Surface Water Management
Master Plan Update
Following Hurricane Ian (2022)

Prepared For:

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EXECUTIVE SUMMARY

Since incorporation, the City has dramatically improved the rainfall-based stormwater management system island-wide. Hurricanes in 2022 and 2024 provided a recent reminder that most of the island is low and vulnerable to storm surge, which is a flooding event that is independent of the conveyance capacity of the interior surface water management system. Topographic maps of the island (see **Exhibit 1** and **Exhibit 2**) show that most of the island is below elevation 4 feet North American Vertical Datum of 1988 (NAVD 88) and developed areas generally range from 4 feet to 8 feet NAVD 88. After Hurricane Ian, USGS recorded water levels which varied across the island from 8 feet to 13 feet NAVD 88.

Sanibel contains two large freshwater basins which outfall to Pine Island Sound to the north via water control structures. Each water control structure also includes operable gates which can be opened to allow additional flow out of the basins upstream, in accordance with the City's 1994 Weir Control Policy. The surface water management system for Sanibel has a dual mandate of environmental protection and flood mitigation, and the potential for sea level rise over the City's next 50 years adds another layer of complexity to management of the system.

When Hurricane Ian made landfall in late September 2022 it caused the island to be overtopped with storm surge and led to saltwater contamination of freshwater ponds and wetlands. In the months following Hurricane Ian, there was significant vegetation loss and a general sense amongst residents that the island's hydrology changed.

One of the goals of this report is to review current and historical data to identify whether changes have occurred to the island's internal hydraulics or hydrology. Also included is a review of sea level rise projections and how the island's stormwater management system may be impacted. Finally, extensive field inspection efforts have been performed to inspect the City's drainage conveyance elements for sedimentation and refine the City's stormwater management mapping.

Water level monitoring sensors were installed in 14 locations throughout the island in 2024. These installations supplement two existing monitoring stations and USGS well L-1403. The east and west basins generally act as a level pool and runoff is efficiently conveyed to the Sanibel River, as designed. Water levels across the west basin are nearly identical. West Gulf Drive was identified as one of the "flood prone areas" which do exist across the island, but overall, the observed data indicates that Sanibel's primary stormwater management infrastructure is operating as intended.

The system is still operating similarly to observations in 1953. Little to no deep percolation is occurring, which is consistent with *The Sanibel Report* (1976). Deep percolation losses from the interior freshwater basins to the ocean have always been considered negligible on Sanibel. It is recommended that the 1988 map of maximum water levels in 1977 continue to be utilized as a guide for new development on Sanibel. Again, data and observations provide strong reassurance that the primary stormwater management infrastructure in the west basin of Sanibel is operating well.

Long-term average NDVI values for Sanibel before and after Hurricane Ian in 2022 are shown, and the hurricane clearly had a tremendous impact on plant life. The initial drop in NDVI just after Ian was about 0.3. Throughout 2023 and 2024, NDVI increased and began to approach pre-Ian levels, but this recovery was reversed in the aftermath of hurricanes Helene and Milton in 2024. However, the island's vegetation is quickly rebounding and appears to be on track to return to pre-Helene levels this year.

Most of the water leaving the interior basins on Sanibel has historically done so through evapotranspiration, a process inherently tied to plants. The expectation was that following Hurricane Ian and the associated vegetation changes, water levels would decline more slowly than before the hurricane due to a reduction in ET caused by plant stress. However, this could not be independently verified using the available data, and it seems unlikely that Hurricane Ian has caused any permanent changes to water levels on the island.

Sanibel's water control structures for the interior freshwater basins include sluice gates that can be opened to allow additional flow out of the basins under certain conditions, as outlined in the City's Weir Control Policy adopted in 1994 (Policy). The Policy allows the gates to be opened under any one of four conditions, and the stated objective of the Policy is "to attempt to retain as much fresh surface water on the island as possible … for the environmental benefit of the island's Interior Wetlands System, so long as developed areas are not adversely impacted." The interior wetlands serve as freshwater reservoirs for the island, helping to conserve water by mitigating saltwater intrusion, recharging the underground freshwater lens, reducing mosquito populations, and reducing exotic plant species that outcompete native vegetation. Therefore, this Policy should be continued for as long as possible when there is the presence of freshwater in the west basin.

However, it is recommended that the City expedites the removal of brackish water from the basins. The minimum water level of freshwater inside the basins should be at least six inches higher than mean sea level. If this does not happen, the freshwater lens under Sanibel is at risk of being compromised. Sea level fluctuates during the year and was as high as 1 foot NAVD 88 in September 2024. Careful coordination should be conducted with the Lee County Mosquito Control District if drastic water level fluctuations are occurring within the basins so that mosquito populations do not become overwhelming.

An additional 820 culverts and 2,220 swales were added to the City's records. An updated **Drainage Features Map Book** includes these features. Field inspection efforts found sedimentation issues at 658 drainage structures, inside 19,400 linear feet of culverts, and 24,200 linear feet of roadside swales.

It is notable that five of the highest ten records at the Fort Myers tide gauge have occurred during the past three wet seasons. **Exhibit 6** shows that minimal flooding occurs in developed areas on Sanibel during the 2-year storm surge event. This report recommends a minimum road elevation of 4.3 feet NAVD 88 for all new roadways. Based on the Intermediate-High curve, significant road base failure is expected for up to 7% of roadways by 2050. In the Intermediate-Low scenario, all roads would be protected if raised to a minimum elevation of 4.3 feet NAVD 88. The Intermediate-High projection shows the 100-year storm today will have a 25-year frequency in 2070.

Regular overtopping of the crest of both weirs has already begun. Measurements clearly indicate that saltwater is regularly entering both basins, though it has historically been flushed out by rainwater shortly thereafter. Since 2022, conductivity levels have been consistently above pre-hurricane levels, showing how long it takes the interior basins to recover to freshwater conditions following such a surge event. There is ongoing flushing of the basin due to rainfall but also likely ongoing saltwater intrusion due to subsequent high tides and storm events. After over two years, the basins still have not recovered to the freshwater range and it remains to be seen how long they will take to return. Adding a backflow prevention flap gate at Tarpon Bay Weir and increasing the height of the existing flap gate at Beach Road Weir would be beneficial in reducing saltwater intrusion into the east basin from monthly high tides and minor storm surge events.

SECTION 1 – INTRODUCTION

Sanibel is a barrier island located on Florida's Gulf Coast in Lee County, near the mouth of the Caloosahatchee River. Since its incorporation in 1974, the City of Sanibel (City) has successfully prioritized environmental preservation and regulated development to coexist with nature (Sanibel 2005 Comprehensive Floodplain Management Plan). As a result, two-thirds of the island is protected as conservation land, including a valuable interior freshwater wetlands ecosystem. As the City recently celebrated its 50th anniversary, this update of the surface water management master plan will serve as a guide for the City's next 50 years by establishing long-range strategies focused on flood mitigation, resiliency, and adaptation to sea level rise.

> *Sanibel's surface water management system is designed to retain freshwater whenever possible. The goal is not for surface water to drain out – instead, the island's wetlands are allowed to fill up until they overflow into the ocean. Draining too much freshwater from the wetlands would cause saltwater intrusion and harm existing freshwater ecosystems.*

Flooding is a weather-related natural disaster typically caused by heavy rainfall (also termed riverine flooding), tropical storm surge, inadequate drainage, or a combination of these factors. Since incorporation, the City has dramatically improved the rainfall-based stormwater management system island-wide. Steps taken include rebuilding water control structures, replacing undersized culverts, and updating the land development code. Comparing recent accounts with those from the 1970s shows that the depth and duration of rainfall-based flooding has greatly improved over the past 50 years.

Hurricanes in 2022 and 2024 provided a recent reminder that most of the island is low and vulnerable to storm surge, which is a flooding event that is independent of the conveyance capacity of the interior surface water management system. Topographic maps of the island (see **Exhibit 1** and **Exhibit 2**) show that most of the island is below elevation 4 feet North American Vertical Datum of 1988 (NAVD 88) and developed areas generally range from 4 feet to 8 feet NAVD 88. The 2022 Hurricane Ian Flood Event Mapping by USGS recorded water levels which varied across the island from 8 feet to 13 feet NAVD 88. Peak water levels recorded at the National Oceanic and Atmospheric Administration (NOAA) Tide Station 8725520 in Fort Myers were 5.4 feet NAVD

88 for Hurricane Helene and 5.5 feet NAVD 88 for Hurricane Milton. Over the course of Sanibel's history, hurricane storm surge has wholly inundated the island with saltwater multiple times, though these events have been separated by prolonged periods of relative calm (*The Sanibel Report*, 1976).

Sanibel contains two large freshwater basins – the 2,020-acre Sanibel River West Basin and the 1,240-acre Sanibel River East Basin. They are 50% freshwater wetlands by area. Both basins are verified as impaired by the State of Florida due to high nutrient levels and low dissolved oxygen levels, and each has been assigned a Total Maximum Daily Load (TMDL) for these pollutants. The City is responsible for managing water quality on Sanibel, and the City's impaired waterbody is also its primary stormwater system, so managing not only stormwater quantity but also quality is necessary. The two basins are separated by Tarpon Bay Road and serve as freshwater reservoirs for the island. The surrounding roads serve as the rims of the reservoirs, and stormwater runoff generally flows west to east within each basin. Each basin outfalls to Pine Island Sound to the north via water control structures. Tarpon Bay Weir is the primary outfall of the west basin and has a crest elevation of 2.0 feet NAVD 88. The east basin outfalls through Beach Road Weir which has a weir crest elevation of 1.5 feet NAVD 88 as well as a one-foot flap gate to prevent backflow from surge events up to 2.5 feet NAVD 88. An internal weir, Tarpon Bay Road Weir, creates a hydraulic connection between the two basins and has a weir crest elevation of 2.3 feet NAVD 88. Each water control structure also includes operable gates which can be opened to allow additional flow out of the upstream basins, in accordance with the City's 1994 Weir Control Policy. The primary limitation to flow out of the gates when opened is the level of the sea, as there are times when high tides or storm surges do not allow flow out of the freshwater basins.

The surface water management system for Sanibel has a dual mandate of environmental protection and flood mitigation. The 1953 report *The Water Table on Sanibel Island* stated that "the aim of water management on such an island [as Sanibel] should be to maintain as high a water table as is consistent with land usage while at the same time providing for the quick escape of excess water." This is a delicate balance for any stormwater management system but is particularly challenging on Sanibel given the island's low ground elevations. The potential for sea level rise over the City's next 50 years adds another layer of complexity to management of the system.

Maintaining elevated water levels internally helps to conserve freshwater by mitigating saltwater intrusion, recharging the underground freshwater lens, reducing mosquito populations, minimizing fire risk, and reducing exotic plant species that outcompete native vegetation. The 1987 Surface Water Management report by Johnson Engineering, Inc. for the City of Sanibel commented that protection of freshwater on the interior of the island is necessary to protect Sanibel's native flora and fauna and that water in the interior wetlands should be maintained, "as fresh as practicable." The report also mentioned that removal of the water control structures at Tarpon Bay and Beach Road would be an environmental disaster, decimating the groundwater table, allowing saltwater intrusion, and converting the freshwater system into a saltwater one.

Minimizing discharge from the weirs helps to reduce the release of nutrients into the surrounding impaired tidal waters. It is in the interest of all to minimize nutrient pollution in the waters so important for tourism and recreation.

When Hurricane Ian made landfall in late September 2022 it caused the island to be overtopped with storm surge and led to saltwater contamination of freshwater ponds and wetlands. The 1953 report on the water table mentioned that large hurricanes can submerge the island and, if not accompanied by heavy rains, drastically affect the vegetation and salinity of the island's interior soils and groundwater. In the months following Hurricane Ian, there was significant vegetation loss and a general sense amongst residents that the island's hydrology changed.

One of the goals of this report is to review current and historical data to identify whether changes have occurred to the island's internal hydraulics or hydrology. Also included is a review of sea level rise projections and how the island's stormwater management system may be impacted. Finally, extensive field inspection efforts have been performed to inspect the City's drainage conveyance elements for sedimentation and refine the City's stormwater management mapping.

Previous studies and reports conducted for the City referenced elevations to the National Geodetic Vertical Datum of 1929 (NGVD 29). For this report, the datum will reference the more recent NAVD 88, which is also consistent with State of Florida agencies and the current flood maps published by the Federal Emergency Management Agency (FEMA). Comparing the two datums for Sanibel results in the following:

- West of Tarpon Bay Road: 0.00 feet NAVD 88 = 1.18 feet NGVD 29

- East of Tarpon Bay Road: 0.00 feet NAVD 88 = 1.17 feet NGVD 29

SECTION 2 – DATA COLLECTION, RESULTS, AND DISCUSSION

Residents of Sanibel report a common belief that the island's hydrology has changed following Hurricane Ian in September 2022, with interior freshwater stages seeming higher during the dry season and water levels receding more slowly than they did in the past. Extensive data collection and review was undertaken in 2024 to investigate this claim and search for underlying trends. The data review also estimated the potential benefits of a modified weir policy.

2.1 Surface Water Level Monitoring

To capture how water levels vary across the island and how they respond to rainfall, recovery, and tropical storm surge events, water level monitoring sensors were installed in 14 locations throughout the island in the second half of 2024. The placement strategy of the new sensors was to: have one sensor for each freshwater subbasin identified in the 2018 Stormwater Master Plan, line up with a former U.S. Geological Survey (USGS) monitoring well location from the 1970s, and that the equipment not be installed on private property. As shown in **Exhibit 3**, many monitoring locations were able to satisfy all three requirements, though compromises had to be reached in a few locations. Johnson Engineering, LLC., installed ten (10) pressure transducers, identified as "JE Level Station 2024" on the exhibit. The Sanibel Captiva Conservation Foundation (SCCF) installed four automated monitoring systems, with radar water level sensors, tipping bucket rain gauges, and cellular connectivity. These installations supplement the two existing SCCF monitoring stations upstream of Tarpon Bay Weir (installed 2015) and Beach Road Weir (installed 2015), and USGS well L-1403 which was installed in the early 1970s.

Graphs of the data collected by the monitoring equipment since installation are provided in **Appendix A**. The graphs show that the east and west basins generally act as a level pool and runoff is efficiently conveyed to the Sanibel River, as designed. Overall, the observed data indicates that Sanibel's primary stormwater management infrastructure is operating as intended. Some location-specific comments are:

> **West Gulf Drive and Murex Lakes Community:** Locations JE 2124 and JE 2125 installed surrounding this neighborhood in Basin 4 recover very slowly, closely matching the rate of evapotranspiration (ET) typical for Sanibel (2.4 inches per week in early September and 1.4 inches per week in late October / early November). This confirms that ET is still occurring

on Sanibel despite the inland freshwater areas being inundated with saltwater. These rates are also within the ranges observed within Sanibel's interior swales in the 1953 report *The Water Table on Sanibel Island*, which were 1.1 inches to 2.6 inches per week, showing that the system is still operating similarly to past observations. The rate of recovery shown in the graphs for JE 2124 and JE 2125 suggests little to no deep percolation is occurring in this location, which is consistent with the water budget presented in *The Sanibel Report* (1976) and discussed further in ***Section 2.2*** of this report. The graphs for JE 2124 and JE 2125 also indicate that runoff to the interior Sanibel River occurs when water in the roadside swale is above elevation 2.9 feet NAVD 88, but not below this elevation. The subbasins throughout the island fill up and then overflow after enough rain, which is illustrated in these graphs. These observations fit well with Figure 2 of the 2018 Stormwater Master Plan, with this location being within one of the "City-identified flood prone areas" on the map. Given the distance between this area and Tarpon Bay Weir, opening the gates to lower the water level in the Sanibel River is not anticipated to significantly improve water level recovery following a storm. A potential solution for this area would be to install roadside swales and culverts along West Gulf Drive, and connect to the existing drainage ditch on the east side of Rabbit Road. The total length of additional improved swales and culverts would be approximately 2,700 feet.

