (Applied Sciences)

SUBJECT: **City of Seminole – Water Quality Summary**
City of Seminole RFQ #21-0409

Introduction

Applied Sciences Consulting, Inc. (CONSULTANT) was tasked by the City of Seminole (City) under RFQ # 21-0409 with conducting a city-wide Watershed Management Plan (WMP) update. The project includes performing a Watershed Evaluation (1st Phase) as well as subsequent phases, including Model Parameterization, Model Development, Floodplain Analysis, Floodplain Level of Service (FPLOS), and Best Management Practices (BMPs).

Currently, Applied Sciences is conducting the Best Management Practices (BMPs) analysis with a focus on flood protection related projects. As part of the scope of work, a supplemental report (captured in this technical memo) was developed to provide a water quality summary. The purpose of the water quality summary is to identify existing reports, studies, and historical records/available water quality data. The results of this technical memo will be used to help supplement the development of flood protection BMPs, where practicable.

Existing Reports, Studies, and Historical Records

This section serves to highlight existing reports, studies, and historical records related to the water quality within the City of Seminole. By distilling key findings and insights from a range of sources, including past reports, we illuminate the prevailing challenges and trends affecting water quality in the City. From identifying significant reports to highlighting historical records that point to problematic water quality issues, this section provides a foundational understanding crucial for devising targeted strategies and initiatives aimed at improving water quality within the City.

Lake Seminole Watershed Management Plan (WMP), 2001

In response to public concerns regarding declining water quality in Lake Seminole, the 2001 Watershed Management Plan (WMP) was authorized by Pinellas County. The WMP outlined specific goals aimed at addressing various water quality issues. These goals included reducing pollutant and nutrient loadings from both external and internal sources, improving lake water quality by lowering the Trophic State Index (TSI) and meeting state water quality standards. Previous monitoring data from the 1990s indicated consistent eutrophic conditions in the lake, but the 2001 assessment using TSI calculations revealed a severe hypereutrophic classification, signaling a further deterioration in conditions. To address this, aggressive measures to reduce nutrient loads were recommended.

The analysis of water and nutrient budgets identified direct runoff as a significant contributor to nitrogen and phosphorus loading in Lake Seminole, with stormwater runoff identified as the primary source of external phosphorus loads. Nutrient recycling processes, such as nitrogen fixation by blue-green algae and sediment fluxes, were also noted. Recommendations to mitigate nutrient loading and reduce cyanobacteria dominance included enhancing stormwater treatment to reduce external phosphorus loads, dredging to remove sediment phosphorus stores, improving internal circulation, and implementing lake level fluctuation plans. Additionally, sediment analysis suggested benefits of sediment removal projects, alum injection, and managing grass carp populations to prevent excessive nutrient release from macrophyte consumption.

Furthermore, the discussion highlighted the detrimental effects of grass carp introduction, mechanical harvesting, shoreline hardening, and excessive algal growth on the native aquatic vegetation. The conversion of nutrient mass by grass carp into inorganic forms available to phytoplankton was identified as a significant contributor to the hypereutrophication of Lake Seminole. These findings underscore the complex interplay between human interventions, nutrient dynamics, and ecological health in the lake ecosystem, necessitating holistic management approaches to address water quality challenges effectively.

Lake Seminole Watershed Reasonable Assurance Plan (RAP), 2007

Pinellas County published a Reasonable Assurance Plan (RAP) in 2007 which outlined strategies and actions aimed at achieving and maintaining compliance with water quality standards. RAPs are typically developed in response to regulatory requirements or as part of a watershed management approach.

Key aspects of a Reasonable Assurance Plan include:

- **Identification of Goals and Objectives**: RAPs define specific water quality goals and objectives tailored to the particular watershed or waterbody under consideration. These goals may include reducing pollutant levels, restoring impaired waters, or protecting vulnerable ecosystems.

- **Assessment of Existing Conditions**: RAPs involve a thorough assessment of existing water quality conditions within the watershed, including the identification of pollution sources, sources of impairment, and contributing factors affecting water quality.
- **Development of Management Strategies**: Based on the assessment of existing conditions, RAPs outline a series of management strategies and best management practices (BMPs) designed to address identified water quality issues. These strategies may include pollution prevention measures, land use management practices, and infrastructure improvements.
- **Implementation Plan**: RAPs include a detailed implementation plan that outlines specific actions, responsible parties, timelines, and funding sources for carrying out the proposed management strategies.
- **Monitoring and Evaluation**: RAPs incorporate provisions for ongoing monitoring and evaluation of water quality parameters to assess the effectiveness of implemented management measures and to track progress towards achieving established goals and objectives.

A RAP is typically developed to provide "reasonable assurance" that implementation of the above components will be sufficient to attain compliance with water quality standards and eliminate the necessity of a Total Maximum Daily Load (TMDL). While a RAP focuses on broader watershed management and prevention of water quality issues, a TMDL is **specifically** focuses on addressing impaired waters and establishing pollutant load limits to achieve water quality standards.

The 2007 RAP contained most of the content previously established in the 2001 Watershed Management Plan, including recommendations for enhancing stormwater treatment, dredging to remove sediments, improving internal circulation, and implementing lake level fluctuation plans.

Lake Seminole Watershed Reasonable Assurance Plan, 2011, 2014, 2019

The Reasonable Assurance Plan (RAP) program requires updated reporting every 5 years after the initial establishment. For Lake Seminole, the updates typically focus on the progress made towards the original 2007 RAP goals. The 2019 RAP was specifically reviewed for this water quality summary. The document demonstrates improvements in the Trophic State Index (TSI) for Lake Seminole, decreasing values from 2007. The lake appears to be above the overall goal of 60-65, however. Additionally, statistical trend analysis indicates a decrease in chlorophyll-a, nitrogen, phosphorous, turbidity and suspended solids.

The RAP provides additional reporting related to the structural, management, legal, policy, compliance and enforcement, and public education strategies defined in the original 2007 RAP. Structural improvements focus on implemented stormwater management facilities including various alum treatment systems and extensive lake dredging that began in 2018. It appears that Pinellas County and other relevant stakeholders (including the City of Seminole) are actively maintaining a strong commitment to the various water quality initiatives established in the 2001 WMP and 2007 RAP.

Compilation of Available Water Quality Data

Understanding water quality necessitates a comprehensive compilation of data from various sources. This section outlines the primary sources of water quality data, emphasizing those deemed most useful due to their extensive period of record and reliability. Additionally, the section highlights the types of data collected, focusing on typical parameters essential for assessing water quality at a high level. These parameters include nitrogen, phosphorus, suspended solids, and other key indicators crucial for evaluating the health of aquatic ecosystems. By examining these sources and data types, a clearer picture of water quality dynamics emerges, guiding effective management strategies and interventions.

There are ten defined waterbodies with overlapping watersheds within the City of Seminole. All of them are defined as Class III waters, i.e., a designated use that provides for fish consumption, recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife *(FAC 62.302.400).* Lake Seminole, Long Bayou, and Boca Ciega, which border the City of Seminole, are considered Outstanding Florida Waters (OFWs). Lake Seminole and Long Bayou are part of the Pinellas County Aquatic Preserve and Boca Ciega is its own aquatic preserve. The OFW designation affords the highest level of protection for waterbodies in Florida. The Impaired Waters Rule (IWR, run 65) database was used to determine which waterbodies have been listed as impaired and for which analyte (**Table 1A, Figure 1A**).

Table 1A: Waterbodies in the City of Seminole

WBID	Waterbody Name	Type	Class	Impairment
1528B	Direct Runoff to Intracoastal Waterway	Estuary	III, Marine	No Data
1694B	Boca Ciega Bay (North)	Estuary	III, Marine	Chlorophyll-a (Trend), Total Nitrogen (Trend), Total Phosphorus (Trend)
1694D	Cross Bayou Drain	Estuary	III, Marine	No Data
1633C	McKay Creek Above Walsingham Reservoir	Stream	III, Fresh	No Data
1641	Cross Canal (South)	Estuary	III, Marine	Chlorophyll-a, Enterococci, Dissolved Oxygen, Fecal Coliform, Total Phosphorus (Trend)
1618	Lake Seminole	Lake	III, Fresh	Chlorophyll-a, pH, Total Nitrogen, Total Phosphorus
1618A	Lake Seminole Outlet	Stream	III, Fresh	No data
1618B	Long Bayou Runoff	Estuary	III, Marine	No data
1618C	Long Bayou/Cross Bayou	Estuary	III, Marine	Enterococci, Total Nitrogen (Trend)
1618D	Seminole Bypass Canal	Stream	III, Fresh	Dissolved Oxygen, Fecal Coliform, Specific Conductance, Total Phosphorus (Trend)

Highlighted rows indicate OFW designation.

The assessment of surface waters performed by the State of Florida is an iterative process. Impairments listed in the above table indicate analytes which have been sampled and have exceeded thresholds a sufficient number of times to warrant further investigation or to be officially confirmed as impaired for a particular analyte. Assessments do not capture all potential pollutants as it is impossible to sample water for all known substances, however, typical pollutants often suggest sources of other pollutants (e.g. a fecal indicator organism can indicate a pollution source like sewage which is a source of nutrients and possibly pharmaceuticals).

Three of the listed waterbodies, Cross Canal South, Long Bayou, and Seminole Bypass Canal, are listed for one or more nutrients as well as a fecal indicator bacterium (FIB) making these three water bodies ideal candidate systems for a pollution/microbial source tracking study. These studies use precise iterative forensic sampling techniques, stakeholder engagement, and reconnaissance to locate and reduce sources of pollution.

Three Alternative Restoration Plans (ARP) have been adopted including Lake Seminole (Nutrients & pH) in 2012, McKay Creek (Escherichia coli) in 2016, and the Seminole Bypass Canal (Chlorophyll-a) in 2018. Prior to the adoption of an ARP, the EPA adopted a total nitrogen and total phosphorus TMDL for McKay Creek (WBID 1633C) in 2013. A fecal coliform TMDL was also adopted by the State of Florida in 2012 for McKay Creek WBID 1633B and McKay Creek Tidal (1633). WBID 1633B has since been split into Taylor Lake (1633A), McKay Creek above Walshingham Reservoir (1633C), and McKay Creek above Taylor Lake (1633D).

The Florida Department of Health's (DOH) Florida Water Management Inventory (FWMI) GIS data (last updated 07/06/2023) indicates that there are 6,747 known sewer connections, but 2,776 parcels are classified in less certain terms as "likely sewer", "likely septic", "not applicable", "somewhat likely sewer", "somewhat likely septic", and "unknown" (**Table 2A, Figure 2A**). While malfunctioning septic systems are known sources, sewer connections and failing sewer mains and gravity lines can also be sources.

Figure 3A shows all cleanup sites located within the City. There are ten petroleum cleanup sites, three dry cleaning sites, and one brownfield area. There are no permitted wastewater outfalls, wastewater treatment or PFAS (per- and polyfluoroalkyl substances; long lasting chemicals, components of which break down very slowly over time) sites within the City.