Casa Ybel Road and Algiers Lane: Monitoring well location JE 2127 in Basin 5a was installed in a roadside retention swale that is immediately adjacent to a drainage ditch. The graph for this well shows that it has a slower rate of recovery than the downstream monitoring locations, which is typical for retention areas. Analyzing the graph during a dry period in October shows it recovering at a rate of 7.2 inches per week, far exceeding the recovery rates observed at JE 2124 and JE 2125. Removing the estimated evapotranspiration rate of 1.4 inches per week shows that the retention area recovered at a rate of 5.8 inches per week. This indicates that when retention areas on Sanibel are adjacent to a receiving ditch, the areas are recovering (and functioning) as designed following rainfall events.

Sanibel East Basin: Water level monitoring sensors were placed by SCCF at the Tarpon Bay Road weir and Beach Road weir, which are the west and east limits of the east basin. The graphs in **Appendix A** of SCCF data collected in 2024 show the water levels at these two locations are nearly identical and remained so through rainfall, storm surge, and gate operation events, despite being nearly 3 miles apart from one another. This provides strong reassurance that the primary stormwater management infrastructure in Sanibel's east basin is functioning as intended. An interesting observation for the east basin is that the water levels changed very little and were nearly flat in late October and early November 2024, a dry period following Hurricane Milton. This correlates with resident observations that something in the hydrology of Sanibel changes following a storm surge event. Likely factors are reduced ET due to widespread loss of vegetation, upland areas continually draining into the central conveyance (as observed at JE 2127), percolation being de minimis for the interior wetland systems on Sanibel (consistent with discussions previously and in ***Section 2.2*** of this report), and mean sea level being a foot and a half or more below the overflow weir crest (additional supporting evidence that percolation to tide is not occurring in the east basin). And, because of the loss of vegetation that previously blocked views into inundated areas (i.e., wetlands), standing water is more visible to residents post-storm. As a result, residents may come to associate the short-term hydrologic change that occurs immediately following a surge event with the visible standing water they see months or years afterward, although this water has always been present. Gate operation events in mid-November reduced the water level throughout the basin by half of a foot, and the water in the basin remained at that level throughout the month that followed. This verifies that operation of the gates is an effective way to reduce water levels in the Sanibel east basin.

Sanibel West Basin: Graphs for water level monitoring sensors JE 2121 and JE 2126, placed at the west and east limits of the west basin, show water levels across the basin are nearly identical and remained so through rainfall and storm surge events, despite being separated by a distance of 4 miles. In early September 2024, the gates on Tarpon Bay Weir were opened for about two days, which lowered the water level upstream of the weir by a foot (lowering below this elevation was inhibited due to sea level). The west end of the basin showed a delayed recovery, with water levels dropping by a half of a foot after two days. Based on this, it can be extrapolated that the west end would drain down and be nearly equal to the east end after four days. This is within the range of expectations for the stormwater management system, given the distance between the ends of the basin, there being a wetland slough separating them, and summer storms occurring before and during the gate opening event. The data and observations provide strong reassurance that the primary stormwater management infrastructure in the west basin of Sanibel is operating well.

Table 1 reproduces the results of a water table data collection effort by the USGS in the 1970s. Maximum annual water table levels at several well locations were recorded for the years 1971-1977. The 1977 results were used to create a wet season water table map of Sanibel, which was published in 1988 to serve as a guide for prospective new residential development. The 2024 water level monitoring graphs in **Appendix A** include the 1977 maximum water levels of the nearest USGS well(s). Comparing the two, it is evident that the surface water levels in the interior basins are near the weir crest elevations and the groundwater levels are similar to those recorded in 1977. It is recommended that the 1988 map of maximum water levels in 1977 continue to be utilized as a guide for new development on Sanibel.

Table 1. Maximum water levels for the water table aquifer for Sanibel Island, 1971-1977.

Well Number	Maximum Water Levels for Water-Table Aquifer, 1971-1977, USGS, Sanibel Island, FL (feet NAVD 88)						Current Basin Control Elev.
	1971	1972	1974	1975	1976	1977[1]	
L-1403	2.18	2.42	2.45	2.05	1.82	2.55	1.5
L-1405	1.76	2.36	1.33	0.08	0.71	2.26	1.5
L-1411	1.66	2.11	1.27	0.88	0.82	2.24	1.5
L-1412	2.27	2.61	1.99	1.23	1.49	2.61	1.5
L-1414	1.97	2.08	1.86	0.42	0.80	2.15	2.0/1.5
L-1415	1.89	2.04	1.66	0.60	0.66	2.37	1.5
L-1416	1.89	2.78	1.47	0.12	0.44	2.43	1.5
L-1451	1.49	2.41	1.4	0.77	0.82	2.65	1.5
L-1453	1.66	2.64	1.22	0.7	0.62	2.72	1.5
L-1455	1.07	1.68	1.44	0.66	0.8	2.38	1.5
L-1459	2.21	2.86	2.27	1.52	1.71	2.89	1.5
L-1476	0.99	0.92	0.83	0.43	0.28	1.74	2.0
L-1478	1.36	0.87	0.62	0.42	0.34	1.64	2.0
L-1480	1.07	0.68	0.77	0.31	0.46	2.18	2.0
L-1482	1.67	1.09	1.33	0.06	0.95	2.2	2.0
L-1494	1.68	0.92	1.11	0.41	0.67	2.99	2.0
L-1497	1.25	0.45	0.79	0.53	0.65	2.87	2.0
L-1499	1.58	0.87	1.27	0.28	0.5	2.94	2.0
L-1501	1.96	1.11	1.89	0.49	0.93	2.63	2.0

1. Water levels from 1977 were used to create the Wet Season Water Table map for Sanibel, published in 1988.

2.2 Water Budget and the Normalized Difference Vegetation Index

A water budget estimates the quantities of water entering and leaving a system. Inflows often include precipitation, treated wastewater effluent, incoming surface water runoff from adjacent watersheds, and groundwater inflow. Outflows include runoff, groundwater outflow (percolation), open water evaporation, soil evaporation, and transpiration from plants. In vegetated areas, the last two components are often reported together and are referred to as evapotranspiration (ET). Inflows and outflows are typically equal when looking at a water budget on an annual basis, unless there was a change in storage within the basin. Sanibel generally does not have changes in storage from year to year. In *The Sanibel Report* (1976), an average annual water budget was created for the interior wetland areas of Sanibel. This water budget is still valid today. A cross section of the island is provided in **Figure 1** to serve as a pictorial representation of the water budget.

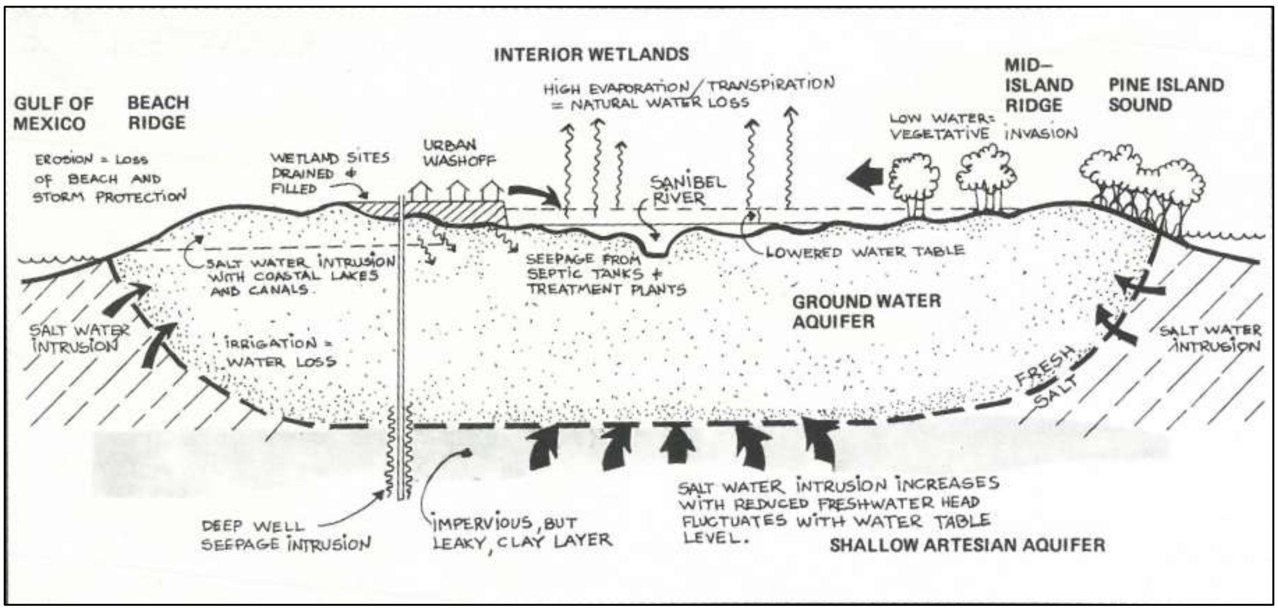

Figure 1. Graphical representation of the water budget of the freshwater basins on Sanibel, taken from *The Sanibel Report* (1976).

Open-water evaporation and ET account for nearly all yearly outflow from the interior freshwater wetlands on Sanibel, as shown in **Table 2**. Estimates of evaporation and ET can be difficult to verify, especially for wetlands on barrier islands, but approximations were made in the 1976 report using a pan evaporation coefficient of 0.7 for the basin.

Table 2. Annual water budget for interior wetlands of Sanibel, inches (from *The Sanibel Report*, 1976).

Inflows		Outflows	
Precipitation	43.2	Water Storage	0.0
Surface Water	0.0	Open Water Evaporation	12.3
Groundwater	0.0	Evapotranspiration	37.1
Upward Leakage	1.2	Irrigation Pumping	0.0
Artesian Wells	2.5	Surface Water (Runoff)	0.1
Treated Wastewater Effluent	3.8	Groundwater (Percolation)	0.3
Total	**≈ 50**	**Total**	**≈ 50**

Table 2 shows that deep percolation losses from the interior freshwater basins to the ocean have always been considered negligible on Sanibel. To independently verify this, a quick analysis of groundwater flow through the surficial aquifer was performed using Darcy's Law, which describes fluid flow through porous media and considers the hydraulic gradient and aquifer permeability. The 1992 Update Report of Sanibel's Surface Water Management Plan stated testing from 1990 measured permeability coefficients ranging from 0.77 to 34.02 feet per day on Sanibel. Multiplying these coefficients by the hydraulic gradient from the interior wetlands to the surrounding sea and an approximate/effective aquifer area result in average loss estimates of 2.9 to 130 gallons per minute, or between 0.02 inches and 0.8 inches per year, less than 2% of the annual budget. This estimate is conservatively high since it does not take into account the differing specific gravities of freshwater and saltwater. The value of 0.3 inches per year shown in **Table 2** is also a conservatively high assumption for groundwater outflows from the system and shows that deep percolation has never been a significant loss from the system, even prior to storm surge inundation in 2022.

It should be noted that, while surface water runoff accounts for only a very small portion of annual outflow in a 50-inch precipitation year, more runoff will occur during years where high precipitation or surge events cause water to be evacuated as flow over the weir crests or through the gates.

Any impact to evaporation or ET will result in dramatic impacts to watershed hydrology on Sanibel. Open water areas did not change in size after Hurricane Ian in 2022, so the focus now shifts to changes in the plants on the island. One method of quantifying vegetation greenness and density is the Normalized Difference Vegetation Index (NDVI), which can be calculated for an area using multispectral imagery. Comparing NDVI values over time is a useful way to assess changes in plant health and coverage and subsequent changes in watershed hydrology (Worley et al., 2022). NDVI is a ratio between red and near infrared wavelengths (USGS, 2025) and is calculated as shown in **Equation 1**. The information needed to calculate NDVI can be obtained from satellites such as Landsat 8. The Landsat 8 satellite was launched by USGS and NASA in 2013 and records an image of Sanibel every 16 days at a 30-meter spatial resolution. Landsat 9, which is nearly identical to its predecessor, was launched in 2021 and also records an image every 16 days. Consequently, an image of Sanibel is now taken every 8 days. Landsat Spectral Indices products are courtesy of the U.S. Geological Survey Earth Resources Observation and Science Center. Surface reflectance and top of atmosphere datasets from Landsat 8 were used in NDVI calculations for the period of record. Surface reflectance data is atmospherically corrected and is especially useful when comparing images of a region over time (USGS, 2022). Top of atmosphere data requires less processing and can be filtered by the amount of cloud cover present. NDVI values range from -1.0 to +1.0, with more positive numbers indicating denser or healthier vegetation (see also **Figure 2**).

Equation 1. Formula for NDVI and corresponding Landsat 8 band values.

$$NDVI = \frac{NIR - R}{NIR + R} = \frac{Band\ 5 - Band\ 4}{Band\ 5 + Band\ 4}$$

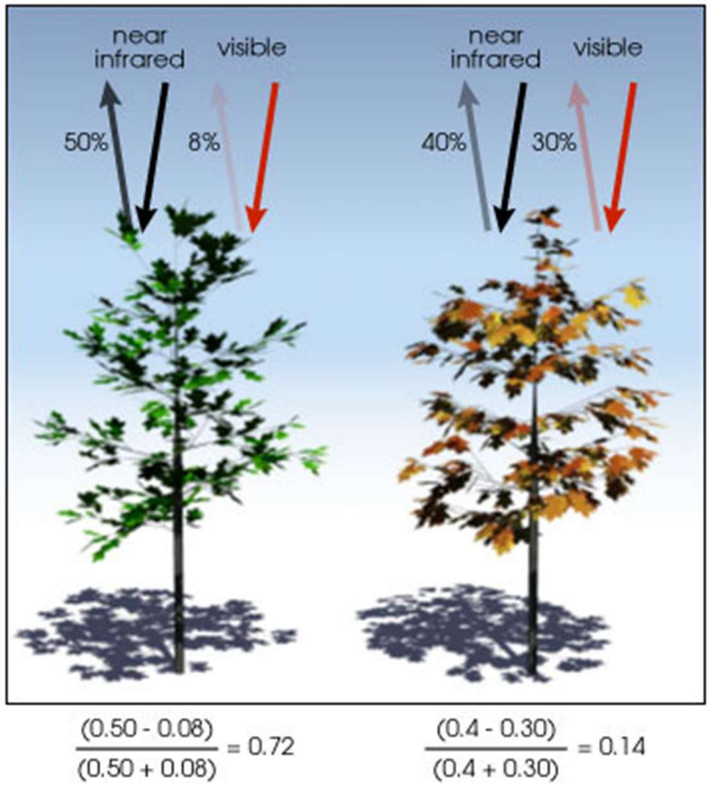

Figure 2. Example NDVI values for healthy and unhealthy vegetation (NASA, 2000).

Long-term average NDVI values for Sanibel before and after Hurricane Ian in 2022 are provided in **Figure 3** and **Figure 4**. The figures are on a scale of green to white to blue, with green being healthy vegetation, white being no or dead vegetation, and blue being open water. Satellite images with greater than 1% cloud cover were excluded from the analysis, which used top of atmosphere data. **Figure 3** shows the pre-Hurricane Ian period from November 2013 to September 2022, and **Figure 4** shows the period after the storm, November 2022 to September 2023. The hurricane clearly had a tremendous impact on plant life.

Figure 3. Map showing NDVI values before Hurricane Ian (average Nov. 2013 to Sept. 2022).

Figure 4. Map showing NDVI values after Hurricane Ian (average Nov. 2022 to Sept. 2023).

Figure 5 uses Landsat 8 and 9 surface reflectance data that was processed to exclude cloudy pixels from the images and shows the average NDVI value over the interior freshwater basins from 2013 to 2025. The average NDVI value for 2013 to 2022 was 0.68, despite the area of analysis including both roofs and roads, areas with NDVI values at or below zero. An average NDVI value of 0.68 is very high and represents dense, healthy subtropical vegetation. For the first year after the storm, this average was reduced to 0.38, which is markedly low for a subtropical plant community and represents stressed vegetation. (As a comparison, Worley et al. [2022] reported the average NDVI value for the Chipola River watershed dropped from 0.64 to 0.59 following Hurricane Michael in 2018, which resulted in measurable reductions in ET and subsequent increases in river flows by less than 6%, with some subwatersheds seeing up to 22% increase in streamflow.)

The initial drop in NDVI just after Ian was about 0.3. Throughout 2023 and 2024, NDVI increased and began to approach pre-Ian levels, but this recovery was reversed in the aftermath of hurricanes Helene and Milton in the fall of 2024. However, the island's vegetation is quickly rebounding and appears to be on track to return to pre-Helene levels this year.

Figure 5 also includes the monthly minimum and maximum water levels recorded at Beach Road Weir by SCCF from 2019 to 2025. Note that the maximum surge level from Hurricane Ian was not recorded since the monitoring equipment was inundated, so an estimate obtained from USGS was used. Water levels before and after Ian were compared to explore any changes which the hurricane may have caused. In the initial months following Hurricane Ian, there seemed to be a slight increase in the minimum water levels at Beach Road, but by the beginning of 2023, stages were similar to those experienced in 2019-2022. However, during the dry seasons of 2024 and 2025, water levels stayed unusually high, likely because of reduced ET. With only six years of data, it is difficult to determine how unusual these observations are. However, it seems likely that surface water levels will recover fully as vegetation recovers.

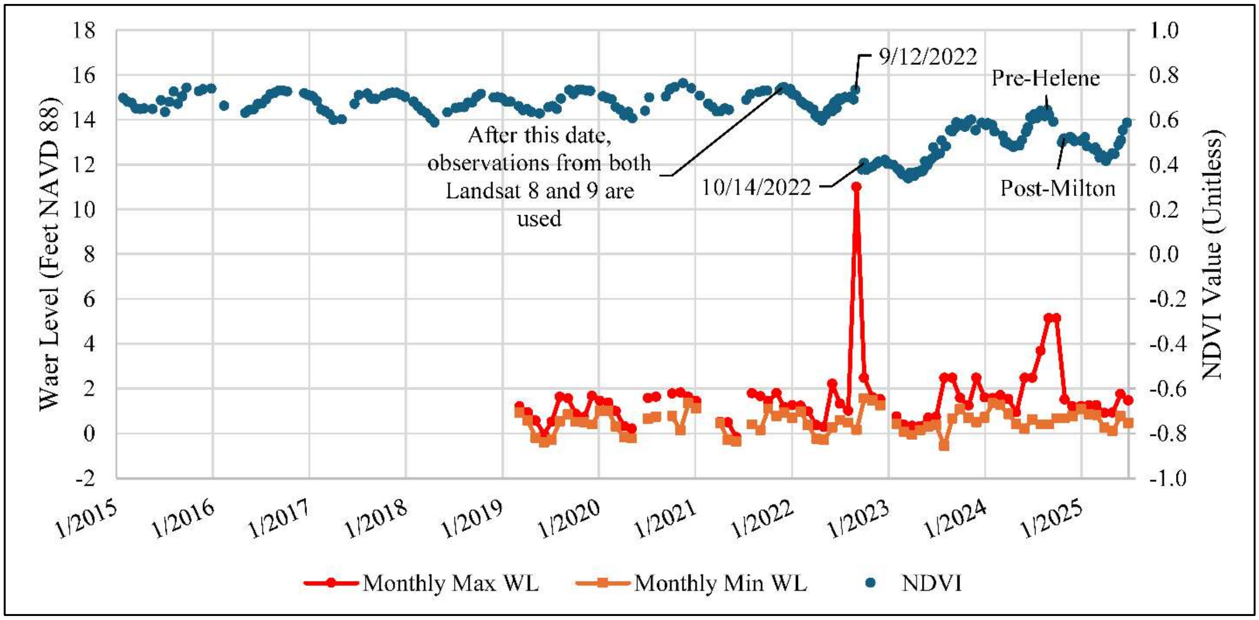

Figure 5. Water levels recorded at Beach Road Weir and average Landsat 8 and 9 NDVI values for the interior freshwater basins.

Water level data upstream of Beach Road Weir was obtained from SCCF and analyzed to see if there were changes in the rate of decline of surface water levels during periods without rainfall and without weir gate operation. Under these conditions, the rate of decline should be roughly equivalent to ET. The expectation was that following Hurricane Ian and the associated vegetation changes, water levels would decline more slowly than before the hurricane due to a reduction in ET caused by plant stress. However, this did not appear to be the case. If anything, water levels have been declining more quickly a year after the hurricane. **Figure 6** shows water levels and the periods of decline analyzed for the period of record. It is unclear what may have caused the increased decline rates in late 2023 and early 2024, but two theories present themselves. One possibility is that, with less vegetation present in the wetlands, the water surface is exposed to more direct sunlight, causing an increase in evaporation rates which make up for the reduced evapotranspiration rates. The other possibility is that vegetative regrowth caused increased water uptake by plants.

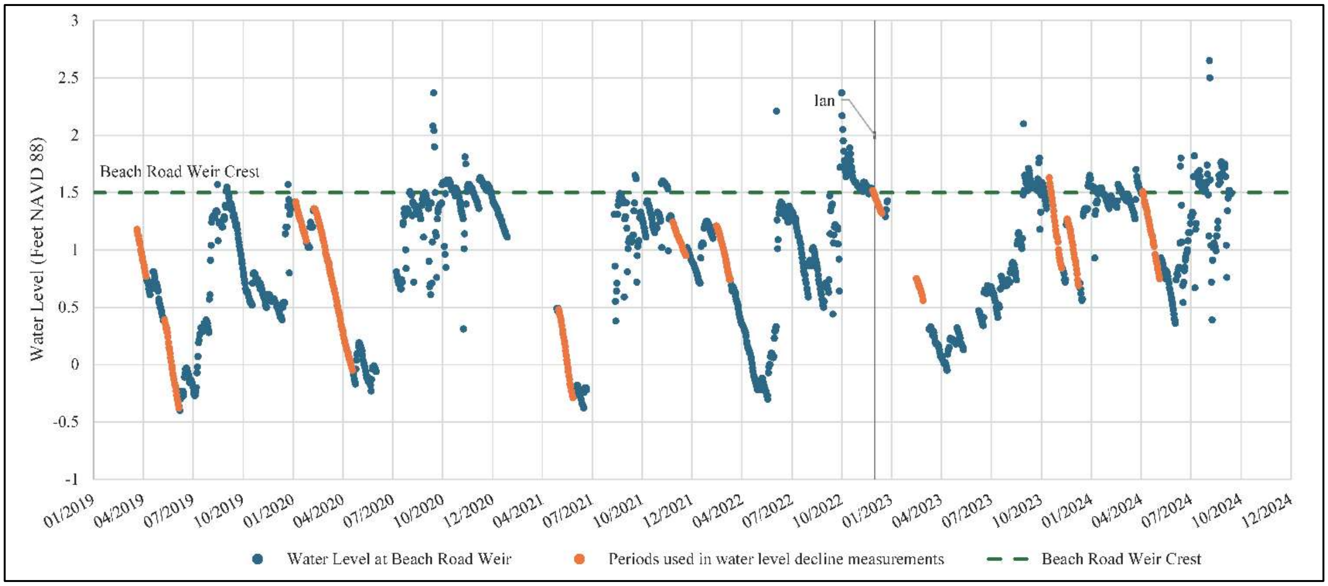

Figure 6. Water level and water level decline periods at Beach Road Weir.

2.3 Groundwater Level Monitoring

In addition to the water level analyses discussed previously, groundwater data was evaluated at USGS surficial aquifer well L-1403, which is located in the east basin along Casa Ybel Road (see **Figure 7**). The well was installed in the early 1970s, and daily measurements were taken from 1973 until 2018. Periodic field measurements have also been recorded over the years, typically once per month, although this is not always the case. Any data from November 2018 or later comes exclusively from the field measurements, and it should be noted that since this data is taken infrequently, it likely fails to capture the extremes, both high and low, of the water table. It should also be noted that although measurements are typically taken once per month, no measurements have been posted online since March 2025.

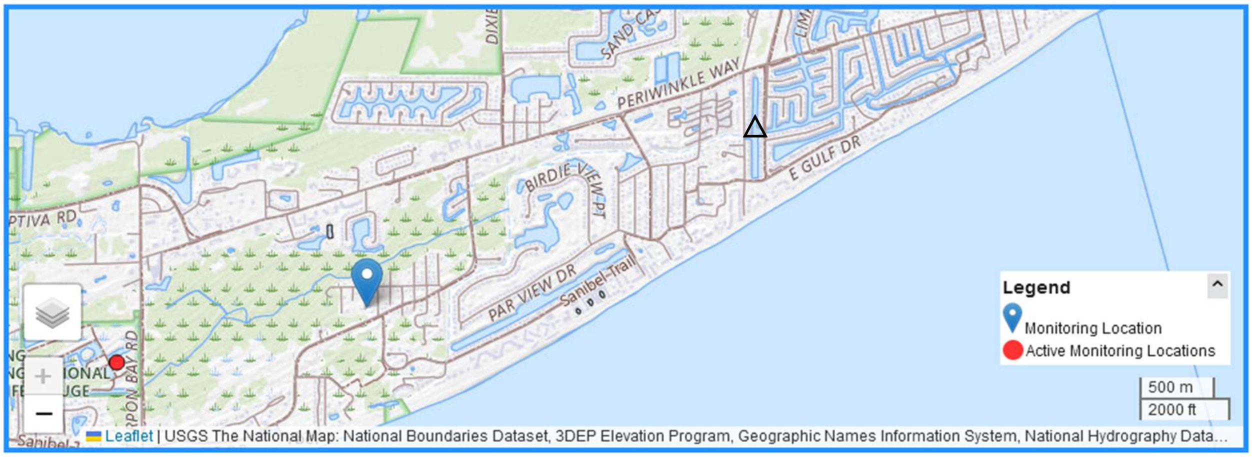

Figure 7. Location of USGS well L-1403 (blue marker) and Beach Road Weir monitoring equipment (black marker).

To quantify the changes that residents have noted, annual minimum, average, and maximum groundwater stages were reviewed at L-1403 from 2017 to 2024, shown in **Table 3**. Between 2017 and 2024, there was a net change in minimum water level of 1.3 feet, a significant rise for Sanibel. At the same time, yearly average and maximum water levels have seen more modest increases. However, it should once again be noted that over this eight-year period, between seven and twelve measurements were taken each year at the well, so the sample size is too small to allow for definite conclusions to be drawn. The minimum levels experienced in recent years are also not unprecedented. In the years 2003, 2005, and 2015, annual minimums of 0.19, -0.09, and -0.35 were recorded.

Table 3. Surficial aquifer water level at L-1403 for years 2017 to 2024, feet NAVD 88.

Year	2017	2018	2019	2020	2021	2022	2023	2024	Change 2017-2024
Minimum	-1.15	-1.20	-0.86	-0.62	-0.61	-0.45	-0.27	0.17	*1.32*
Average	0.58	-0.38	0.29	0.73	0.66	0.81	0.91	1.71	*1.14*
Maximum	2.00	0.41	1.65	1.96	1.90	2.25	2.27	2.50	*0.50*
Total Rainfall (in.)	54.9	38.3	43.1	66.9	49.8	51.2	37.9	76.0	--

It is likely that these increases were caused by two factors. First, Southwest Florida experienced heavy rainfall in 2024 (see **Table 3**). Second, significant vegetation loss occurred in the aftermath of Hurricane Ian.

It is possible that the heavy rainfall Southwest Florida experienced in 2024 has kept groundwater higher than normal and prevented stages from falling as low as they usually do. While the former claim appears to be true, the latter seems unlikely when other years of high rainfall are considered. When comparing 2020 (66.9 inches) and 2024 (76.0 inches), a much greater increase is seen in the annual minimum stage than in the annual maximum stage, 0.79 feet versus 0.31 feet. So, while rainfall does play a role in groundwater levels, it is not the only factor.

Most of the water leaving the interior basins on Sanibel has historically done so through evapotranspiration, a process inherently tied to plants. Given that plant populations have experienced a significant decline after Hurricane Ian, it would make sense for water levels to recede more slowly following rainfall events. **Figure 8** shows the relationship between NDVI (i.e., vegetative health) and groundwater at L-1403 over the period from 2013 to 2024. The average groundwater stage for each water year is included to show the overall trend.

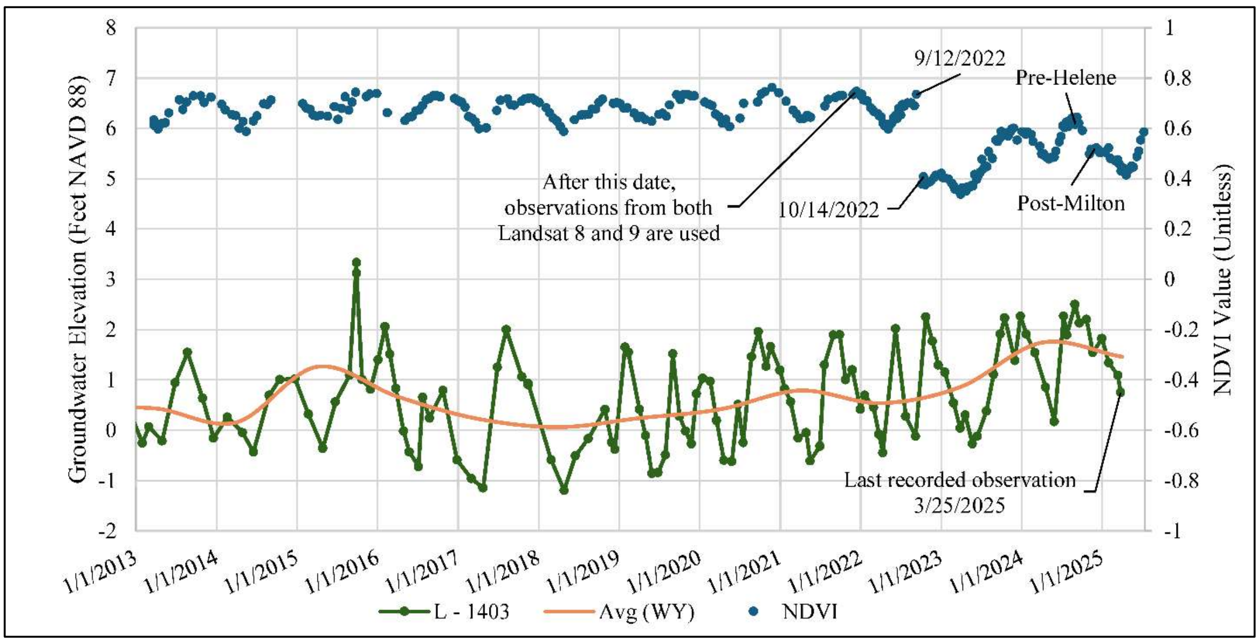

Figure 8. Water level at USGS well L-1403 and calculated Landsat 8 and 9 NDVI values for the interior basins over time. Orange line indicates average level per water year.