Table 2A: DOH Water Management Inventory Counts within the City of Seminole

Classification	Count
Known Sewer	6747
Likely Septic	48
Likely Sewer	2369
Not applicable	252
SWL Septic	49
SWL Sewer	1
Unknown	57
Total	9523

Conclusion

The previous summary serves as a valuable resource, highlighting existing reports, studies, and historical records relevant to water quality within the City of Seminole. Insights gleaned from these sources provide essential context for devising targeted strategies aimed at improving water quality conditions. As with most data dependent fields, comprehensive monitoring efforts should be expanded to include a wider range of pollutants and establish long-term monitoring programs. Additionally, spatial data on pollution sources should be improved to facilitate targeted mitigation efforts. Finally, water quality considerations must be integrated into project planning processes to mitigate adverse impacts and promote sustainable development, including implementing Best Management Practices (BMPs) and preserving natural habitats.

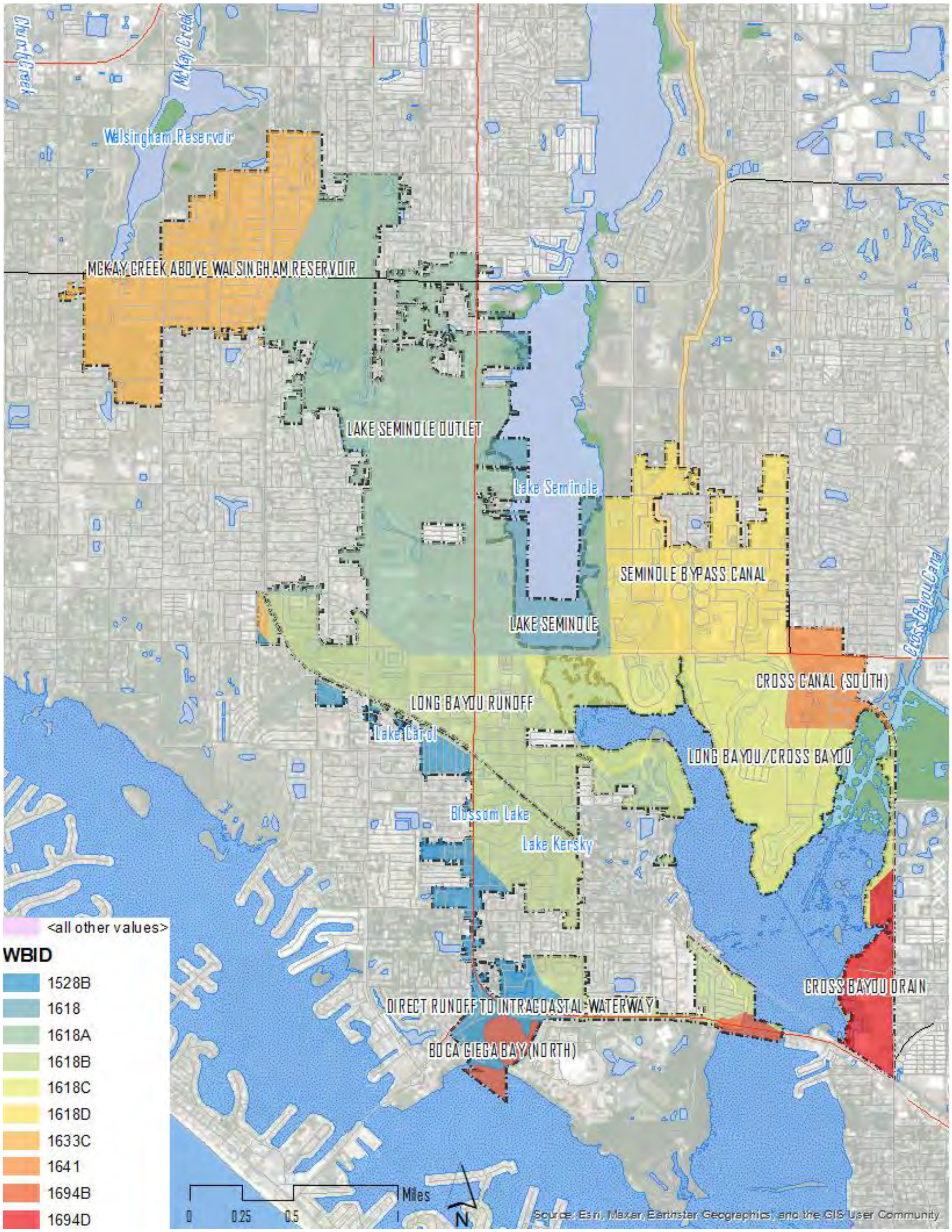


***Figure 1A**: City of Seminole Waterbody IDs (WBIDs)*

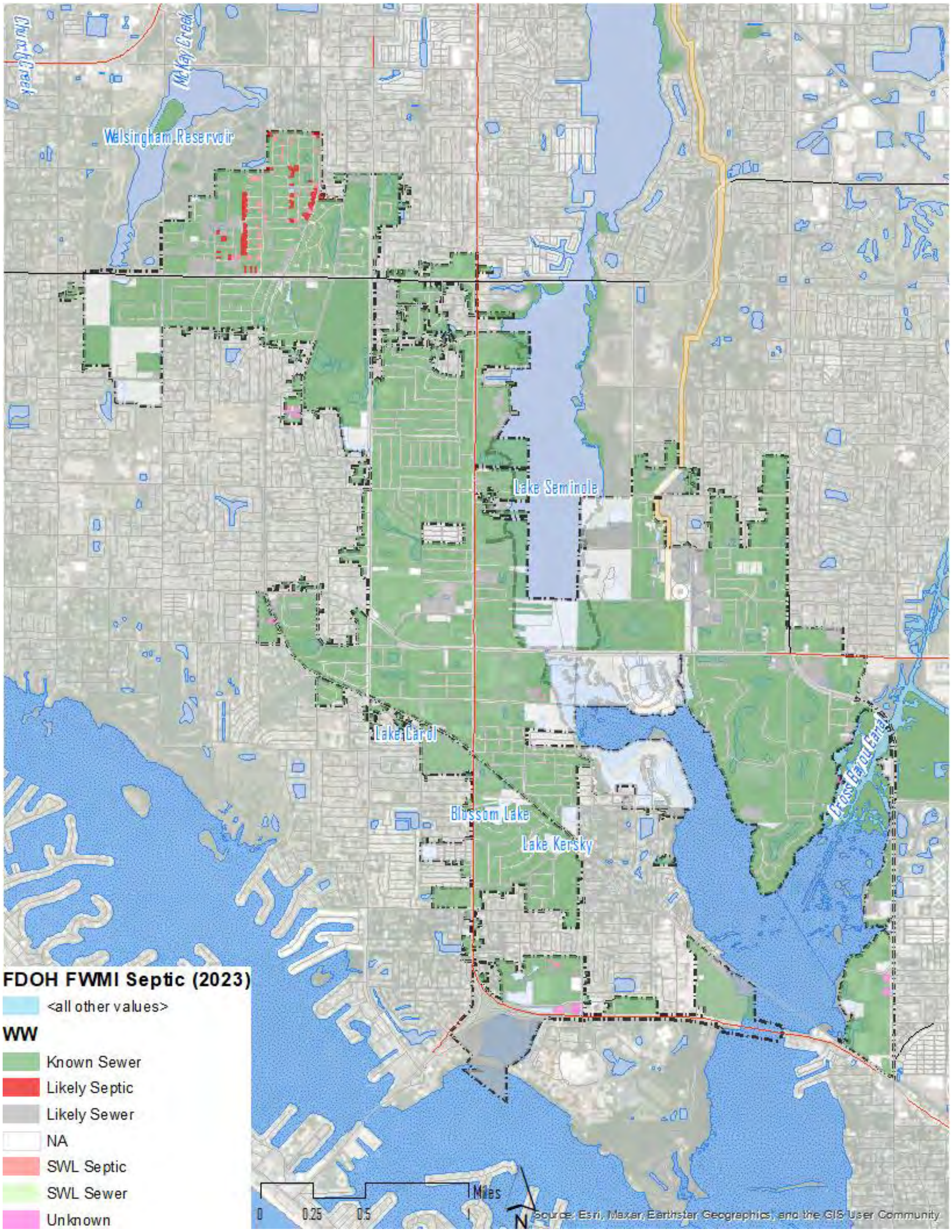


Figure 2A: *DOH Water Management Inventory Coverage in the City of Seminole*

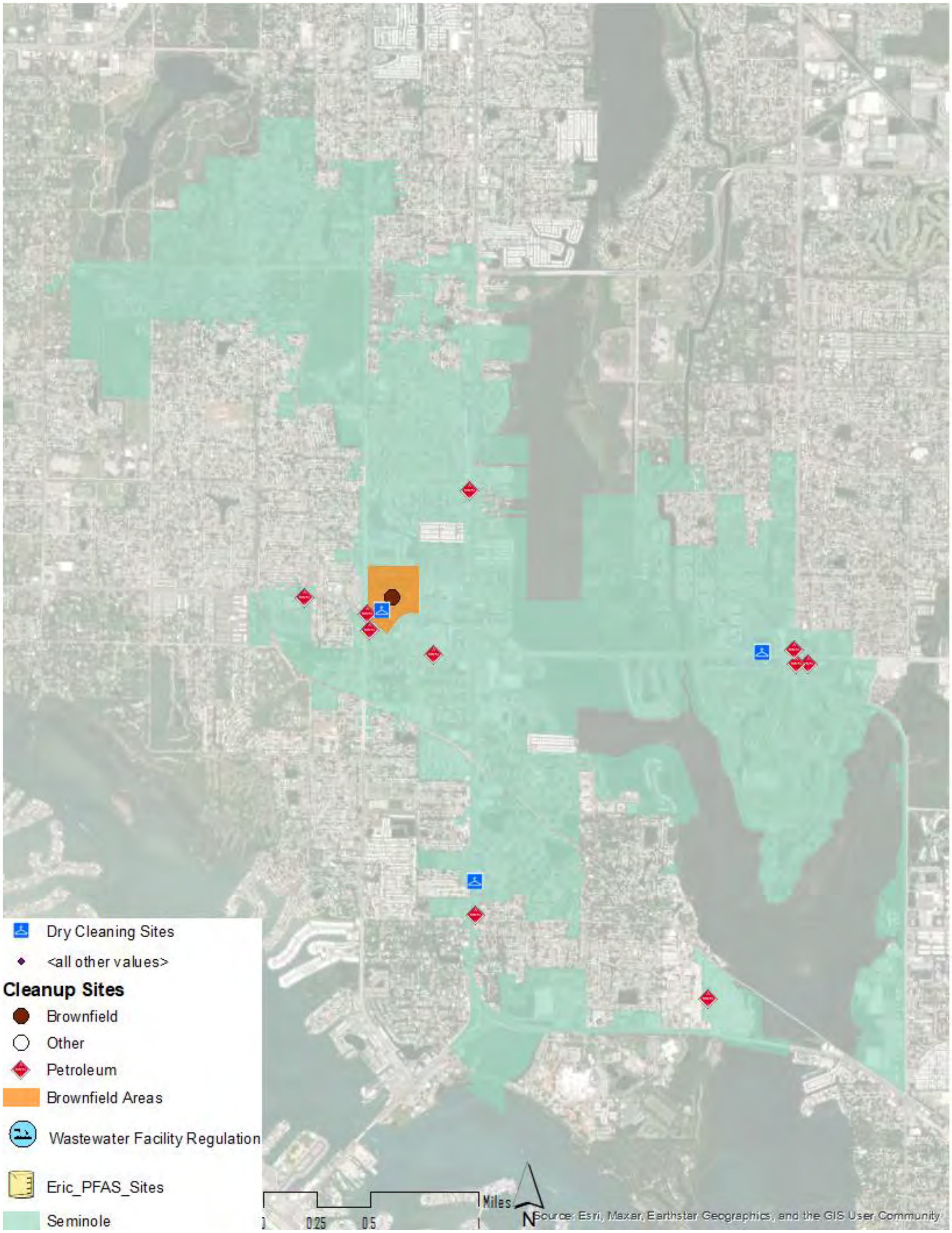


***Figure 3A**: Clean Up Sites Within the City of Seminole*

11 APPENDIX B – PERMITTING REVIEW

DATE: March 4, 2024

TO: Rodney Due (City of Seminole)

FROM: Taylor Lankford, PE

CC: Meeting Attendees

SUBJECT: **City of Seminole WMP – Informal ERP Review for Conceptual BMPs**

City of Seminole RFQ # 21-0409; SWFWMD Agreement # 22CF0003382 (Q163)

Notes on Meeting held on March 4, 2024 @ 10:30 A.M.

TEAMs Call

Attendance: Rodney Due, City of Seminole
Barbara Dunn, City of Seminole
Rob McDaniel, PE, SWFWMD, ERP Evaluation Manager
Oscar Robayo, PhD, PE, SWFWMD, Engineering & Watershed Management Section
Elie Araj, PE, Applied Sciences
Taylor Lankford, PE, Applied Sciences

Applied Sciences met with City of Seminole and SWFWMD staff to discuss conceptual BMP projects developed as part of the City of Seminole Watershed Management Plan (WMP). BMP sites were defined through evaluation of Flood Protection Level of Service (FPLOS) deficiencies along with consideration for observed flooding and historical flooding complaints. Projects may focus on improved conveyance, new stormwater outfalls, and increased stormwater storage. The following introduces each BMP and lists key components for the conceptual project. Environmental Resource Permitting (ERP) notes are also included below each BMP example.

BMP 1 – Lake Pearl Area

Historical flooding issues and violation of City Flood Protection Level of Service.

Design elements:

- New stormwater conveyance features
- New bypass outfall system
- Potential conversion of open channel to box culvert system
- Backflow preventer at existing outlet

Permitting Notes

- No new impervious areas proposed.
- Long Bayou impairment needs to be evaluated if inflow volumes are increased.
- A new individual SWERP application needed to demonstrate no-rise condition for offsite peak flood stages via storage modeling for 2.33-yr, 10-yr, 25-yr, and 100-yr storm events.

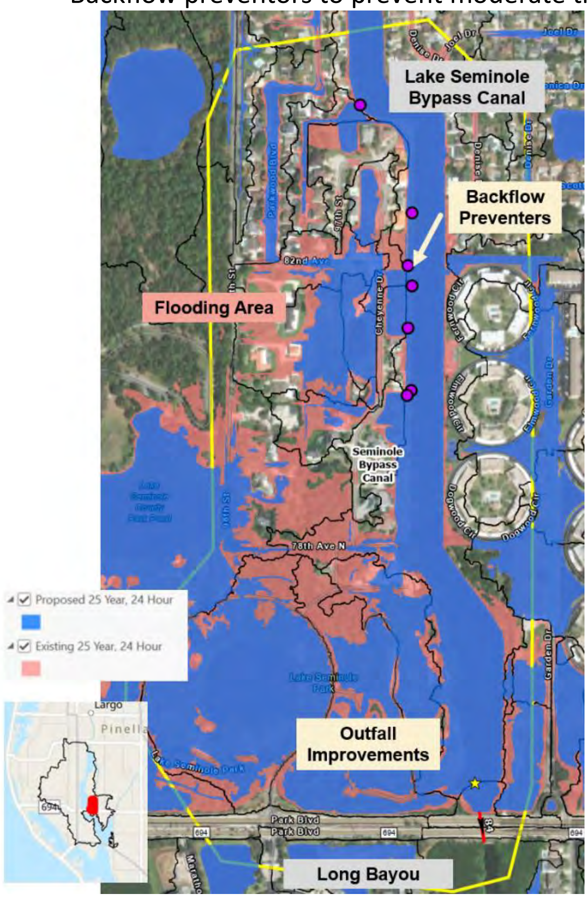
BMP 2 – Lake Seminole Bypass

Historical flooding issues and violation of City LOS.

Modeling results indicate significant head loss at the Lake Seminole Bypass outfall structure.

Design elements:

- Expansion of outfall weir and box culvert system under Park Blvd to reduce upstream flooding.
- Currently 4, 7 ft x 12 ft box culverts under Park Blvd and large concrete weir at elevation 1.88 NAVD88-ft
- Backflow preventors to prevent moderate tidal surge issues (around 4 to 5 feet)



Permitting Notes

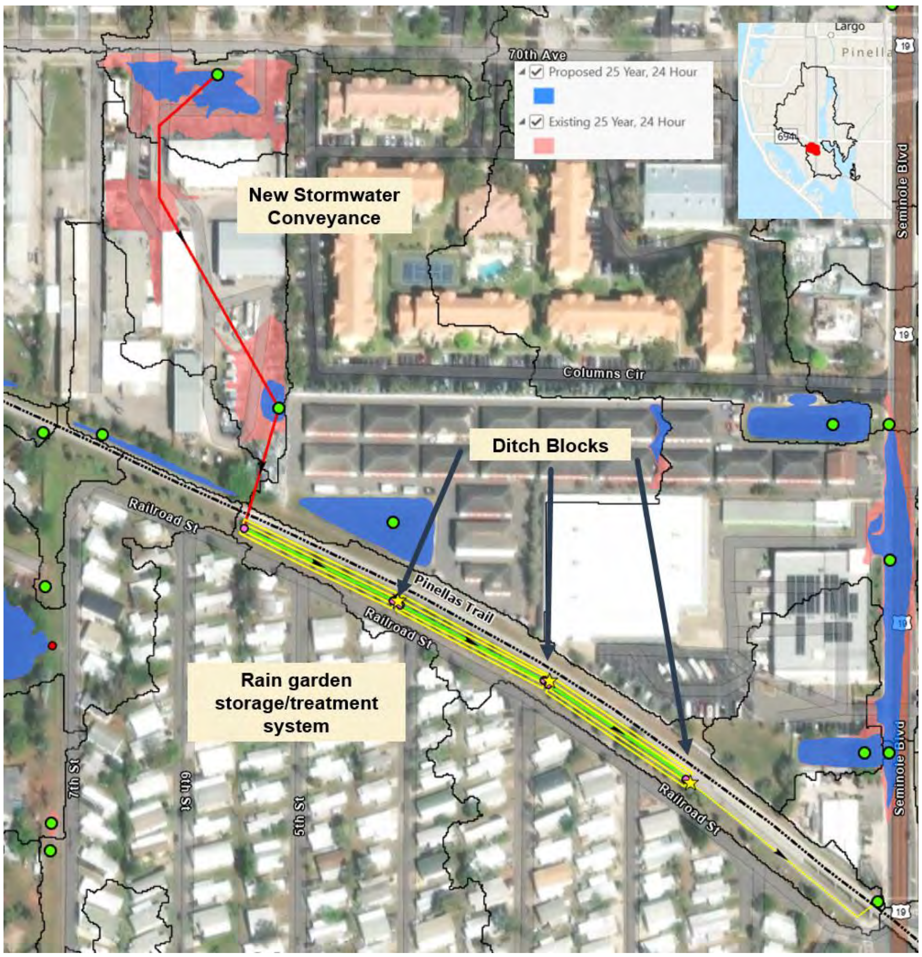
- Discharging into Long Bayou.
- Culvert expansion needs coordination with Pinellas County.
- Installation of back flow preventers are likely to be exempt from permit.
- A new individual SWERP application needed to demonstrate no offsite peak stage increases via storage modeling for 2.33-yr, 10-yr, 25-yr, and 100-yr storm events.
- Requires coordination with Pinellas County for Bypass Canal activities and Park Blvd right-of-way intervention.

BMP 3 – 70th Ave Commercial Area

Frequent flooding at commercial site with no stormwater drainage infrastructure

Design elements:

- New stormwater conveyance features
- Lack of storage features to route runoff
- Small, linear ponds proposed along Pinellas trail
- Tiered system with ditch blocks to retain stormwater and provide some water quality treatment



Permitting Notes

- If limited to retrofit activities, the alternative is likely feasible for a General Permit under Rule 62-330.451

BMP 4 – 112th St North

Flooding and LOS violations along 112th St and 111th St

Design elements:

- New stormwater features along 112th St N
- Re-routing and upsizing stormwater along 113th St S
- New stormwater outfall system along 70th Ave, east to Long Bayou
- In-line baffle box treatment at City public works office
- Tie in previous commercial site to new outfall
- Upsizing existing system on east side of Seminole Blvd

Permitting Notes

- Adding a new southeast outfall discharging to Long Bayou.
- A new individual SWERP application is needed to demonstrate treatment and attenuation for the added stormwater discharges.