As previously stated, it makes sense that loss of vegetation would cause water levels to recede more slowly following rainfall events. This was generally not found to be the case for surface water across the island, but an investigation into minimum groundwater levels illustrates the changes experienced by many Sanibel residents. Although minimum groundwater levels have been trending upwards since 2017 (see **Table 3**), they are well within the historical range for the period of record (see **Figure 9**). It seems unlikely that Hurricane Ian has caused any permanent changes to water levels on the island.

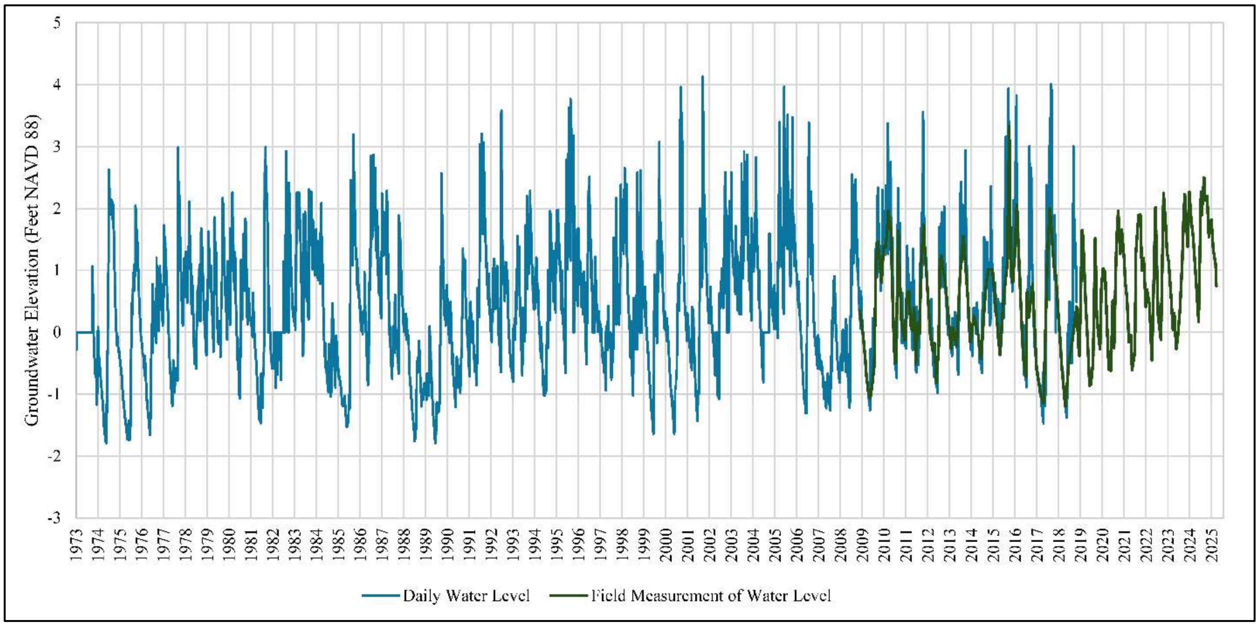

Figure 9. Long-term groundwater elevation at USGS well L-1403.

2.4 West Basin Weir Policy Review

Sanibel's water control structures for the interior freshwater basins include sluice gates that can be opened to allow additional flow out of the basins under certain conditions. The stated objective of the City's Weir Control Policy adopted in 1994 (Policy) is "to attempt to retain as much fresh surface water on the island as possible … for the environmental benefit of the island's Interior Wetlands System, so long as developed areas are not adversely impacted." The Policy allows the gates to be opened under one of four conditions: interior flooding conditions, pre-storm conditions, surface water duration conditions, or miscellaneous conditions. It should be noted that the third condition, surface water duration, has never been used to open the weirs. The details of the first three conditions are described further in the Policy document, and the fourth condition is the shortest, saying "The City Manager may deviate from the above standards when deemed necessary for the prevention of immediate harm to persons, property, or the environment." As mentioned previously, the interior wetlands serve as freshwater reservoirs for the island, helping to conserve water by mitigating saltwater intrusion, recharging the underground freshwater lens, reducing mosquito populations, and reducing exotic plant species that outcompete native vegetation. The weirs were designed to keep upstream water as fresh as practicable to protect Sanibel's native flora and fauna.

Prior to the construction of the weirs, it was common to see the groundwater fall below sea level during dry periods due to uncontrolled runoff and significant evapotranspiration (Provost, 1953). Due to differences in specific gravity, freshwater floats above saltwater, resulting in a freshwater lens under all islands, including Sanibel (see **Figure 1**). The 1953 report *The Water Table on Sanibel Island* stated that, "for every foot the fresh water table is elevated above mean sea level, the salt water underlying it is depressed by 40 feet." At the time the weir policy was adopted in 1994, mean sea level around Sanibel was about -0.4 feet NAVD 88, which meant the water levels in the west basin were elevated 2.4 feet above mean sea level. The shallow water table aquifer is underlain by a clay and limestone layer 20 to 25 feet below land surface (Clark, 1976), so the freshwater lens was not necessarily 100 feet thick but significant pressure was exerted by the west basin to maintain the freshwater lens under Sanibel. Mean sea level has averaged 0.17 feet NAVD 88 for the past three years (2022-2024) so the difference in elevation is less today, but still sufficient for maintenance of the water table aquifer. This Policy should be continued for as long as possible when there is the presence of freshwater in the west basin.

There are times when the City Manager may want to operate the weir gates under the fourth condition, miscellaneous. This has occurred multiple times in recent years to improve working conditions during hurricane recovery efforts and to expedite the removal of brackish water from the basins. Some important considerations when operating under this condition are:

> **Tide:** Sea level is the primary limitation to flow out of the gates. High tides or storm surges can cause sea water to flow into the freshwater basins. The gates should not be opened when tidal waters are above the water level inside the system to prevent backflow.
>
> **Freshwater Surcharge:** The minimum water level of freshwater inside the basins should be at least six inches higher than mean sea level. At no point in the year should the interior water level be less than six inches above sea level, because the freshwater lens under Sanibel is at risk of being compromised if the difference between the two is less than six inches. Daily

tide information included in the graphs in **Appendix A** shows that sea level fluctuates during the year and was as high as 1 foot NAVD 88 in September 2024.

Dry Season: It is not uncommon to receive less than an inch of rainfall during a dry season month. May is the month with the highest potential ET, estimated at 6 inches for wetlands in South Florida (Abtew et al., 2003). At least six inches of surplus water should be retained within the basins on May 1 to allow for dry season ET outflows. This surplus amount is in addition to the minimum freshwater surcharge amount, so a total of one foot of water above mean sea level needs to be retained on May 1.

Fire Risk: Over-draining the interior basins greatly increases the risk of wildfires.

Mosquito Control: Wide fluctuations in water levels in and around Sanibel were determined to be one of the primary causes of overwhelming populations of the black salt marsh mosquito (Aedes taeniorhynchus), which lays its eggs on moist ground (not water) and the eggs remain and do not hatch until inundated, weeks or months later (Provost, 1953). Construction of the weirs has the benefit of keeping water in the breeding areas as much as possible and also helps with the distribution of minnows during the early wet season, allowing minnows to quickly access the larvae, once hatched. Careful coordination should be conducted with the Lee County Mosquito Control District if drastic water level fluctuations are occurring within the basins so that mosquito populations do not become overwhelming.

The east basin weir level is 1.5 feet NAVD 88. Since this is already low, there is no capacity for water levels to be lowered further.

SECTION 3 – SURFACE WATER MANAGEMENT DAMAGES POST-HURRICANE IAN

Field inspections of the primary stormwater management system on Sanibel are conducted every year, typically at the beginning of each dry season. Following Hurricane Ian in 2022, the system was reviewed by City staff to identify and repair areas of immediate concern. The primary system was further reviewed by Johnson Engineering in the early months of 2023 and 2024, and locations of highest concern were addressed by the City internally and/or through the City's contractors.

Additional field inspections of the secondary drainage system were conducted in the summer of 2024 to create a comprehensive update to the Surface Water Management Master Plan for Sanibel, reflecting the current conditions of the system after Hurricane Ian. The inspections included an update of the City's mapping and identification of additional repairs needed beyond the major repair efforts conducted previously.

3.1 Stormwater Management System Mapping Update

An inventory of existing pipes and inlets within the City of Sanibel are contained in a forty-page document called Map Book Drainage, dated August 30, 2007. Within the inventory document there are 32 plan sheets showing the locations of the primary drainage infrastructure throughout the City. Secondary infrastructure, including driveway culverts and swales on minor roads, was mentioned in the notes but features were not shown individually. As a part of this update to the Surface Water Management Master Plan, the secondary culverts and swales were field located and inventoried to include individual identification numbers and attributes such as culvert material and diameter, resulting in the addition of 820 culverts and 2,220 swales to the City's records. An updated **Drainage Features Map Book** was created by Johnson Engineering to include these features and was provided to the City.

3.2 Stormwater Management System Damage Inspections

Coupled with the field mapping efforts, a visual inspection of newly added features was conducted to identify additional repairs needed beyond the previous major repair efforts. Field inspection efforts found sedimentation issues at 658 drainage structures, inside 19,400 linear feet of culverts, and 24,200 linear feet of roadside swales. A bid solicitation package was advertised by the City to select a contractor who is currently performing the repair and maintenance work.

SECTION 4 – SURFACE WATER MANAGEMENT RESILIENCY

Sanibel's low-lying profile and status as a barrier island make it particularly vulnerable to hurricanes and storm surge. **Figure 10** shows how the monthly maximum tide at the Fort Myers tide gauge has increased over time. Refer to **Table 4** for the numerical values of the ten highest water levels recorded at the gauge, as well as the storm events they correspond with. It is notable that five of the highest ten records occurred during the past three wet seasons.

Over the course of Sanibel's history, storm surge has wholly inundated the island with saltwater multiple times, though there was a long period of relative calm prior to 2022, as shown in **Figure 11**. Plans for stormwater management on Sanibel must consider the island's unique susceptibility to saltwater flooding and sea level rise.

Sanibel contains two large freshwater basins which serve as freshwater reservoirs for the island. Each basin has a weir which serves as a salinity barrier by allowing freshwater to flow out of the basin and preventing tides from pushing saltwater into the interior. As discussed previously, protection of freshwater resources in the interior of the island is necessary to protect Sanibel's native flora and fauna. However, when high sea levels exceed the weir crest elevation (or the perimeter rim elevation of the basins), backflow of saltwater into the freshwater basins occurs.

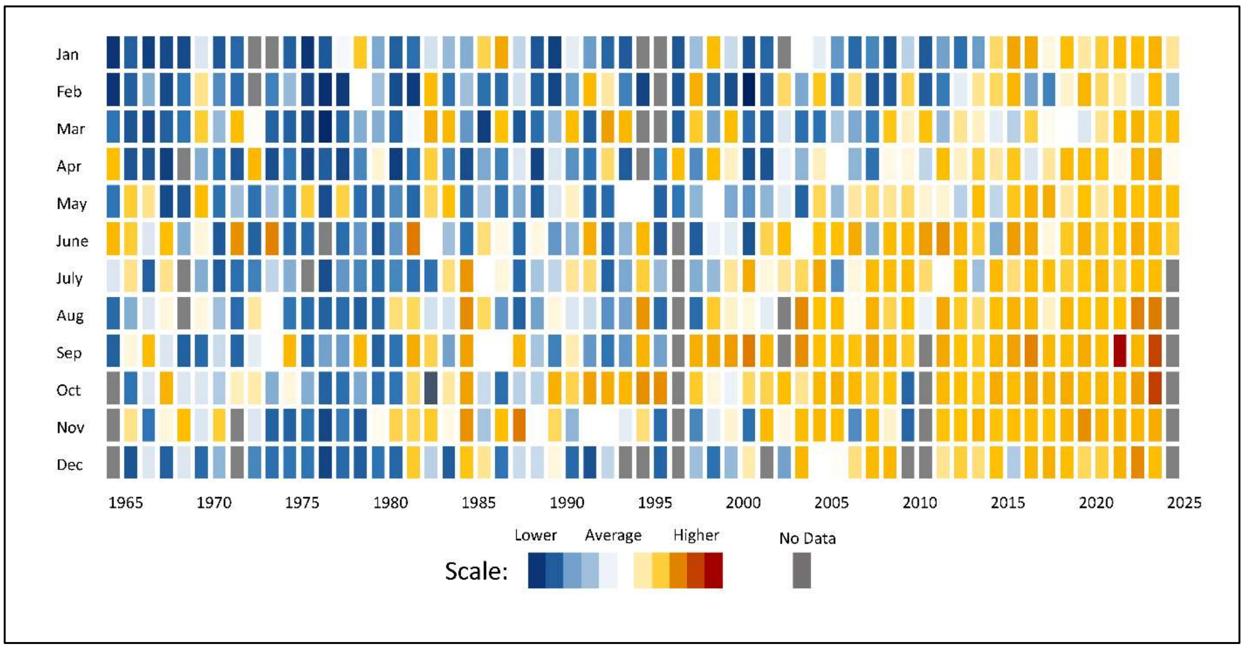

Figure 10. Overall trend of monthly maximum tide elevation at NOAA Fort Myers Tide Station 8725520.

Table 4. Ten highest water levels recorded at NOAA Fort Myers Tide Station 8725520.

10 Highest Water Levels – *1965 to Present*			
Rank	**Peak Elevation (ft NAVD 88)**	**Date**	**Event**
1	7.52	2022-09-28	Hurricane Ian
2	5.53	2024-10-10	Hurricane Milton
3	5.4	2024-09-27	Hurricane Helene
4	3.68	1988-11-23	Tropical Storm Keith
5	3.59	2001-09-14	Tropical Storm Gabrielle
6	3.58	1982-06-18	Subtropical Storm One
7	3.53	2024-08-04	Tropical Storm Debby
8	3.47	2023-08-30	Hurricane Idalia
9	3.36	1974-06-25	Subtropical Storm One
10	3.32	2017-09-11	Hurricane Irma

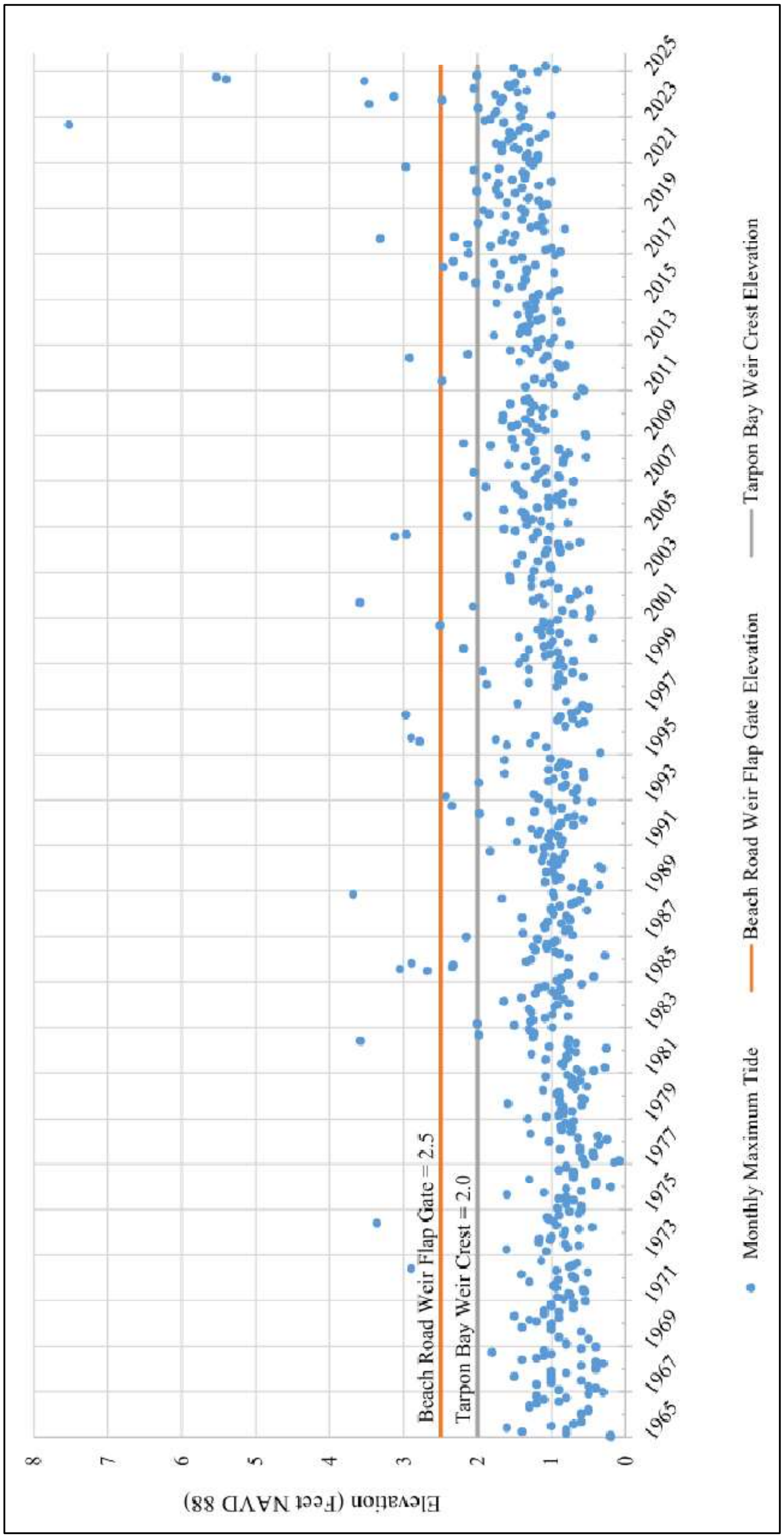

Figure 11. Recorded monthly maximum tide elevations at NOAA Fort Myers Tide Station 8725520.

4.1 City Roadway Elevation Analysis

A citywide analysis of roadway elevations was performed using LiDAR data from Lee County, collected in 2018-19. To generate a representative grid of the island, points were placed at road intersections and at regular intervals when no intersections were present. Mapping of the points and their corresponding elevations is provided in **Exhibit 4**. A percent exceedance curve is provided in **Figure 12** which shows the percentage of roadways below certain elevations.

This roadway elevation analysis was repeated for several other coastal areas using LiDAR data from SFWMD, last updated in 2023. These areas were: City of Fort Myers Hurricane Evacuation Zone A, City of Naples Hurricane Evacuation Zone A, City of Marco Island, City of Miami Beach, City of Key Biscayne, and City of St. Pete Beach. Marco Island, Miami Beach, Key Biscayne, and St. Pete Beach were chosen because they are barrier islands, like Sanibel. Hurricane Evacuation Zone A for Fort Myers and Naples were chosen due to their proximity to Sanibel. **Figure 13** compares the percent exceedance curves for all these municipalities with Sanibel's. Sanibel's roadways are generally more elevated than three of the four other barrier islands studied but are lower than the nearest two mainland areas.

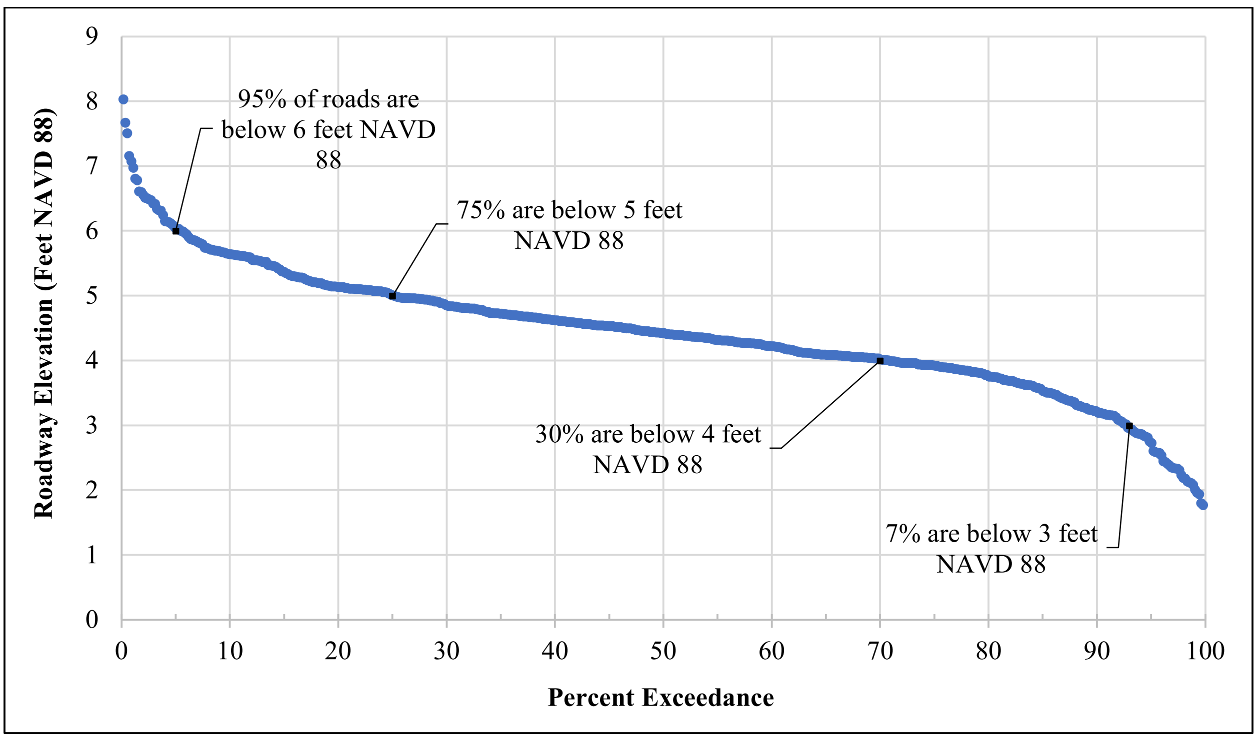

Figure 12. Percent exceedance curve for public roadways on Sanibel.

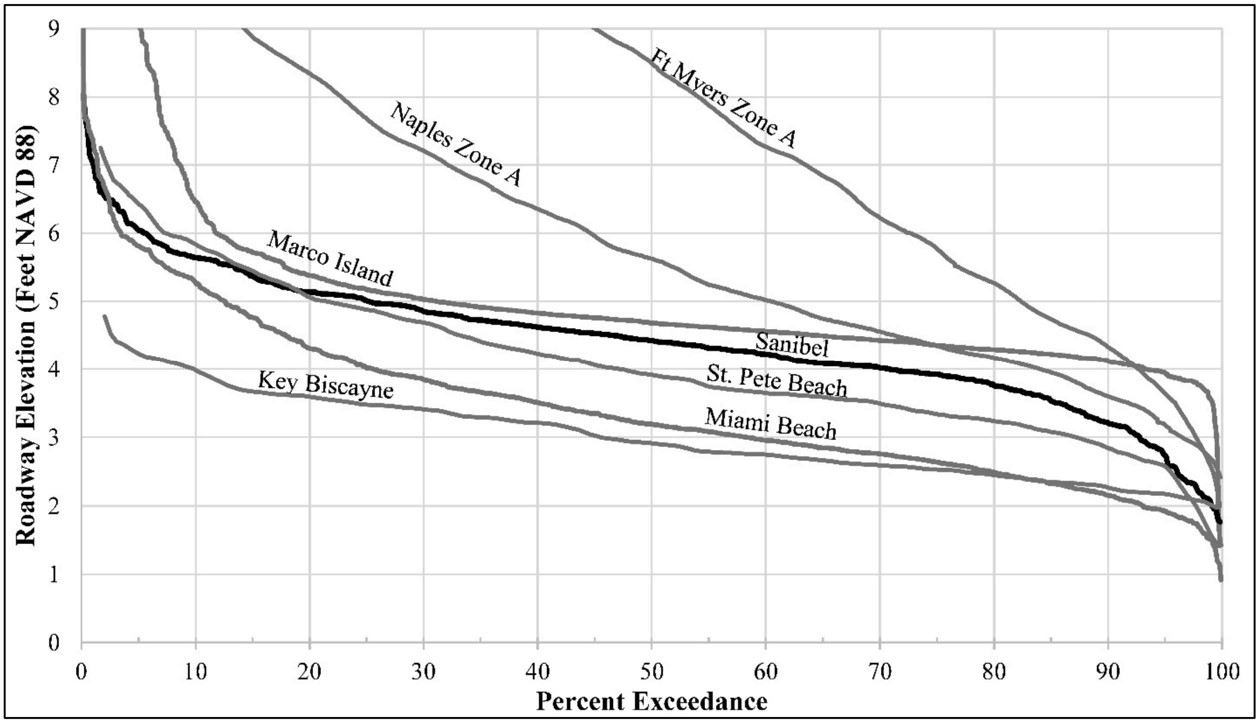

Figure 13. Comparison of percent exceedance curves for Sanibel vs. other coastal municipalities.

4.2 100-Year and 2-Year Flood Depth Maps

Public availability of flood mapping assists residents in understanding flood hazards in the vicinity of their property. FEMA publishes maps of the 100-year flood elevation which are used to establish federal flood insurance rates for a property. However, the maps do not indicate the anticipated maximum depth of water on the property. As a complement to the maps published by FEMA, a flood depth map was created to show the 100-year flood depths across Sanibel, provided as **Exhibit 5**. The flood depths shown on the map were calculated by subtracting the 2019 LiDAR ground elevations from the FEMA base flood elevations, last updated in 2022. The map shows that nearly all of Sanibel is inundated during the 100-year surge event. Additionally, a 2-year (50-percent-annual-chance) flood depth map was created and is provided as **Exhibit 6**. This map shows that minimal flooding occurs in developed areas on Sanibel during the 2-year storm surge event.

4.3 Sea Level Rise Projections

Sea level rise projections for Sanibel are provided in **Figure 14** and are based on the 2022 Intermediate-Low, Intermediate, and Intermediate-High curves developed by the National Oceanic and Atmospheric Administration for the Fort Myers Tide Station 8725520. Labeled data points are included at the planning horizons of 2050 and 2070. Additionally, the expected 2-year storm surge elevation is layered onto the Intermediate-High curve. Critical elevations such as island-wide road crown elevations and the crest elevations of Tarpon Bay Weir and Beach Road Weir are also provided for reference. These are shown as horizontal lines to indicate the water level at which the infrastructure will become inundated.

This report recommends a minimum road elevation of 4.3 feet NAVD 88 for all new roadways, which would protect them from sea level rise until mean sea level reaches 2.3 feet NAVD 88 (assuming a road base thickness of 2 feet). Levels above 2.3 feet NAVD 88 would lead to a waterlogged base. Having a waterlogged base for long periods will damage a road, and total inundation can have an adverse effect on pavement life. Based on the Intermediate-High curve, significant road base failure is expected for up to 7% of roadways by 2050. Increasing the minimum existing roads to elevation 4.3 feet NAVD 88 will provide increased protection until 2070. By 2080, however, up to 75% of roads are anticipated to experience road base failure if the Intermediate-High curve becomes reality. When looking at the Intermediate-Low curve, approximately 20% of roadways are vulnerable to road base failure by 2080 and all would be protected if raised to a minimum elevation of 4.3 feet NAVD 88.

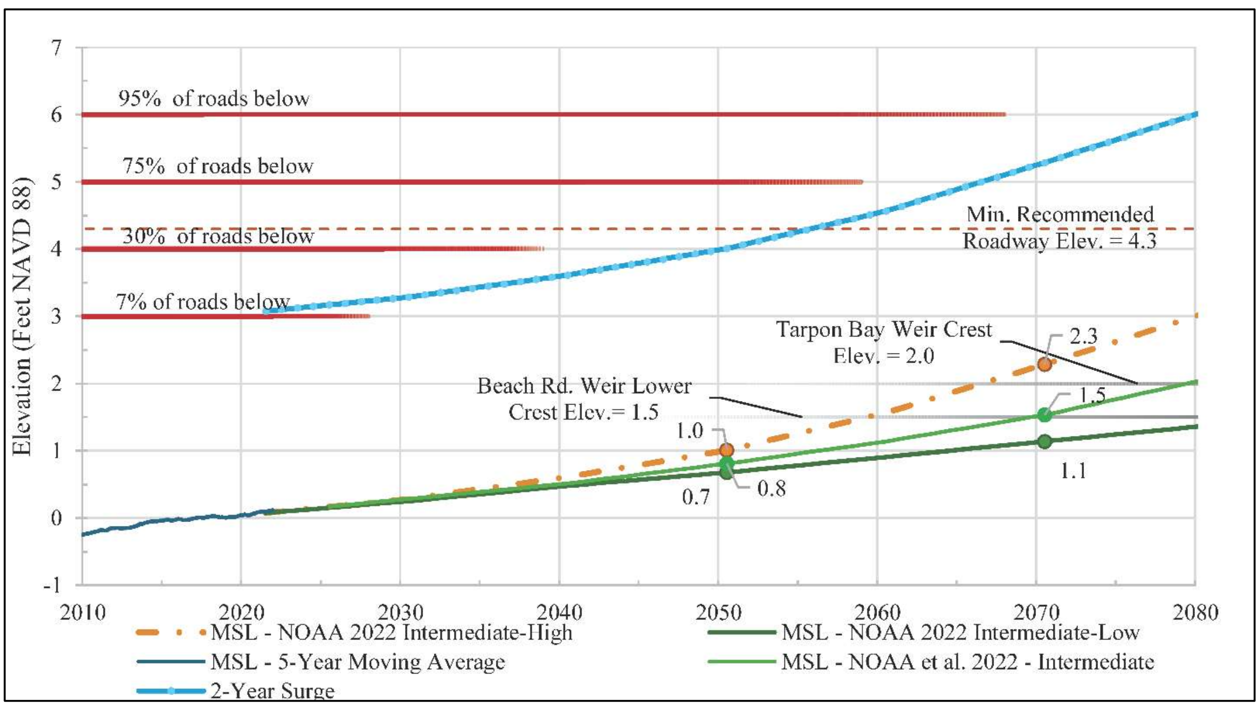

Figure 14. Sea level rise projections for Sanibel, with road elevations and weir crest elevations provided for reference.