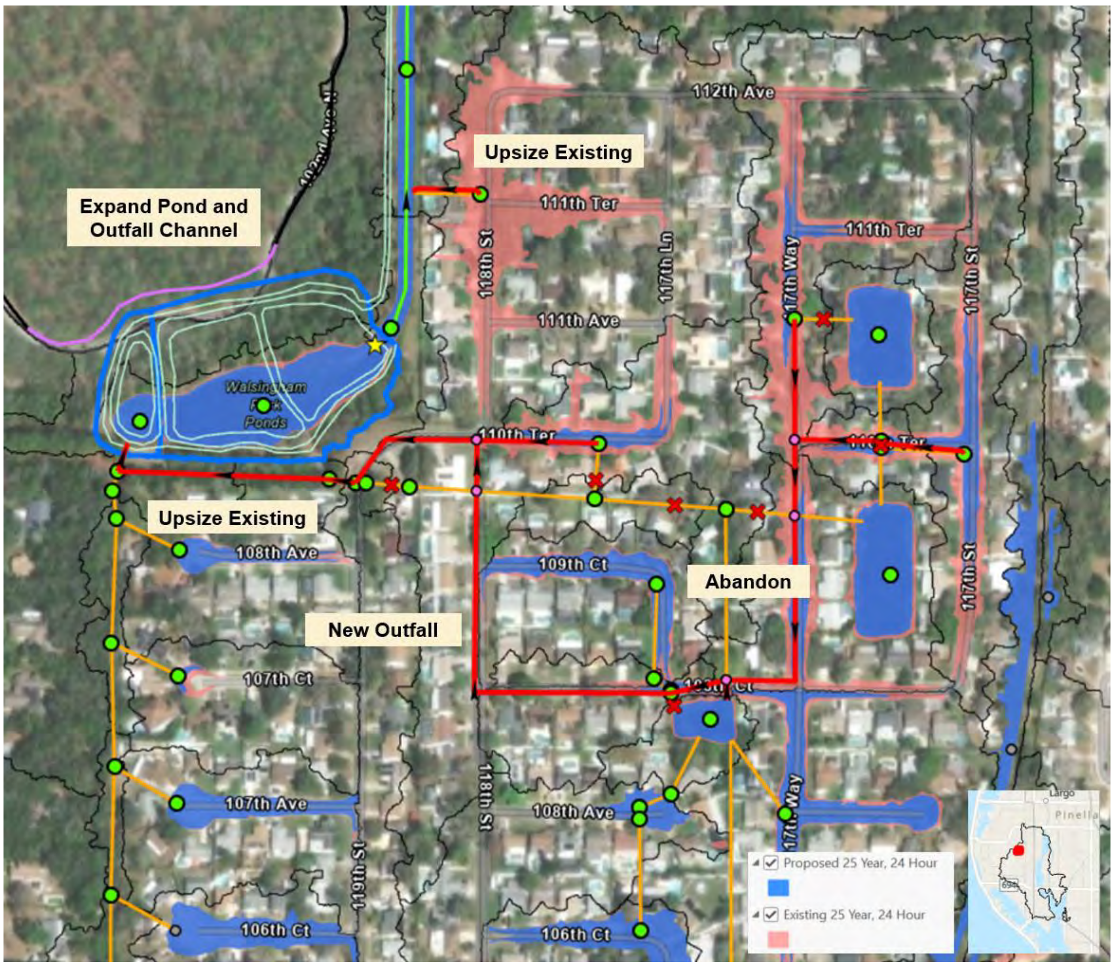
BMP 5 – Walsingham Park

LOS violations for streets and structures within this area

1970s development with limited stormwater storage/conveyance

Design elements:

- New stormwater collection/outfall system
- Existing pipes are difficult to access/maintain
- Expansion of Walsingham Park Ponds and outfall channel system (Pinellas County)



Permitting Notes

- A new conveyance system to reroute stormwater discharges to the west into a proposed expansion of Walsingham Park Pond (constructed under Permit No. 8744).
- Most likely needs SWERP Permit modification if construction was authorized under Permit No. 8744 (revisions 0, 1, and 2).
- If the Walsingham Park Pond is not permitted, the activity might qualify for a general permit under Rule 62-330.451 for stormwater retrofit activities (but pond expansion needs to evaluate acreage of wetland impacts).

BMP 6 – Seminole Lake Country Club

Tidal issues, soil saturation, and potential maintenance issues with storage reduction in ponds

Evaluation of varying tidal and soil storage conditions

Design elements focused on potential future conditions:

- Upsizing stormwater features, consideration for pump stations, seawalls, roadway raising, etc.
- Minor upgrades to existing stormwater conveyance systems – addition of pipes/inlets to alleviate nuisance flooding
- Recommendations for future studies/feasibility options
- Evaluation of existing pond sedimentation

Permitting Notes

- Area affected by lack of maintenance (sedimentation has reduced storage capacity of ponds).
- Needs new individual SWERP application to evaluate the benefits of maintenance activities.

BMP 7 – Oaks of Seminole Condominium

Opportunity for better stormwater management and water quality improvements

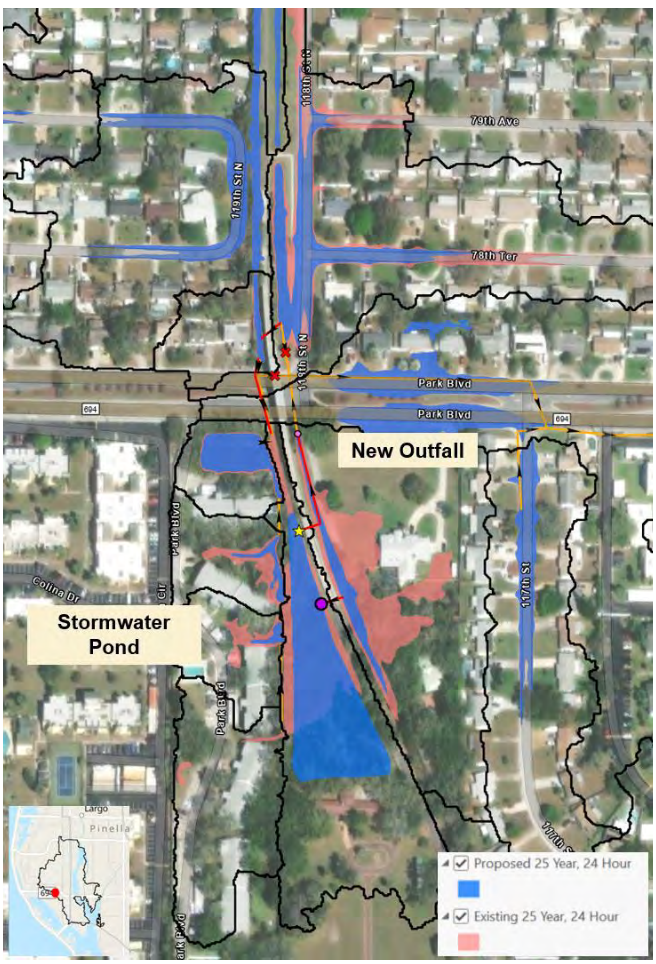
Older condominium development without a properly designed stormwater management facility

City of Seminole purchase of 5.53 acres in 2019

Mixed use – affordable housing, overflow parking for Seminole City Park, stormwater management with community in mind

Design elements:

- New stormwater conveyance features
- New stormwater pond/reservoir
- Integrated park/recreation opportunities for the community



Permitting Notes

- The proposed stormwater pond will need to demonstrate water quality benefits and no offsite adverse impacts.
- New pond discharging to existing stormwater conveyance system.

- If no impervious area added, the alternative may qualify for a general permit under Rule 62-330.45 for stormwater retrofit activities.

The meeting was adjourned around 11:15 A.M.

These meeting minutes represent our best recollection, understanding, and documentation of the items discussed including any action items that may be required.

12 APPENDIX C – OPINION ON PROBABLE COST

Project Name:		BMP 1 - Lake Pearl Area	Opinion of Probable Cost City of Seminole Watershed Management Plan March 2024			
Client:		City of Seminole				
ITEM	FDOT INDEX NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	PAY ITEM TOTAL
1	101-1	MOBILIZATION	LS	1	Varies	$212,470
2	102-1	MAINTENANCE OF TRAFFIC	DA	30	$2,500.00	$75,000
3	104 11	FLOATING TURBIDITY BARRIER	LF	200	$18.00	$3,600
4	104-13-1	SILT FENCE STAKED (TYPE III)	LF	3,500	$6.00	$21,000
5	110 1 1	CLEARING & GRUBBING	AC	1.50	$80,000.00	$120,000
6	120-5	CHANNEL EXCAVATION	CY	2,200	$45.00	$99,000
7	120-6	EMBANKMENT	CY	2,500	$30.00	$75,000
8	285-711	OPTIONAL BASE, BASE GROUP 11	SY	1,500	$45.00	$67,500
9	327-70-05	MILLING EXISTING ASPHALT PAVEMENT, 2" AVG DEPTH	SY	1,833	$5.00	$9,167
10	334-1-13	SUPERPAVE ASPHALTIC CONC, TRAFFIC C	TN	120	$150.00	$17,944
11	400-3-1	CONC CLASS III (CULVERTS) (BOX CULVERT)	CY	1,260	$1,500.00	$1,890,432
12	425-1-903	INLETS (SPECIAL) (J BOT, <10')	EA	2	$7,303.73	$14,607
13	425-2-91	MANHOLE (J-8) (<10')	EA	2	$10,000.00	$20,000
14	430-175-124	PIPE CULVERT, OPT MATERIAL,ROUND, 24"S/CD	LF	380	$160.00	$60,800
15	430-175-148	PIPE CULVERT, OPT MATERIAL, ROUND, 48"S/CD	LF	1,160	$500.00	$580,000
16	430-175-154	PIPE CULVERT, OPT MATERIAL, ROUND, 54"S/CD	LF	470	$595.00	$279,650
17	430-982-142	MITERED END SECTION, OPTIONAL ROUND, 54" CD	EA	1	$10,000.00	$10,000
18	520-2-1	CURB CONCRETE (MIAMI)	LF	1,500	$45.00	$67,500
19	522-1	CONC SIDEWALK & DRIVEWAYS (4" THICK)	SY	140	$62.60	$8,764
20	570- 1- 6	PERFOMANCE TURF (BAHIA)	SY	8,000	$8.00	$64,000
21	2373	BYPASS PUMPING SYSTEM	DA	22	$2,600.00	$57,200
22	9999	BACKFLOW PREVENTER (LARGE, 60 IN PIPE)	EA	1	$75,000.00	$75,000
						$3,828,634
Total Design Cost with Contingency (15%)						$574,295
Total Construction Cost with Contingency (30%)						$1,148,590
Total Project Cost						**$5,551,519**

* project estimates do not include costs for utility relocations.
* 6 % was used for mobilization costs

Project Name:		**BMP 2 - Seminole Bypass Improvements**	Opinion of Probable Cost City of Seminole Watershed Management Plan March 2024			
Client:		**City of Seminole**				
ITEM	FDOT INDEX NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	PAY ITEM TOTAL
1	101-1	MOBILIZATION	LS	1	Varies	$106,345
2	102-1	MAINTENANCE OF TRAFFIC	DA	45	$2,500.00	$112,500
3	104 11	FLOATING TURBIDITY BARRIER	LF	400	$18.00	$7,200
4	104-13-1	SILT FENCE STAKED (TYPE III)	LF	500	$6.00	$3,000
5	285-711	OPTIONAL BASE, BASE GROUP 11	SY	800	$45.00	$36,000
6	327-70-05	MILLING EXISTING ASPHALT PAVEMENT, 2" AVG DEPTH	SY	800	$5.00	$4,000
7	334-1-13	SUPERPAVE ASPHALTIC CONC, TRAFFIC C	TN	60	$150.00	$9,000
8	400-3-1	CONC CLASS III (CULVERTS) (BOX CULVERT)	CY	449	$1,500.00	$673,750
9	9999	BACKFLOW PREVENTER (SMALL 18 TO 24 IN PIPE)	EA	7	$20,000.00	$140,000
10	2373	BYPASS PUMPING SYSTEM	DA	30	$2,600.00	$78,000
						$1,169,795
Total Design Cost with Contingency (15%)						$175,469
Total Construction Cost with Contingency (30%)						$350,939
Total Project Cost						**$1,696,203**

* project estimates do not include costs for utility relocations.
* 10 % was used for mobilization costs