Future sea level rise will worsen the impacts of tropical storm surge events, increasing the frequency and depth of flooding on the island. To illustrate this, a 2-year (50-percent-annual-chance) flood depth map was created based on the Intermediate-High curve at 2070 and is provided as **Exhibit 7**. Comparing this with the 2022 map, most developed areas on Sanibel are shown to be inundated with one to four feet of water. This level of inundation is similar to what was recently experienced on Sanibel from Hurricanes Helene and Milton in 2024. Over the next fifty years, residents of Sanibel need to be increasingly in tune with storm forecasts and ready to evacuate the island when necessary.

Table 5 predicts the future frequency of surge events if the Intermediate-High curve becomes reality. As sea level rises, less surge is required for water to reach a given elevation, and it is likely that high-elevation surges will occur more frequently.

As a comparison, Tropical Storm Debby would be considered a 5-year storm today, hurricanes Helene and Milton would be roughly 20-year storms, and Hurricane Ian would be approximately a 300-year storm.

Table 5. Future storm surge frequency following sea level rise.

	Today MSL ≈ 0 feet NAVD 88	***2040*** MSL ≈ 0.6 feet NAVD 88	***2070*** MSL ≈ 2.3 feet NAVD 88
Stillwater Surge Elevation, feet NAVD 88	Return Interval	Return Interval	Return Interval
3	*2-yr*	*< 2-yr*	*< 2-yr*
3.5	*5-yr*	*2-yr*	*< 2-yr*
4	*10-yr*	*5-yr*	*< 2-yr*
6	*25-yr*	*20-yr*	*7-yr*
8	*100-yr*	*80-yr*	*25-yr*
12	*500-yr*	*450-yr*	*270-yr*

4.4 Beach Road Weir and Tarpon Bay Weir

Based on the current 2-year storm surge of 3 feet NAVD 88 shown in **Figure 13**, regular overtopping of the lower crest of both weirs has already begun. This is occurring even with the 1-foot flap gate installed on Beach Road Weir, designed to offer protection against saltwater intrusion from sea levels up to 2.5 feet NAVD 88. To confirm this, specific conductivity data collected upstream of Beach Road Weir over the past 5 years was reviewed along with data collected throughout the west basin.

Specific conductivity is a measure of a solution's ability to conduct electricity and is an indirect measurement of the concentration of dissolved ions in solution. It is often used in place of directly measuring the salinity of a sample. Generally, freshwater's specific conductivity is between 0 and 5 millisiemens per centimeter (mS/cm), ocean water tends to have a value of about 55 mS/cm, and brackish water is in between 5 and 55 mS/cm. **Figure 15** plots specific conductivity at Beach Road Weir along with maximum monthly tide measurements, and **Figure 16** plots specific conductivity at three locations in Sanibel's west basin as shown in **Exhibit 8**.Conductivity data points above the yellow line indicate that water above the Beach Road Weir is brackish, and tide points above the yellow line indicate that the monthly maximum tide exceeded the Beach Road Weir's lower crest elevation of 1.5 feet NAVD 88.

Of the measurements taken at Beach Road Weir from January 2019 to August 2022, most were above 5 mS/cm. This clearly indicates that saltwater is regularly entering the east basin, though it has historically been flushed out by rainwater shortly thereafter. The spikes in conductivity before 2022 appear to be correlated with tides which were higher than the fixed weir crest but lower than the top of the flap gate, so it is possible that the backflow prevention flap allows some saltwater backflow. Measurements taken in the west basin show a similar pattern.

In late September of 2022, Hurricane Ian made landfall in Southwest Florida, bringing massive storm surge with it. Conductivity was not measured in September 2022 due to Ian, and the monthly maximum tide shown on the graph (about 7.6 feet NAVD 88, recorded in Fort Myers) is much lower than the actual water level near the weir on Sanibel. USGS mapping on Sanibel shows the surge elevations ranged from 8 to 13 feet NAVD 88. Since 2022, conductivity levels have been consistently above pre-hurricane levels, showing how long it takes the interior basins to recover to freshwater conditions following such a surge event. There is ongoing flushing of the basin due to rainfall but also likely ongoing saltwater intrusion due to subsequent high tides and storm events. After over two years, the basins still have not recovered to the freshwater range and it remains to be seen how long it will take to return. Recommendations for improvements to the weirs and weir policy are provided in the next section.

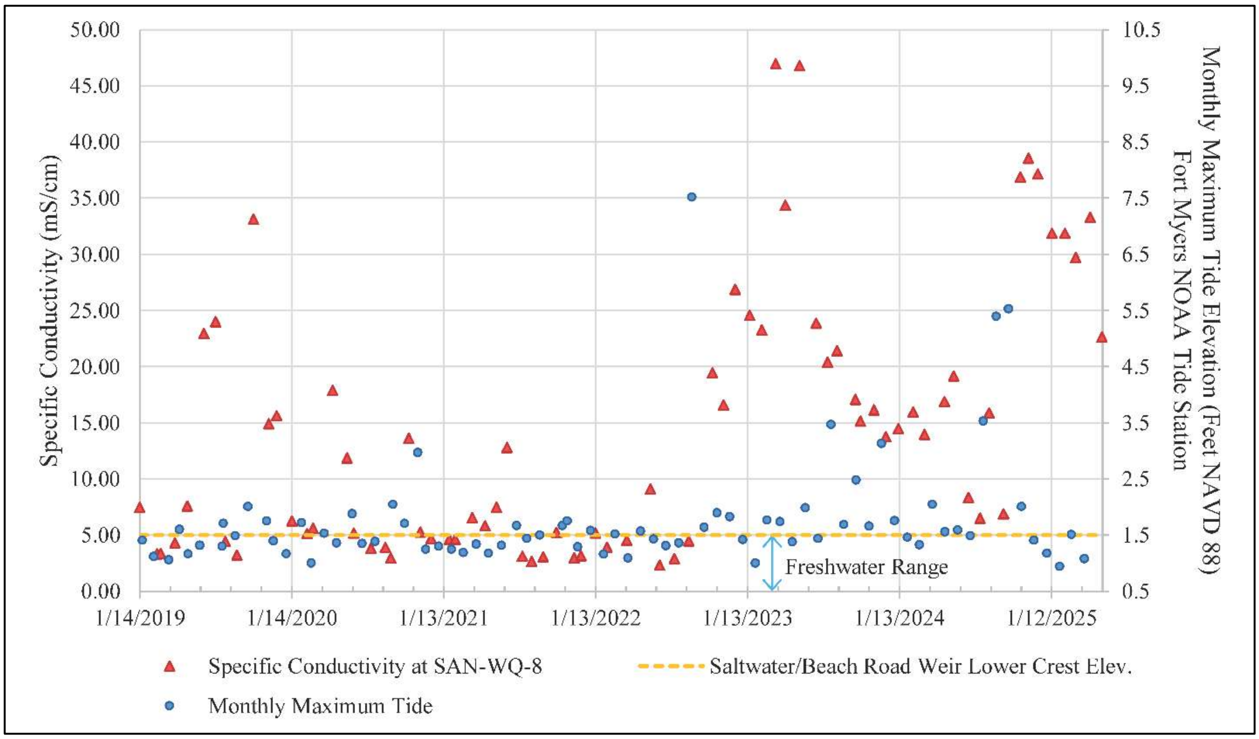

Figure 15. Specific conductivity upstream of Beach Road Weir and maximum monthly tide levels.

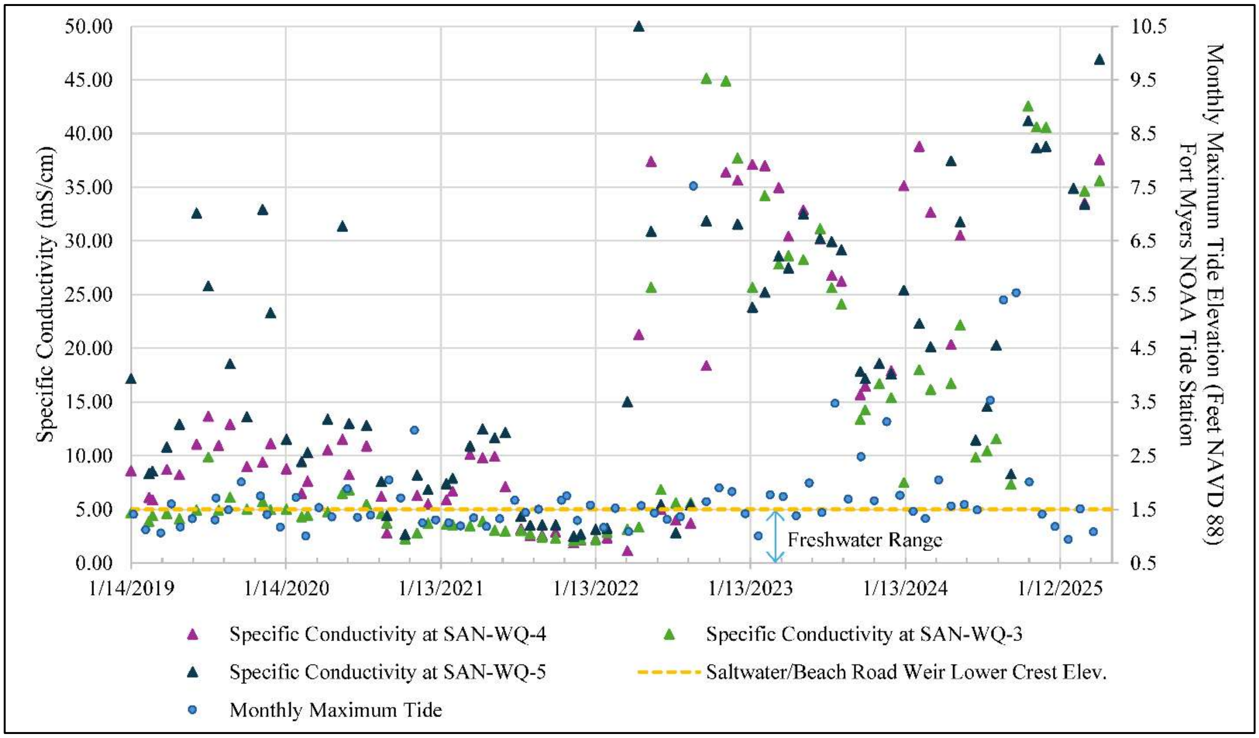

Figure 16. Specific conductivity in the interior basins.

SECTION 5 – CONCLUSIONS AND RECOMMENDATIONS

Improvements to the stormwater management system made by the City of Sanibel since incorporation in 1974 have dramatically reduced rainfall-based flooding across the island, and the system currently performs very well. Extensive data collection and review in the second half of 2024 found that the internal basins generally act as a level pool and runoff is efficiently conveyed to the Sanibel River and outfall weirs. One area found to need improvement was West Gulf Drive, from Island Inn Road to Rabbit Road. This area was also identified as a flood-prone area in the 2018 Stormwater Master Plan.

Recent hurricanes provided reminders that the island is low and vulnerable to storm surge, which is a flooding event that is independent of the interior surface water management system. The primary system was inspected and significant blockages were repaired by the City shortly after each storm. Additional field inspections of the secondary drainage system were conducted in the summer of 2024 to create a comprehensive update of the Surface Water Management Master Plan for Sanibel. The inspections resulted in an updated map of the system and identification of additional needed repairs. A bid solicitation package was advertised by the City in January 2025 to select a contractor to perform the remaining repair work.

A review of multispectral satellite imagery from 2013 to 2024 showed a sudden drop in vegetation greenness and density on Sanibel following Hurricane Ian in September 2022. Despite this, water level sensing equipment on Sanibel confirmed that evapotranspiration is currently occurring at the anticipated rates. This demonstrates the long-term resiliency of natural systems, even if severely impacted in the short term.

Some sensors on Sanibel also confirmed that deep percolation from Sanibel's interior to the sea is near zero, which is consistent with publications from 1953 and 1976. Other sensors recorded that percolation is functioning well when internal retention areas have a ditch immediately adjacent. Groundwater data shows a slight increasing trend in annual minimum water levels since 2017, but the difference is well within the historical range. Surface water stages have largely behaved as expected, increasing with storm events and decreasing during droughts.

East basin water levels changed very little from mid-October through the end of 2024, aside from a gate operation event in mid-November, which correlates with observations from residents that something in the hydrology of Sanibel changes following a storm surge event. Likely factors are reduced evapotranspiration in the first month after the storm, upland areas continually draining into the central conveyance system, a lack of percolation from the interior wetland systems, and mean sea level being at least a half-foot higher during September to November 2024 than the average sea level for the year. Additionally, when the plants on the island are stripped of their leaves after a windstorm it is much easier to see into the wetlands and notice the presence of water which is not as easily observed during times when the vegetation is lusher.

Current groundwater monitoring wells show that maximum water levels on Sanibel in 2024 are very similar to those recorded in 1977. It is recommended that the water table map published in 1988 continue to be utilized as the guide for new development on Sanibel.

Review of data from the second half of 2024 verified that operation of the gates is an effective way to reduce water levels in the basin, with very little rebounding occurring during dry periods once the gates are closed. A slight update to the weir operation policy may be beneficial to encourage the evacuation of saltwater from the interior freshwater basins, reduce environmental damages caused by a prolonged increase in salinity levels, and ensure unintended consequences do not occur due to over-draining the system. This should only be done at the beginning of the wet season, to ensure that water levels do not fall too low. In general, the primary objective of the City's Weir Control Policy should be to continue retaining as much freshwater on the island as practicable. If the City Manager deems it necessary to open the gates based on the 'Miscellaneous' condition, it is recommended that: tidal waters not be allowed to flush back into the basins, water inside the basin be held at least one foot above mean sea level, and coordination occur with the Lee County Mosquito Control District and the Sanibel Fire Department. It is also advised that the vertical datum used in the Weir Control Policy be updated to the newer NAVD 88 from the current NGVD 29. Telemetry upgrades are recommended to the gates at both weirs to allow remote operation of the gates and real-time monitoring of gate position, upstream water level, downstream water level, and salinity.

Mean sea level at the NOAA Tide Station in Fort Myers has averaged 0.17 feet NAVD 88 for the past three years (2022-2024), an increase from -0.5 feet NAVD 88 in the early 1970s and -0.4 feet NAVD 88 in the late 1990s. Sea level rise projections for Sanibel anticipate mean sea level will rise to 1.1 feet NAVD 88 in 2070 based on NOAA's Intermediate-Low scenario, 1.5 feet NAVD 88 in the

Intermediate scenario, or 2.3 feet NAVD 88 in the Intermediate-High scenario. It is recommended that the minimum roadway elevation for Sanibel be at least 4.3 feet NAVD 88, which would require raising approximately 50% of the City's roadways. This provides protection of roadways from road base failure for the next 45 years in the Intermediate-High sea level rise scenario.

FEMA maps of Sanibel published in 2022 show minimal flooding occurs in developed areas during the 2-year storm surge event. However, if the NOAA Intermediate-High sea level rise scenario for 2070 becomes reality, most developed areas will experience flooding in the 2-year storm surge event, with depths ranging from one to four feet above ground level. This level of inundation is similar to what was recently experienced on Sanibel from Hurricanes Helene and Milton in 2024. Over the next fifty years, residents of Sanibel need to be increasingly in tune with storm forecasts and evacuate the island when necessary.

The current 2-year storm surge elevation of 3 feet NAVD 88 indicates that regular overtopping of both weirs should be expected. Adding a backflow prevention flap gate at Tarpon Bay Weir and increasing the height of the existing flap gate at Beach Road Weir would be beneficial in reducing saltwater intrusion into the east basin from monthly high tides and minor storm surge events. However, the maximum height of the flap gate is limited by other low spots around the perimeter of the basins which would allow inflow that bypasses the weirs. In the interim, repairs are required to the flap gate at the Beach Road Weir to ensure the flap gate is achieving a sufficient seal.

SECTION 6 – CAPITAL IMPROVEMENT PLAN

Since incorporation, the City has implemented a number of Capital Improvement Projects that have been beneficial in reducing riverine (rainfall-based) flooding. Steps taken include rebuilding water control structures, replacing undersized culverts, and updating the land development code. Further Capital Improvement Projects are recommended to reduce saltwater intrusion, expedite post-storm recovery efforts, mitigate the effects of projected sea level rise, and improve drainage in flood-prone areas within the City.

Table 6. Capital Improvement Plan.

Short, Intermediate, or Long-term	Master Plan Future Capital	Project Type	Design Cost	Design FY	Construction Cost	Construction FY
Short	Beach Road Weir Flap Gate Modifications	Weir System	$ 65,000	TBD	$ 250,000	TBD
Short	Tarpon Bay Weir Flap Gate Addition	Weir System	$ 65,000	TBD	$ 250,000	TBD
Short	Tradewinds Subdivision Drainage	Area Specific Project	Already Designed	TBD	$ 4,500,000	TBD
Short	Bailey Road Drainage	Area Specific Project	$ 35,000	TBD	$ 150,000	TBD
Short	Sanibel Slough Dredging	Slough Dredging	$ 212,000	25	$ 1,630,000	26
Short	Clam Bayou Box Culvert Replacement	Box Culvert	$ 800,000	26	$ 4,000,000	27
Short	East Periwinkle Box Culvert Replacement	Box Culvert	$ 750,000	29	$ 4,000,000	30
Short	*Annual Swale Maintenance*	*Ongoing Maintenance*	--	--	*$ 250,000 – $ 500,000*	*Annually*
Intermediate	Beach Road Weir Pump Station	Weir System	$ 300,000	TBD	$ 2,500,000	TBD
Intermediate	Tarpon Bay Weir Pump Station	Weir System	$ 300,000	TBD	$ 4,900,000	TBD
Intermediate	Beach Road Weir Gate Automation	Weir System	$ 55,000	TBD	$ 200,000	TBD
Intermediate	Tarpon Bay Weir Gate Automation	Weir System	$ 55,000	TBD	$ 200,000	TBD
Intermediate	West Gulf Drive Drainage	Area Specific Project	$ 240,000	TBD	$ 2,400,000	TBD
Long	Road Elevating (Dixie, Bailey, Tarpon)	Road Elevation	$ 2,924,000	TBD	$ 29,240,000	TBD
	FY26 Total		**$ 910,000**		**$ 1,630,000**	
	Total		**$ 5,801,000**		**$ 54,220,000**	

6.1 2018 Master Plan Recommendations

The following table shows the status of various recommendations made in the 2018 Master Plan.

Table 7. Status of 2018 Master Plan recommendations.

Project	Status
Dredging Sanibel Slough	Underway
Jamaica & Tahiti Flood Improvements	Designed
Flood Prone Areas	Underway in East Rocks area
Algiers Lane south of Casa Ybel Rd Flood Improvements	
Atlanta Plaza Drive north side of Casa Ybel Road Flood Improvements	
Periwinkle Way and Dixie Beach Boulevard Flood Improvements	
Residential streets around Donax Street from Middle Gulf Drive to Junonia Street Flood Improvements	
Switching to a GIS-based inspection system	Underway
Land Development Code changes	

6.2 Weir System Improvements

Improvements to the existing outfall weirs are recommended to improve operational flexibility and reduce saltwater intrusion into the interior freshwater wetland ecosystem in the City's interior.

Pump Stations at Weirs: As previously noted, high sea level is the primary limitation to flow out of the weir gates. Releases generally occur when freshwater stages are well above sea level, but there are times when the City Manager may want to preemptively evacuate as much water as possible (e.g., before a hurricane). When tidal waters exceed interior freshwater stages, the gates cannot be opened since they would not be able to lower the stage and would instead allow saltwater backflow. And, with potential future sea level rise, this could become a more common obstacle to releasing water. To combat this issue, pump stations could be installed at both weirs. This improvement would give the City Manager an increased ability to release water when the gravity system is limited by high tides. However, it should be noted that pumps will not negate storm surge or increase flow capacity – they would simply allow the system to continue working as it does today.

Flow through the existing weir gates was considered when determining appropriate pump sizes. Given a head difference of 6 inches between headwater and tailwater at the weirs, the

Beach Road Weir gates would allow a flow of about 91,000 gallons per minute (gpm), or 204 cubic feet per second (cfs). Under the same conditions, the Tarpon Bay Weir gates would allow a flow of around 183,000 gpm, or 408 cfs. These flows are significant, and several pumps operating simultaneously would be required to match this flow capacity. Space constraints around the weirs will likely limit the size of the pumps to be much smaller than these conceptual flowrates.

Three pump size options for each weir were evaluated, and the time it would take each to reduce basin water levels by 6 inches was estimated. In this scenario, it is assumed that no rainfall or other inflow occurs during while the drawdown is performed. These options are compared in **Table 8**.

For constructability and budgetary reasons, it is recommended that portable trailer pumps be considered as an alternative to constructing permanent pump stations. If trailer pumps were implemented, it is estimated that a maximum of two pumps with capacities of 30 cfs each could be placed at Beach Road Weir, and four at Tarpon Bay Weir. In this scenario, Beach Road Weir would have a pumping capacity of 60 cfs, and Tarpon Bay Weir would have a capacity of 120 cfs. The 1989 Conceptual Plan for an entirely pump-controlled surface water management system recommended pump sizes of 60 cfs and 350 cfs for the Beach Road and Tarpon Bay weirs, respectively, under the “all pump” scenario, which was not the final recommendation of the report. The report instead recommended continuing with gravity flow at the weirs. Stormwater modeling performed for the 2018 Master Plan shows that the peak flow at Beach Road Weir for the 3-year, 1-hour design storm (depth = 2.4 inches) is about 150 cfs, and this flow capacity was included as an option in the table at both locations.

Table 8. Comparison of pump sizes and drawdown times.

Weir	Scenario	Flow (cfs)	6" Drawdown Time (hours)
Tarpon Bay	*Four Trailer Pumps*	120	40
Tarpon Bay	*150 cfs Design Match*	150	32
Tarpon Bay	*1989 Plan “All Pump” Scenario*	350	14
Tarpon Bay	*Existing Gates (No Pump)*	408	12
Beach Road	*1989 Plan “All Pump” Scenario*	50	64
Beach Road	*Two Trailer Pumps*	60	54
Beach Road	*3-Year, 1-Hour Storm*	150	22

Beach Road	*Existing Gates (No Pump)*	204	16

It is estimated that pump station design for each weir will cost $300,000, and construction costs for Beach Road and Tarpon Bay weirs will be approximately $2.5 million and $4.9 million, respectively. This yields a total cost of $2.8 million for the Beach Road pumpstation and $5.2 million for the Tarpon Bay pumpstation.

Automation of Weir Gates: Currently, weir gates must be manually opened or closed by on-site personnel. Installing motors with a remote operating system would make it possible for city staff to operate the gates without having to place themselves in potentially dangerous situations by going out to the weir during storms. Additionally, since it would allow for remote operation of the gates at night, it would allow the City to adjust the gates without being on-site in the middle of the night. Automating the weir gates is expected to cost $220,000 for each weir, or $440,000 total.

Weir Flap Gate Modifications: Beach Road Weir already has a 1-foot flap gate which is designed to protect against saltwater intrusion from sea levels up to 2.5 feet NAVD 88. Based on historical specific conductivity data, it is possible that this flap is not sealed properly. If this is true, it is recommended that the flap gate be repaired. The City may also want to consider installing a larger flap gate to prevent saltwater intrusion at stages above 2.5 feet NAVD 88.

Tarpon Bay Weir has a crest elevation of 2.0 feet NAVD 88 and does not have a flap gate. As a result, it is more vulnerable to backflow than Beach Road Weir is, so installing a backflow prevention gate may be advantageous. Flap gate modifications are expected to cost $315,000 for each weir, or $630,000 total.

6.3 Box Culvert Installations

Based on post-Ian inspections by others, the existing box culverts at Clam Bayou and East Periwinkle are are damaged and should be replaced.

Clam Bayou Box Culvert: Design for the Clam Bayou Culvert is expected to cost $800,000 and begin in FY 26, and construction is anticipated to cost about $4 million and begin in FY 27. Funding will be provided by the Hurricane Ian Stormwater Repair grant from FDEP.

East Periwinkle Box Culvert: Designing the East Periwinkle Box Culvert will cost approximately $750,000, and construction will cost about $4 million. Design is expected to begin in FY 29 and construction in FY 30.

6.4 Area-Specific Projects

The 2018 Master Plan found that the repetitive flooding which occurs in certain areas of Sanibel is likely a localized issue caused by a lack of maintenance or hydraulic connectivity to the Sanibel River.

Tradewinds Subdivision Drainage: The City has identified the Tradewinds subdivision as a flood-prone area. According to drainage improvement plans developed by Haley Ward, Inc., the system was initially designed to outfall into the Gulf but is now routed to the interior of the island. The drainage system needs to be updated so that flow will be directed toward the Sanibel River. This will involve regrading swales and replacing or adding new culverts and inlets. As design is complete, only construction costs need to be accounted for. It is expected that construction of this project will cost about $4.5 million, and it has not yet been decided when construction will begin.

West Gulf Drive Drainage: West Gulf Drive has been identified as a flood-prone area, likely due to a lack of drainage infrastructure. The suggested improvement project would involve improvement of approximately 2,700 LF of roadside swales and culverts, which would connect to the swale on the east side of Rabbit Road. This project was also recommended in the 2018 Stormwater Master Plan. Adjusting the 2018 cost estimate for inflation, improvements are expected to cost about $2,400,000.

Bailey Road Drainage Improvements: This project is the addition of a culvert under Bailey Road to improve hydraulic connectivity. This improvement is anticipated to cost $185,000 total, with no date set for beginning design or construction.

6.5 Road Elevation

Following the citywide analysis of roadway elevations, city representatives identified three roads as ideal candidates for being raised to the minimum recommended roadway elevation of 4.3 feet NAVD 88 to maintain road base integrity. In total, the construction costs of raising these roads is anticipated to be about $29 million. Dixie Beach Boulevard and Bailey Road were chosen as they are some of the lowest-elevation roads on Sanibel, problematically low (as seen in **Exhibit 4**), and Tarpon Bay Road is an important thoroughfare with some areas below the standard.

In total, raising 2.75 miles of road to 4.3 feet NAVD 88 is proposed. It is estimated that procuring and installing sheet piles will cost $6.3 million per mile, accounting for over half the project's cost. See **Table 9** for a detailed cost breakdown.

Dixie Beach Boulevard Elevating: This project involves raising 1.74 miles of paved road to elevation 4.3 feet NAVD 88. Currently, this road's average elevation is about 2.89 feet NAVD 88. Construction costs are anticipated to be approximately $18,700,000.

Bailey Road Elevating: This project involves raising 0.42 miles of paved road to elevation 4.3 feet NAVD 88. Currently, this road's average elevation is about 3.09 feet NAVD 88. Construction costs are anticipated to be approximately $4,500,000.

Tarpon Bay Road Elevating: This project involves raising 0.59 miles of paved road to elevation 4.3 feet NAVD 88. On average, this section is at elevation 3.96 feet NAVD 88. Construction costs are anticipated to be approximately $6,100,000.

Table 9. Itemized cost estimate for elevating roads.

Bid Line Item	Dixie Beach	Bailey Road	Tarpon Bay Road
Mobilization	$1,291,000	$307,000	$418,000
Maintenance of Traffic	$645,000	$154,000	$209,000
Sheet Pile	$10,962,000	$2,646,000	$3,717,000
Import Fill	$1,300,000	$268,000	$216,000
Asphalt Overlay	$375,000	$91,000	$128,000
Asphalt Milling	$247,000	$60,000	$114,000
Road Striping	$27,000	$7,000	$9,000
30% Contingency	$3,873,000	$921,000	$1,255,000
Sub-Total	*$18,720,000*	*$4,454,000*	*$6,066,000*
		Total	**$29,240,000**

6.6 Sanibel Slough Dredging

Sanibel Slough is considered "impaired" by the Florida Department of Environmental Protection (FDEP) due to excessive nutrients. To improve water quality and increase stormwater capacity, a dredging project is underway. This project is the dredging of approximately 1,100 linear feet of canal between Elinor Road and Beach Road. This project is currently in the permitting phase and construction is expected to cost about $1.63 million. Dredging is expected to begin in FY 26 and will be funded by grants from FDEP and EPA.

Once construction is complete, the City will monitor water quality and stormwater capacity improvements to determine if dredging other areas would be beneficial.