Project Name:		BMP 3 - 70th Ave Commercial	Opinion of Probable Cost City of Seminole Watershed Management Plan March 2024			
Client:		City of Seminole				
ITEM	FDOT INDEX NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	PAY ITEM TOTAL
1	101-1	MOBILIZATION	LS	1	Varies	$23,487
2	120-1	EXCAVATION REGULAR (PONDS)	CY	1,500	$12.00	$18,000
3	285-711	OPTIONAL BASE, BASE GROUP 11	SY	600	$45.00	$27,000
4	327-70-05	MILLING EXISTING ASPHALT PAVEMENT, 2" AVG DEPTH	SY	600	$5.00	$3,000
5	334-1-13	SUPERPAVE ASPHALTIC CONC, TRAFFIC C	TN	24	$150.00	$3,600
6	400-2-11	CONC CLASS III (DITCH BLOCK WEIRS)	CY	5	$1,100.00	$5,500
7	425-1-903	INLETS (SPECIAL) (J BOT, <10')	EA	2	$7,303.73	$14,607
8	425-2-91	MANHOLE (J-8) (<10')	EA	1	$10,000.00	$10,000
9	430-175-112	PIPE CULVERT,OPTIONAL MATERIAL,ROUND, 12"S/CD	LF	220	$145.00	$31,900
10	430-175-115	PIPE CULVERT, OPT MATERIAL, ROUND, 15"S/CD	LF	190	$500.00	$95,000
11	430-982-123	MITERED END SECTION, OPTIONAL ROUND, 15" CD	EA	1	$1,500.00	$1,500
12	522-1	CONC SIDEWALK & DRIVEWAYS (4" THICK)	SY	140	$62.60	$8,764
13	570- 1- 6	PERFOMANCE TURF (BAHIA)	SY	2,000	$8.00	$16,000
						$258,359
Total Design Cost with Contingency (15%)						$38,754
Total Construction Cost with Contingency (30%)						$77,508
Total Project Cost						**$374,620**

* project estimates do not include costs for utility relocations.
* 10 % was used for mobilization costs

Project Name:		BMP 4 - 112th St North	Opinion of Probable Cost City of Seminole Watershed Management Plan March 2024			
Client:		City of Seminole				
ITEM	FDOT INDEX NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	PAY ITEM TOTAL
1	101-1	MOBILIZATION	LS	1	Varies	$240,230
2	102-1	MAINTENANCE OF TRAFFIC	DA	45	$2,500.00	$112,500
3	104 11	FLOATING TURBIDITY BARRIER	LF	200	$18.00	$3,600
4	104-13-1	SILT FENCE STAKED (TYPE III)	LF	7,500	$6.00	$45,000
5	104-18	INLET PROTECTION SYSTEM	EA	15	$105.00	$1,575
6	285-711	OPTIONAL BASE, BASE GROUP 11	SY	4,889	$45.00	$220,000
7	327-70-05	MILLING EXISTING ASPHALT PAVEMENT, 2" AVG DEPTH	SY	4,889	$5.00	$24,444
8	334-1-13	SUPERPAVE ASPHALTIC CONC, TRAFFIC C	TN	350	$150.00	$52,500
9	400-2-11	CONC CLASS III (RETAINING WALLS)	CY	37	$1,043.39	$38,605
10	400-3-2	CONC CLASS III (ENDWALLS)	CY	18	$1,043.39	$18,781
11	425-1-903	INLETS (SPECIAL) (J BOT, <10')	EA	5	$7,303.73	$36,519
12	425-2-91	MANHOLE (J-8) (<10')	EA	10	$10,000.00	$100,000
13	430-175-118	PIPE CULVERT,OPTIONAL MATERIAL,ROUND, 18"S/CD	LF	400	$130.00	$52,000
14	430-175-124	PIPE CULVERT,OPTIONAL MATERIAL,ROUND, 24"S/CD	LF	55	$160.00	$8,800
15	430-175-130	PIPE CULVERT, OPT MATERIAL, ROUND, 30"S/CD	LF	185	$235.00	$43,475
16	430-175-148	PIPE CULVERT, OPT MATERIAL, ROUND, 48"S/CD	LF	1,240	$500.00	$620,000
17	430-175-154	PIPE CULVERT, OPT MATERIAL, ROUND, 54"S/CD	LF	2,500	$595.00	$1,487,500
18	430-175-160	PIPE CULVERT, OPT MATERIAL, ROUND, 60"S/CD	LF	1,200	$650.00	$780,000
19	430-175-172	PIPE CULVERT, OPT MATERIAL, ROUND, 72"S/CD	LF	70	$1,500.00	$105,000
20	520-2-1	CURB CONCRETE (MIAMI)	LF	500	$45.00	$22,500
21	520-1-10	CONC CURB & GUTTER (TYPE F)	LF	1,000	$83.47	$83,470
22	522-1	CONC SIDEWALK & DRIVEWAYS (4" THICK)	SY	1,111	$62.60	$69,556
23	2373	BYPASS PUMPING SYSTEM	DA	30	$2,600.00	$78,000
24	9999	BAFFLE BOX, NSBB 816, OLDCASTLE UNIT	EA	1	$150,000.00	$150,000
						$4,394,055
Total Design Cost with Contingency (15%)						$659,108
Total Construction Cost with Contingency (30%)						$1,318,216
Total Project Cost						**$6,371,379**

* project estimates do not include costs for utility relocations.
* 6 % was used for mobilization costs

Project Name:	BMP 5 - Walsingham Park	Opinion of Probable Cost City of Seminole Watershed Management Plan March 2024				
Client:	City of Seminole					
ITEM	FDOT INDEX NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	PAY ITEM TOTAL
1	101-1	MOBILIZATION	LS	1	Varies	$231,873
2	102-1	MAINTENANCE OF TRAFFIC	DA	45	$2,500.00	$112,500
3	104 11	FLOATING TURBIDITY BARRIER	LF	350	$18.00	$6,300
4	104-13-1	SILT FENCE STAKED (TYPE III)	LF	8,000	$6.00	$48,000
5	104-18	INLET PROTECTION SYSTEM	EA	15	$105.00	$1,575
6	110 1 1	CLEARING & GRUBBING	AC	2.25	$80,000.00	$180,000
7	120-1	EXCAVATION REGULAR (POND ENLARGEMENT)	CY	16,000	$12.00	$192,000
8	120-5	CHANNEL EXCAVATION (CHANNEL WIDENING)	CY	5,500	$45.00	$247,500
9	285-711	OPTIONAL BASE, BASE GROUP 11	SY	3,667	$45.00	$165,000
10	327-70-05	MILLING EXISTING ASPHALT PAVEMENT, 2" AVG DEPTH	SY	3,667	$5.00	$18,333
11	334-1-13	SUPERPAVE ASPHALTIC CONC, TRAFFIC C	TN	266	$150.00	$39,875
12	400-2-11	CONC CLASS III (WEIR EXPANSION)	CY	62	$1,100.00	$68,444
13	400-3-2	CONC CLASS III (ENDWALLS)	CY	18	$1,043.39	$18,781
14	425-1-903	INLETS (SPECIAL) (J BOT, <10')	EA	4	$7,303.73	$29,215
15	425-2-91	MANHOLE (J-8) (<10')	EA	3	$10,000.00	$30,000
16	430-175-130	PIPE CULVERT, OPT MATERIAL, ROUND, 30"S/CD	LF	430	$235.00	$101,050
17	430-175-136	PIPE CULVERT, OPT MATERIAL, ROUND, 36"S/CD	LF	445	$280.00	$124,600
18	430-175-142	PIPE CULVERT, OPT MATERIAL, ROUND, 42"S/CD	LF	200	$420.00	$84,000
19	430-175-148	PIPE CULVERT, OPT MATERIAL, ROUND, 48"S/CD	LF	500	$500.00	$250,000
20	430-175-154	PIPE CULVERT, OPT MATERIAL, ROUND, 54"S/CD	LF	1,080	$595.00	$642,600
21	430-175-160	PIPE CULVERT, OPT MATERIAL, ROUND, 60"S/CD	LF	310	$650.00	$201,500
22	430-175-166	PIPE CULVERT, OPT MATERIAL, ROUND, 66"S/CD	LF	500	$1,100.00	$550,000
23	430-175-172	PIPE CULVERT, OPT MATERIAL, ROUND, 72"S/CD	LF	65	$1,500.00	$97,500
24	430-185-136	PIPE CULVERT,OPTIONAL MATERIAL,ROUND, JACK & BORE, 36", STORM AND CROSS DRAIN	LF	150	$3,000.00	$450,000
25	2292	CURB CONCRETE (MIAMI)	LF	2,500	$45.00	$112,500
26	522-1	CONC SIDEWALK & DRIVEWAYS (4" THICK)	SY	556	$62.60	$34,778
27	2373	BYPASS PUMPING SYSTEM	DA	23	$2,600.00	$58,500
						$4,096,425
Total Design Cost with Contingency (15%)						$614,464
Total Construction Cost with Contingency (30%)						$1,228,927
Total Project Cost						**$5,939,816**

* project estimates do not include costs for utility relocations.
* 6 % was used for mobilization costs

Project Name:	**BMP 7 - Oaks of Seminole Condominium**					**Opinion of Probable Cost** City of Seminole Watershed Management Plan March 2024
Client:	**City of Seminole**					
ITEM	FDOT INDEX NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	PAY ITEM TOTAL
1	101-1	MOBILIZATION	LS	1	Varies	$36,705
2	102-1	MAINTENANCE OF TRAFFIC	DA	20	$2,500.00	$50,000
3	110-1-1	CLEARING & GRUBBING	AC	0.75	$80,000.00	$60,000
4	110-23	TREE REMOVAL	EA	10	$700.00	$7,000
5	120-1	EXCAVATION REGULAR (PONDS)	CY	8,100	$12.00	$97,200
6	425-1-903	INLETS (SPECIAL) (J BOT, <10')	EA	1	$7,303.73	$7,304
7	425-2-91	MANHOLE (J-8) (<10')	EA	1	$10,000.00	$10,000
8	430-175-118	PIPE CULVERT,OPTIONAL MATERIAL,ROUND, 18"S/CD	LF	215	$130.00	$27,950
9	430-175-124	PIPE CULVERT,OPTIONAL MATERIAL,ROUND, 24"S/CD	LF	235	$160.00	$37,600
10	570- 1- 6	PERFOMANCE TURF (BAHIA)	SY	5,500	$8.00	$44,000
11	2373	BYPASS PUMPING SYSTEM	DA	10	$2,600.00	$26,000
12	9999	BACKFLOW PREVENTER (SMALL 18 TO 24 IN PIPE)	EA	1	$20,000.00	$20,000
						$423,759
Total Design Cost with Contingency (15%)						$63,564
Total Construction Cost with Contingency (30%)						$127,128
Total Project Cost						**$614,451**

* project estimates do not include costs for utility relocations.
* 10 % was used for mobilization costs

13 APPENDIX D – BMP CONCEPT FIGURES

***Exhibit 1**: BMP 1 Pearl Lake Area*

***Exhibit 2**: BMP 2 Seminole Bypass Improvements*

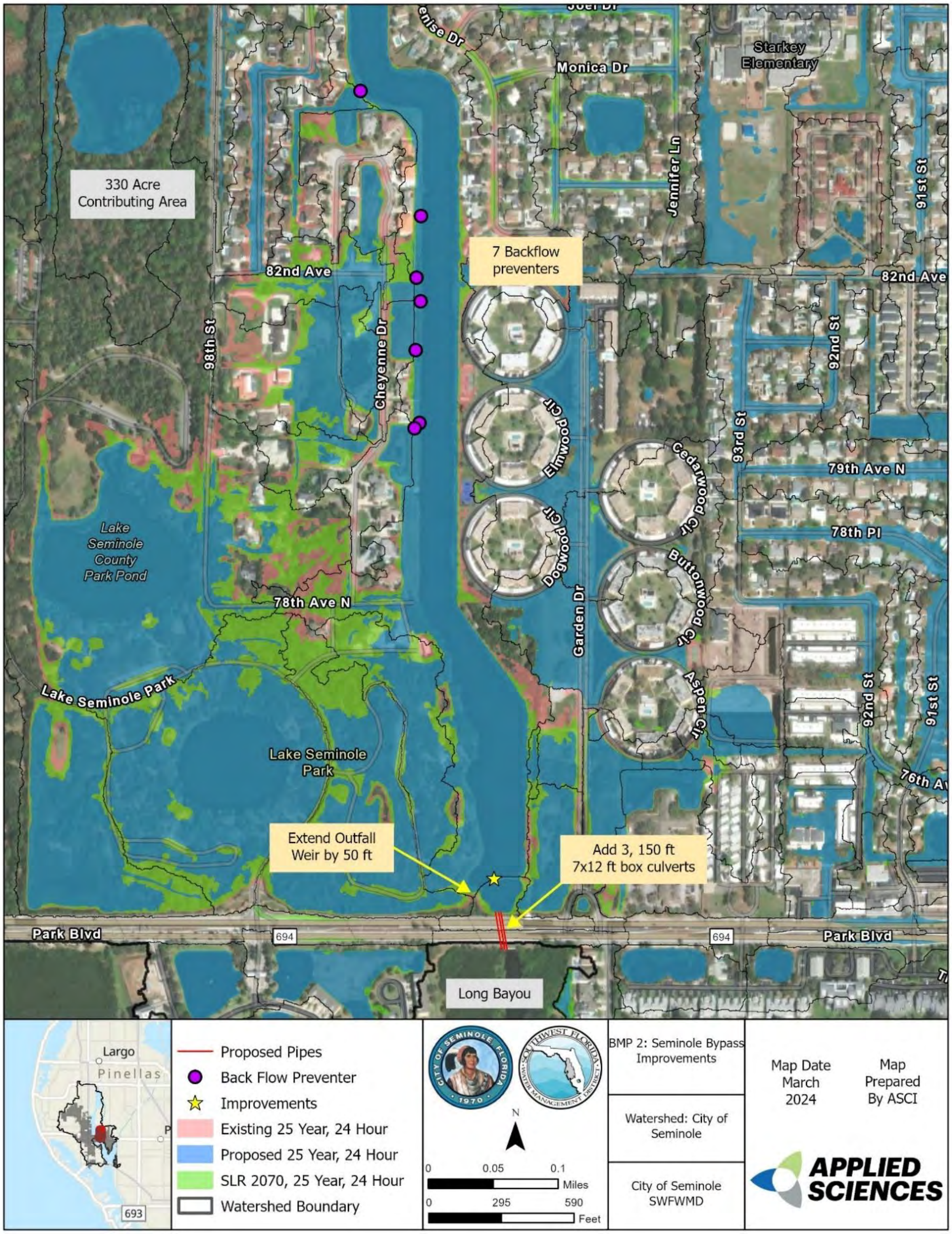


***Exhibit 3**: BMP 3 70th Ave Commercial*

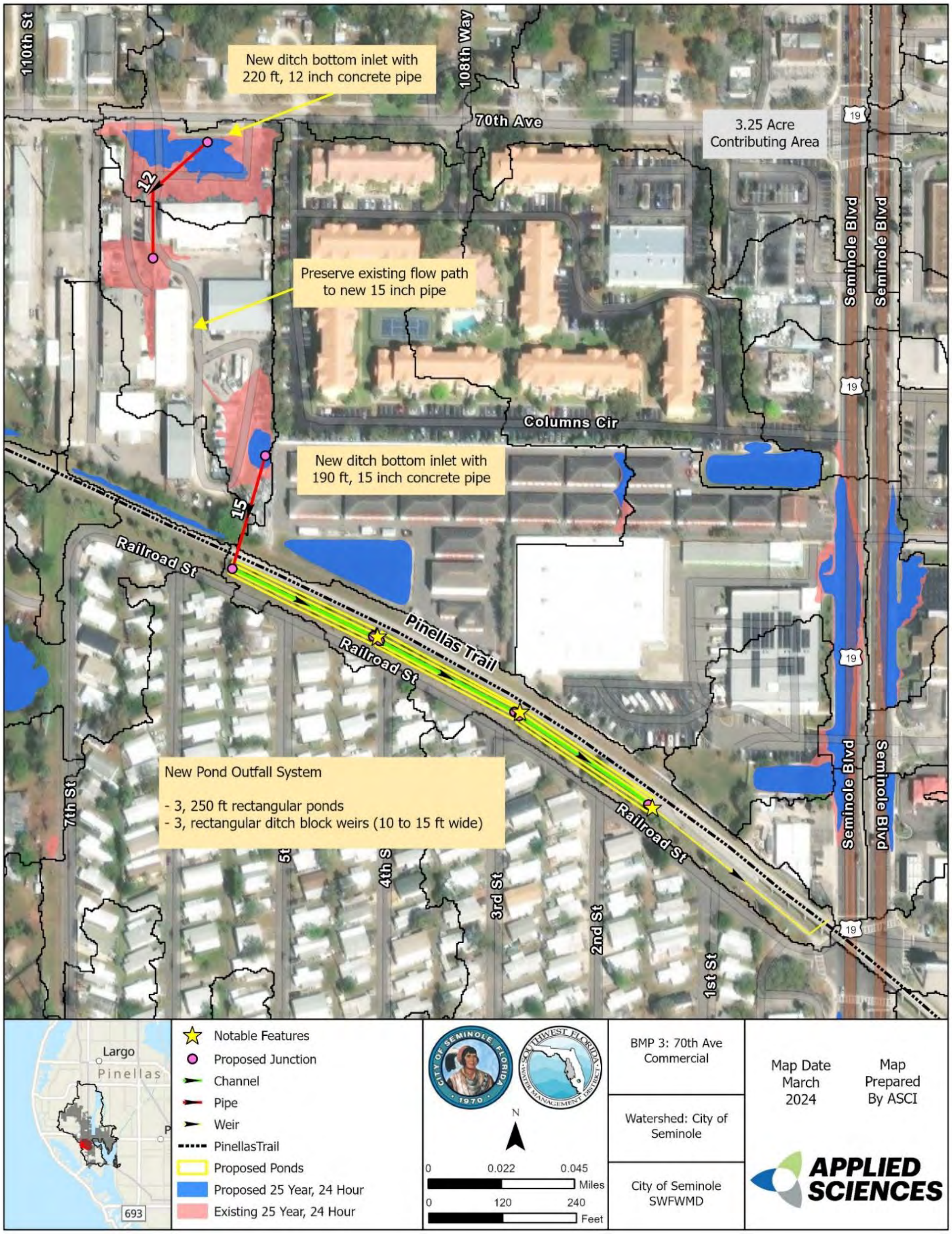


***Exhibit 4**: BMP 4 112th St North*

***Exhibit 5**: BMP 5 Walsingham Park*

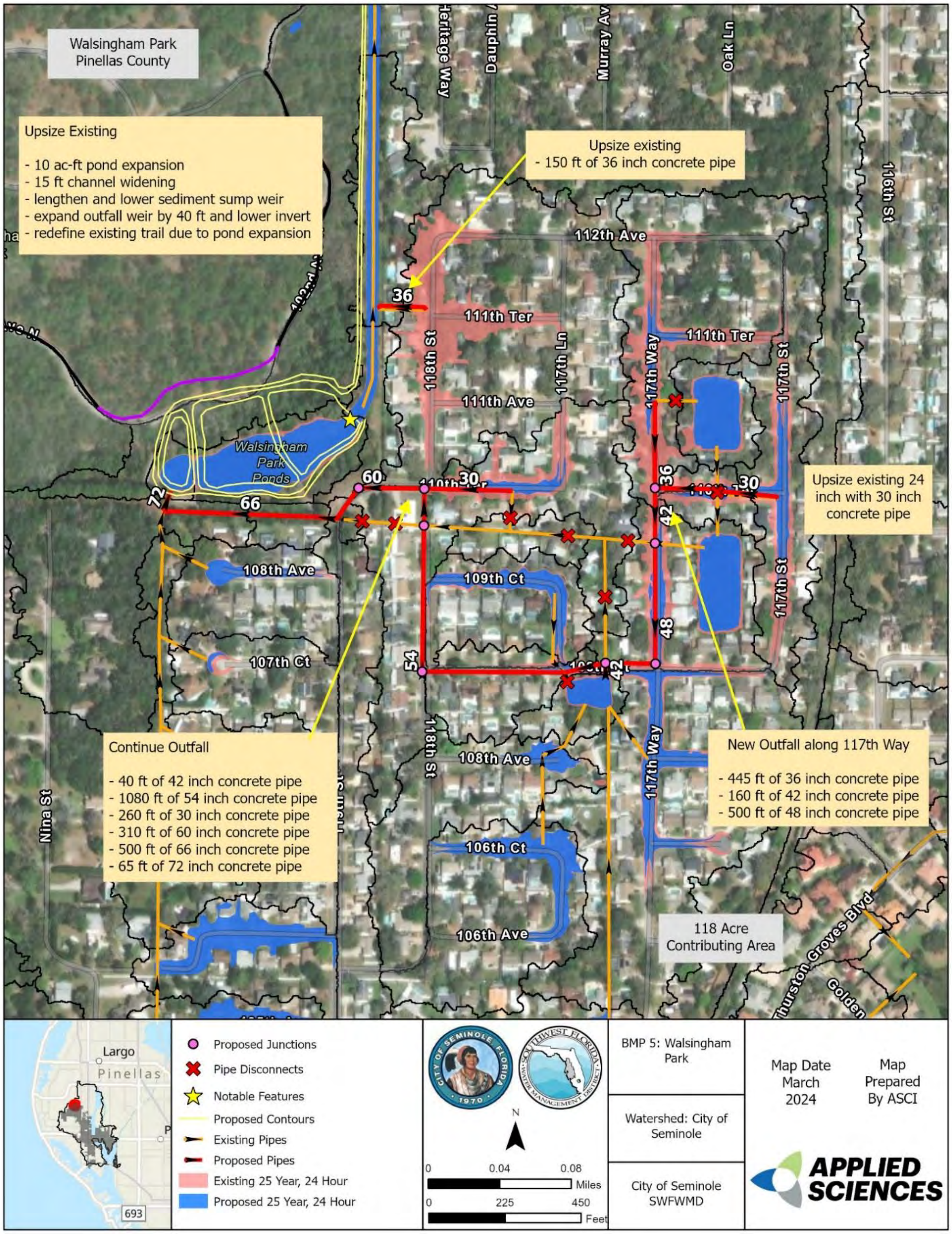


***Exhibit 6**: BMP 6 Seminole Lake Country Club*

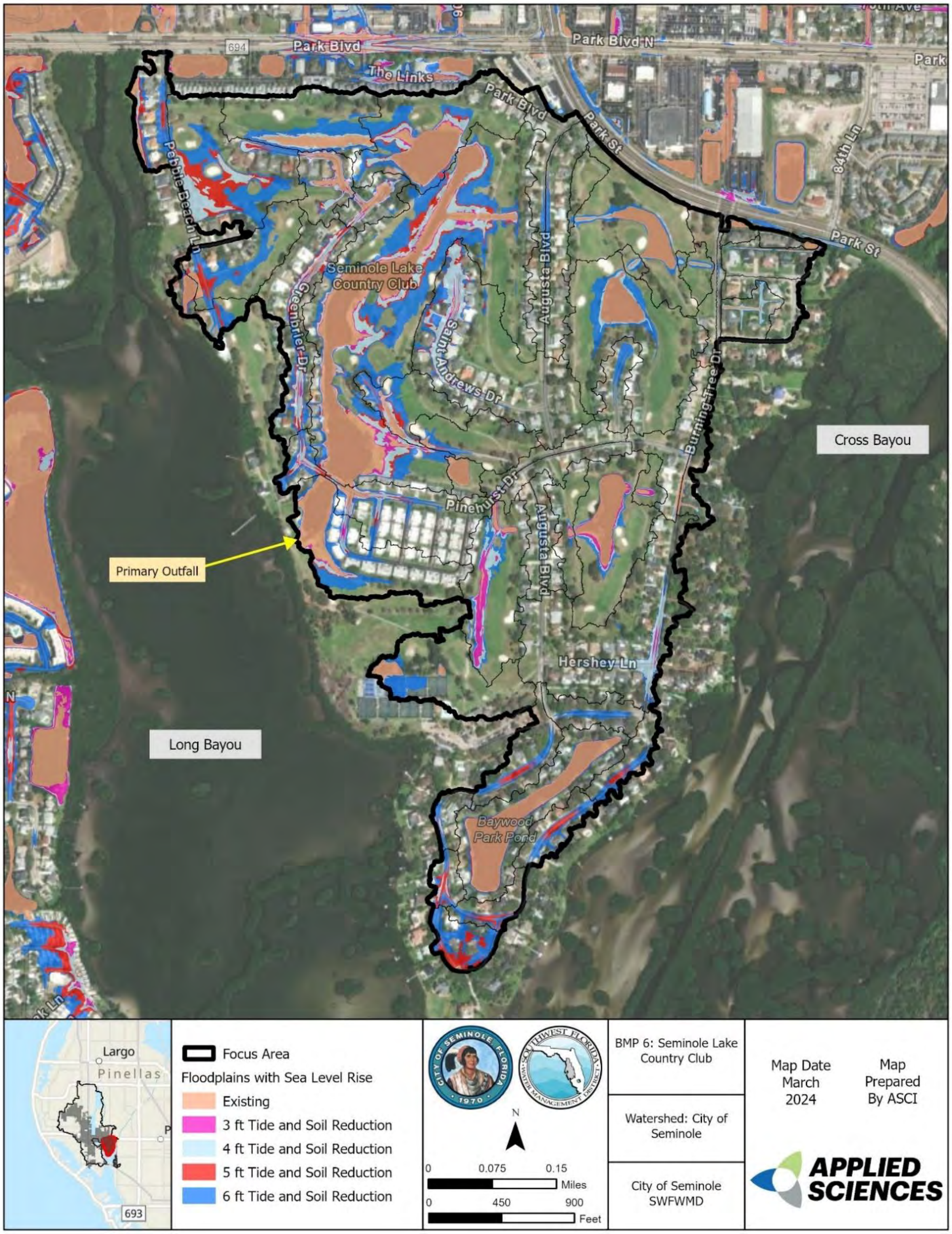
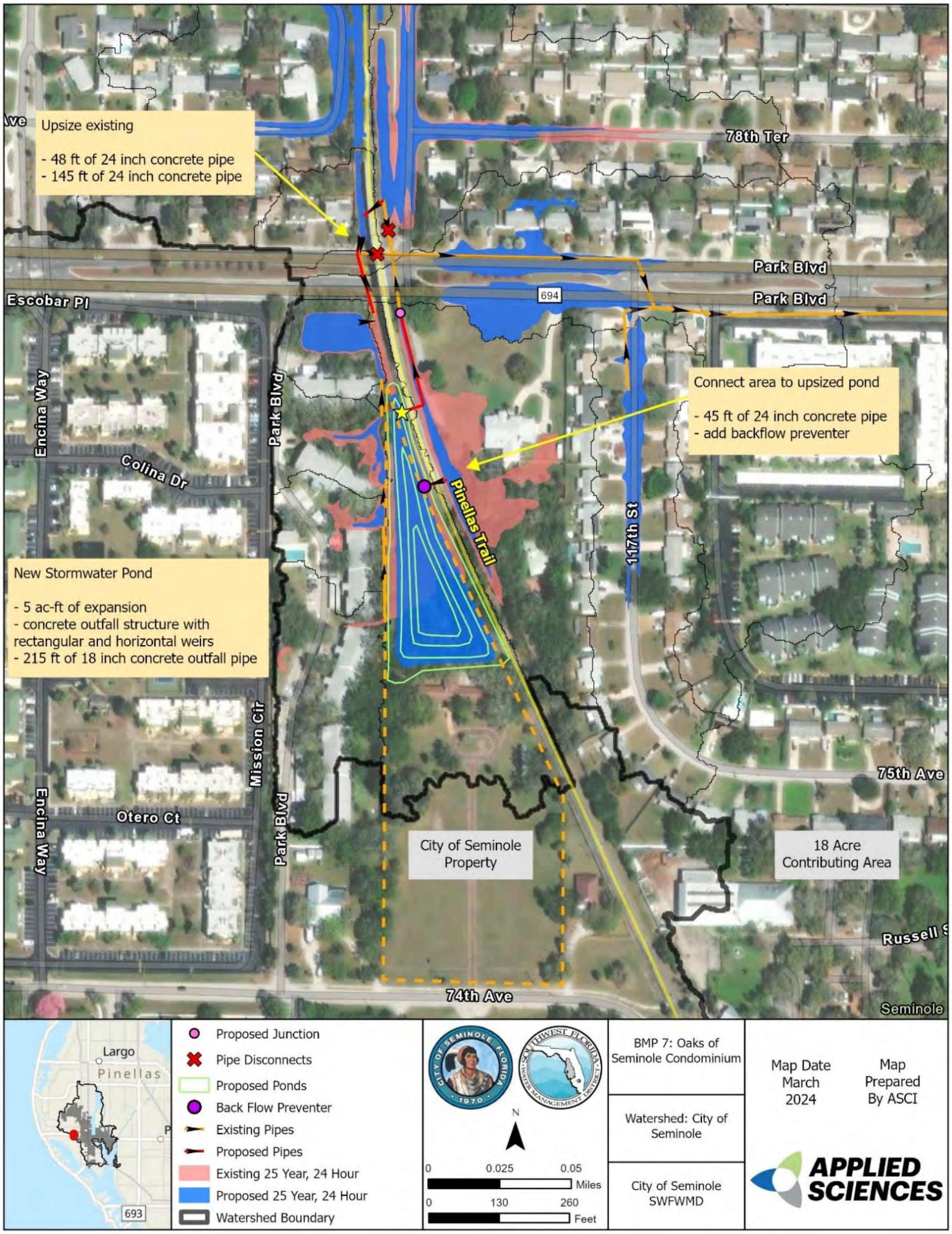


***Exhibit 7**: BMP 7 Oaks of Seminole Condominium*



14 APPENDIX E – BMP MODEL UPDATE REFERENCES

BMP 1 - Pearl Lake Area

Nodes

Name	Comment	BMP_Notes
NZA-0040	Proposed BMP Component, added junction node with minimal storage	construct manhole junction for newly defined pipe system
NZA-0030	Proposed BMP Component, added junction node with minimal storage	construct manhole junction for newly defined pipe system

Links

Name	Comment	BMP_Notes	Type
L-0210P	Proposed BMP Component, new pipe	upsize existing pipe with 569 feet of 48 x 48 inch RCP	PIPE
L-0100P	Proposed BMP Component, new pipe	upsize existing pipe with 30 feet of 24 x 24 inch RCP	PIPE
L-0180P	Proposed BMP Component, new pipe	upsize existing pipe with 27 feet of 60 x 96 inch concrete box culvert	PIPE
L-0090P	Proposed BMP Component, new pipe	upsize existing pipe with 240 feet of 24 x 24 inch RCP	PIPE
L-0040P	Proposed BMP Component, new pipe	upsize existing pipe with 24 feet of 48 x 48 inch RCP	PIPE
L-0190P	Proposed BMP Component, new pipe	upsize existing pipe with 22 feet of 60 x 96 inch concrete box culvert	PIPE
L-0200P	Proposed BMP Component, new pipe	upsize existing pipe with 22 feet of 60 x 96 inch concrete box culvert	PIPE
L-0030P	Proposed BMP Component, new pipe	upsize existing pipe with 20 feet of 48 x 48 inch RCP	PIPE
L-0070P	Proposed BMP Component, new pipe	upsize existing pipe with 125 feet of 24 x 24 inch RCP	PIPE
L-0160P	Proposed BMP Component, new pipe	replace open ditch with 80 feet of 60 x 96 inch concrete box culvert	PIPE
L-0120P	Proposed BMP Component, new pipe	replace open ditch with 400 feet of 60 x 96 inch concrete box culvert	PIPE
L-0170P	Proposed BMP Component, new pipe	replace open ditch with 390 feet of 60 x 96 inch concrete box culvert	PIPE
L-0140P	Proposed BMP Component, new pipe	replace open ditch with 285 feet of 60 x 96 inch concrete box culvert	PIPE
L-0150P	Proposed BMP Component, new pipe	replace open ditch with 210 feet of 60 x 96 inch concrete box culvert	PIPE
L-0130P	Proposed BMP Component, new pipe	replace existing feature with 64 feet of 60 x 96 inch concrete box culvert	PIPE
A16P0080	Proposed BMP Component, new pipe	replace existing feature with 48 feet of 60 x 96 inch concrete box culvert	PIPE
A16P0100	Proposed BMP Component, new pipe	replace existing feature with 14 feet of 60 x 96 inch concrete box culvert	PIPE
A16P0130_1	Proposed BMP Component, updated to positive flow only	install backflow preventer on existing pipe	PIPE
L-0050P	Proposed BMP Component, new pipe	construct new pipe, 545 feet of 48 x 48 inch RCP	PIPE
L-0060P	Proposed BMP Component, new pipe	construct new pipe, 300 feet of 54 x 54 inch RCP	PIPE
L-0110P	Proposed BMP Component, new pipe	construct new pipe, 160 feet of 54 x 54 inch RCP	PIPE
NewPipe_BMP1a	Proposed BMP Component, new pipe	construct new feature, 815 feet of 60 x 96 inch concrete box culvert	PIPE

BMP 2 - Seminole Bypass Improvements

Nodes

Name	Comment	BMP_Notes
None		

Links

Name	Comment	BMP_Notes	Type
A48P0022	Proposed BMP Component, updated to positive flow only	Install backflow preventer	PIPE
A47P0021_1	Proposed BMP Component, updated to positive flow only	Install backflow preventer	PIPE
A48D0021	Proposed BMP Component, updated to positive flow only	Install backflow preventer	DROP STRUCTURE
A47D0020	Proposed BMP Component, updated to positive flow only	Install backflow preventer	DROP STRUCTURE
A48D0020	Proposed BMP Component, updated to positive flow only	Install backflow preventer	DROP STRUCTURE
A24P0142	Proposed BMP Component, updated to positive flow only	Install backflow preventer	PIPE
A49D0020	Proposed BMP Component, updated to positive flow only	Install backflow preventer	DROP STRUCTURE
A24SW0140	Proposed BMP Component, modification of structural weir	Increase structural outfall weir by 50 feet in length	WEIR
A21P0112	Proposed BMP Component, increased number of pipes	Add 3, 150 foot long, 7 x 12 foot box culverts	PIPE

BMP 3 - 70th Ave Commercial

Nodes

Name	Comment	BMP_Notes	
NZA-0090	Proposed BMP Component, added junction node with minimal storage	junction node added to represent manhole connection	
NZA-0080	Proposed BMP Component, added junction node with minimal storage	junction node added to represent manhole connection	
NZA-0030	Proposed BMP Component, added junction node with minimal storage	junction node added to represent connection to weir feature	
NZA-0050	Proposed BMP Component, added junction node with minimal storage	junction node added to represent connection to weir feature	
NZA-0070	Proposed BMP Component, added junction node with minimal storage	junction node added to represent connection to weir feature	
NZA-0060	Proposed BMP Component, added junction node with minimal storage	junction node added to represent connection to channel feature	
NZA-0010	Proposed BMP Component, added junction node with minimal storage	junction node added to represent connection to channel feature	
NZA-0040	Proposed BMP Component, added junction node with minimal storage	junction node added to represent connection to channel feature	

Links

Name	Comment	BMP_Notes	Type
L-0060C	Proposed BMP Component, new channel	construction of 250 foot long rectangular pond, modeled as channel features	CHANNEL
L-0070C	Proposed BMP Component, new channel	construction of 250 foot long rectangular pond, modeled as channel features	CHANNEL
L-0050C	Proposed BMP Component, new channel	construction of 250 foot long rectangular pond, modeled as channel features	CHANNEL
L-0110W	Proposed BMP Component, new weir	construct new weir feature associated with ditch bottom inlet	WEIR
L-0120W	Proposed BMP Component, new weir	construct new weir feature associated with ditch bottom inlet	WEIR
L-0020P	Proposed BMP Component, new pipe	construct new pipe, approximately 220 feet of 12 x 12 inch RCP	PIPE
L-0040P	Proposed BMP Component, new pipe	construct new pipe, approximately 220 feet of 12 x 12 inch RCP	PIPE
L-0080W	Proposed BMP Component, new weir	construct 15 foot concrete rectangular weir, ditch block feature	WEIR
L-0090W	Proposed BMP Component, new weir	construct 10 foot concrete rectangular weir, ditch block feature	WEIR

BMP 4 - 112th St North

Nodes

Name	Comment	BMP_Notes	
NZA-0020	Proposed BMP Component, added junction node with minimal storage	addition of junction node to represent manhole connection	

Links

Name	Comment	BMP_Notes	Type
L-0050P	Proposed BMP Component, upgraded pipe	upsize and reroute existing pipe, 215 feet of 48 x 48 inch RCP	PIPE
L-0070P	Proposed BMP Component, upgraded pipe	upsize and reroute existing pipe, 200 feet of 48 x 48 inch RCP	PIPE
L-0060P	Proposed BMP Component, upgraded pipe	upsize and reroute existing pipe, 195 feet of 48 x 48 inch RCP	PIPE
L-0040P	Proposed BMP Component, upgraded pipe	upsize and reroute existing pipe, 170 feet of 48 x 48 inch RCP	PIPE
L-0080P	Proposed BMP Component, new pipe	upsize and reroute existing pipe, 150 feet of 48 x 48 inch RCP	PIPE
L-0030P	Proposed BMP Component, upgraded pipe	replace and reroute existing pipe, 189 feet of 30 x 30 inch RCP	PIPE
L-0020P	Proposed BMP Component, new pipe	construct new pipe, approximately 485 feet of 48 x 48 inch RCP	PIPE
L-0100P	Proposed BMP Component, new pipe	construct new pipe, 55 feet of 24 x 24 inch RCP	PIPE
L-0170P	Proposed BMP Component, new pipe	construct new pipe, 500 feet of 18 x 18 inch RCP	PIPE
L-0090P	Proposed BMP Component, new pipe	construct new pipe, 1400 feet of 54 x 54 inch RCP	PIPE
L-0110P	Proposed BMP Component, new pipe	construct new pipe, 1100 feet of 54 x 54 inch RCP	PIPE
L-0140P	Proposed BMP Component, new pipe	construct and or replace existing pipe, 75 feet of 60 x 60 inch RCP	PIPE
L-0150P	Proposed BMP Component, new pipe	construct and or replace existing pipe, 70 feet of 60 x 60 inch RCP	PIPE
L-0120P	Proposed BMP Component, new pipe	construct and or replace existing pipe, 600 feet of 60 x 60 inch RCP	PIPE
L-0160P	Proposed BMP Component, new pipe	construct and or replace existing pipe, 55 feet of 72 x 72 inch RCP	PIPE
L-0130P	Proposed BMP Component, new pipe	construct and or replace existing pipe, 545 feet of 60 x 60 inch RCP	PIPE

BMP 5 - Walsingham Park

Nodes

Name	Comment	BMP_Notes
NZA-0010	Proposed BMP Component, added junction node with minimal storage	addition of junction node for manhole connection
NZA-0050	Proposed BMP Component, added junction node with minimal storage	addition of junction node for manhole connection
NZA-0020	Proposed BMP Component, added junction node with minimal storage	addition of junction node for manhole connection
NZA-0060	Proposed BMP Component, added junction node with minimal storage	addition of junction node for manhole connection
NZA-0030	Proposed BMP Component, added junction node with minimal storage	addition of junction node for manhole connection
D18N0110	Proposed BMP Component, updated storage node	increased storage associated with model node due to pond expansion; updated manual basin details as well
D18N0100	Proposed BMP Component, updated storage node	increased storage associated with model node due to pond expansion; updated manual basin details as well

Links

Name	Comment	BMP_Notes	Type
L-0180P	Proposed BMP Component, new or upgraded pipe	upsize existing pipe, 175 feet of 30 x 30 inch RCP	PIPE
L-0020P	Proposed BMP Component, new or upgraded pipe	upsize existing pipe with 138 feet of 36 x 36 inch RCP	PIPE
L-0060P	Proposed BMP Component, new or upgraded pipe	terminate existing pipe at new manhole junction	PIPE
L-0160P	Proposed BMP Component, new or upgraded pipe	terminate existing pipe at new manhole junction	PIPE
L-0070P	Proposed BMP Component, new or upgraded pipe	terminate existing pipe at manhole junction	PIPE
L-0140P	Proposed BMP Component, new or upgraded pipe	replace existing pipe, 66 feet of 72 x 72 inch RCP	PIPE
L-0130P	Proposed BMP Component, new or upgraded pipe	replace existing pipe, 450 feet of 66 x 66 inch RCP	PIPE
L-0120P	Proposed BMP Component, new or upgraded pipe	replace existing pipe, 45 feet of 66 x 66 inch RCP	PIPE
D18O0110D	Proposed BMP Component, modification of structural weir	increased width of structural weir by 40 feet and lowered invert	WEIR
D18O0110A	Proposed BMP Component, modification of weir	increased length of sediment sump overland weir due to pond (	WEIR
D18C0120	Proposed BMP Component, modification of existing channel	increase existing channel width by 15 feet	CHANNEL
D18C0130	Proposed BMP Component, modification of existing channel	increase existing channel width by 15 feet	CHANNEL
L-0090P	Proposed BMP Component, new or upgraded pipe	construct new pipe, 950 feet of 54 x 54 inch RCP	PIPE
L-0050P	Proposed BMP Component, new or upgraded pipe	construct new pipe, 500 feet of 48 x 48 inch RCP	PIPE
L-0110P	Proposed BMP Component, new or upgraded pipe	construct new pipe, 300 feet of 60 x 60 inch RCP	PIPE
L-0030P	Proposed BMP Component, new or upgraded pipe	construct new pipe, 260 feet of 36 x 36 inch RCP	PIPE
L-0100P	Proposed BMP Component, new or upgraded pipe	construct new pipe, 250 feet of 30 x 30 inch RCP	PIPE
L-0150P	Proposed BMP Component, new or upgraded pipe	construct new pipe, 190 feet of 36 x 36 inch RCP	PIPE
L-0040P	Proposed BMP Component, new or upgraded pipe	construct new pipe, 150 feet of 42 x 42 inch RCP	PIPE
L-0080P	Proposed BMP Component, new or upgraded pipe	construct new pipe, 120 feet of 54 x 54 inch RCP	PIPE
L-0170P	Proposed BMP Component, new or upgraded pipe	construct new pipe, 100 feet of 54 x 54 inch RCP	PIPE

BMP 7 - Oaks of Seminole Condominium

Nodes

Name	Comment	BMP_Notes
C07N0020	Proposed BMP Component, updated storage node	increased storage associated with model node due to pond expansion
NZA-0010	Proposed BMP Component, added junction node with minimal storage	additional junction node for manhole connectivity

Links

Name	Comment	BMP_Notes	Type
C07P0020	Proposed BMP Component, new or upgraded pipe	upsize and reroute existing feature with 125 feet of 24 x 24 inch RCP	PIPE
L-0030DS	Proposed BMP Component, new drop structure	new drop structure with 18 inch RCP and weir components	DROP STRUCTURE
L-0020P	Proposed BMP Component, new pipe set to positive flow only	construction of new pipe feature, 50 feet of 24 x 24 inch RCP, install backflow preventer	PIPE
L-0010P	Proposed BMP Component, new or upgraded pipe	construction of new pipe feature, 50 feet of 24 x 24 inch RCP	PIPE