SECTION 7 – REFERENCES

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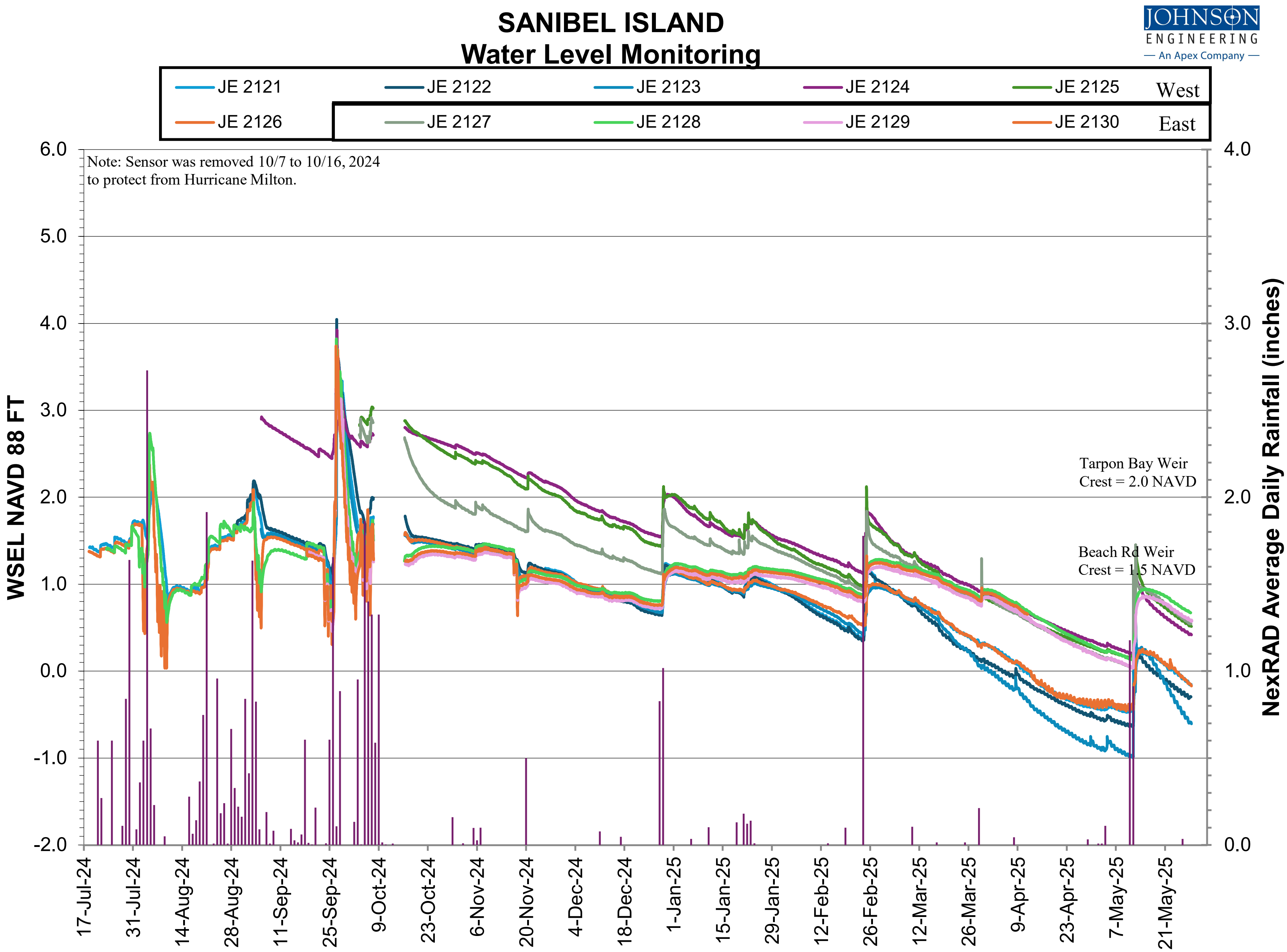
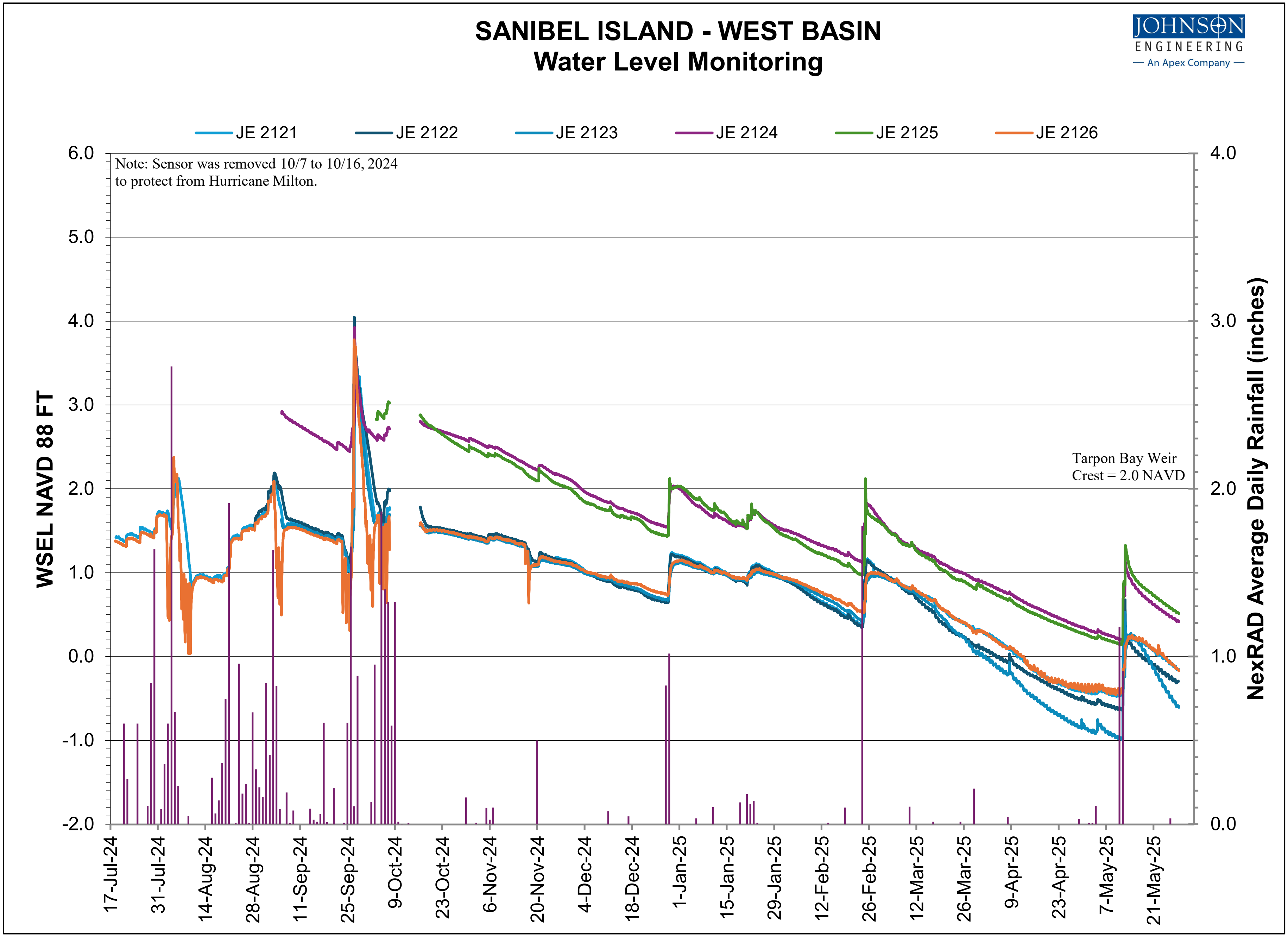
SANIBEL ISLAND
Water Level Monitoring





SANIBEL ISLAND - WEST BASIN
Water Level Monitoring
JOHNSON ENGINEERING
— An Apex Company —
JE 2121
JE 2122
JE 2123
JE 2124
JE 2125
JE 2126
Note: Sensor was removed 10/7 to 10/16, 2024
to protect from Hurricane Milton.
Tarpon Bay Weir
Crest = 2.0 NAVD
WSEL NAVD 88 FT
NexRAD Average Daily Rainfall (inches)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
4.0
3.0
2.0
1.0
0.0
17-Jul-24
31-Jul-24
14-Aug-24
28-Aug-24
11-Sep-24
25-Sep-24
9-Oct-24
23-Oct-24
6-Nov-24
20-Nov-24
4-Dec-24
18-Dec-24
1-Jan-25
15-Jan-25
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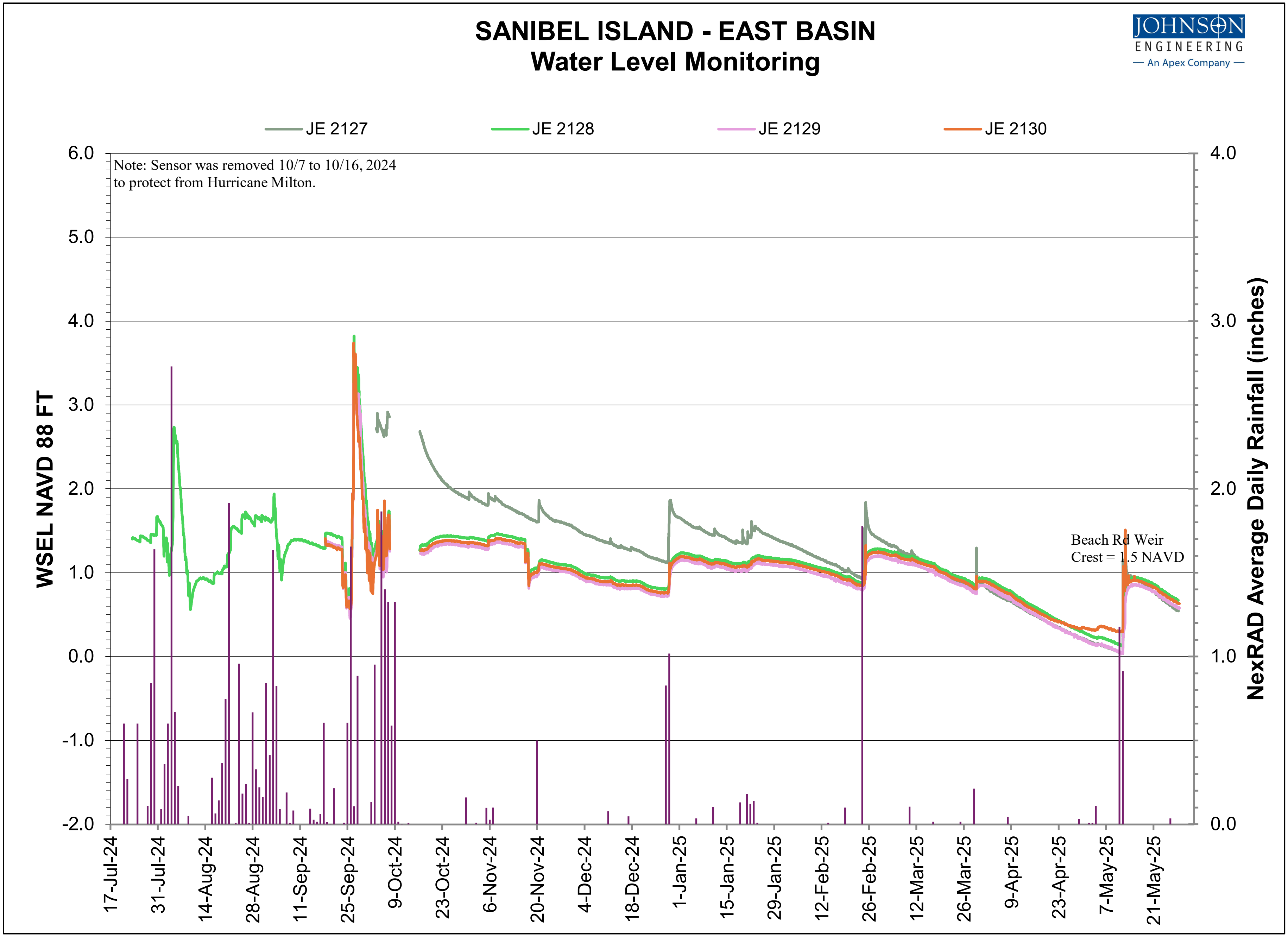
7-May-25
21-May-25



SANIBEL ISLAND - EAST BASIN
Water Level Monitoring
JOHNSON ENGINEERING
— An Apex Company —
JE 2127
JE 2128
JE 2129
JE 2130
Note: Sensor was removed 10/7 to 10/16, 2024 to protect from Hurricane Milton.
Beach Rd Weir Crest = 1.5 NAVD
WSEL NAVD 88 FT
NexRAD Average Daily Rainfall (inches)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
4.0
3.0
2.0
1.0
0.0
17-Jul-24
31-Jul-24
14-Aug-24
28-Aug-24
11-Sep-24
25-Sep-24
9-Oct-24
23-Oct-24
6-Nov-24
20-Nov-24
4-Dec-24
18-Dec-24
1-Jan-25
15-Jan-25
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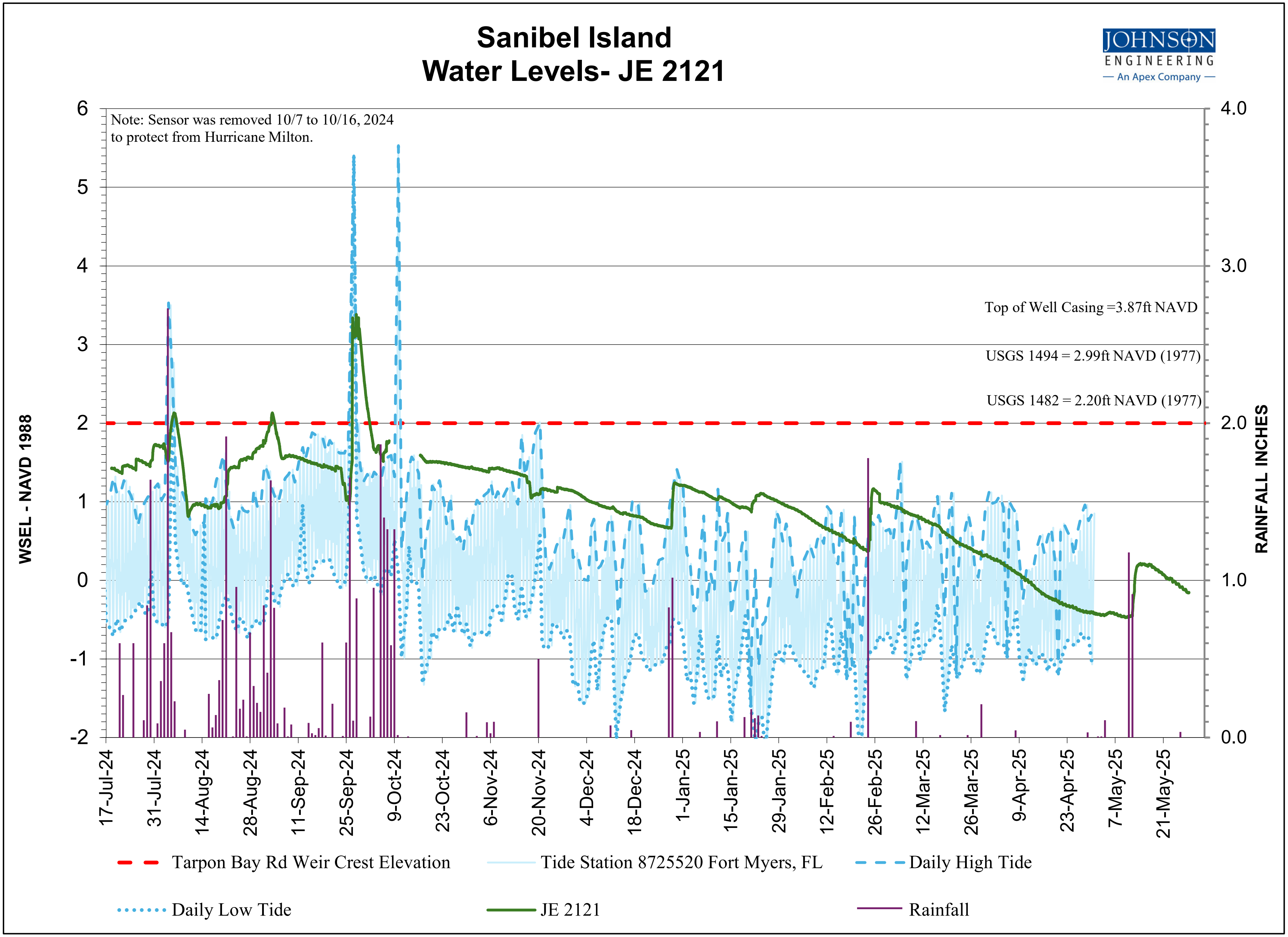
7-May-25
21-May-25


Sanibel Island
Water Levels- JE 2121
JOHNSON ENGINEERING
— An Apex Company —
Note: Sensor was removed 10/7 to 10/16, 2024
to protect from Hurricane Milton.
Top of Well Casing =3.87ft NAVD
USGS 1494 = 2.99ft NAVD (1977)
USGS 1482 = 2.20ft NAVD (1977)
WSEL - NAVD 1988
RAINFALL INCHES
6
5
4
3
2
1
0
-1
-2
4.0
3.0
2.0
1.0
0.0
17-Jul-24
31-Jul-24
14-Aug-24
28-Aug-24
11-Sep-24
25-Sep-24
9-Oct-24
23-Oct-24
6-Nov-24
20-Nov-24
4-Dec-24
18-Dec-24
1-Jan-25
15-Jan-25
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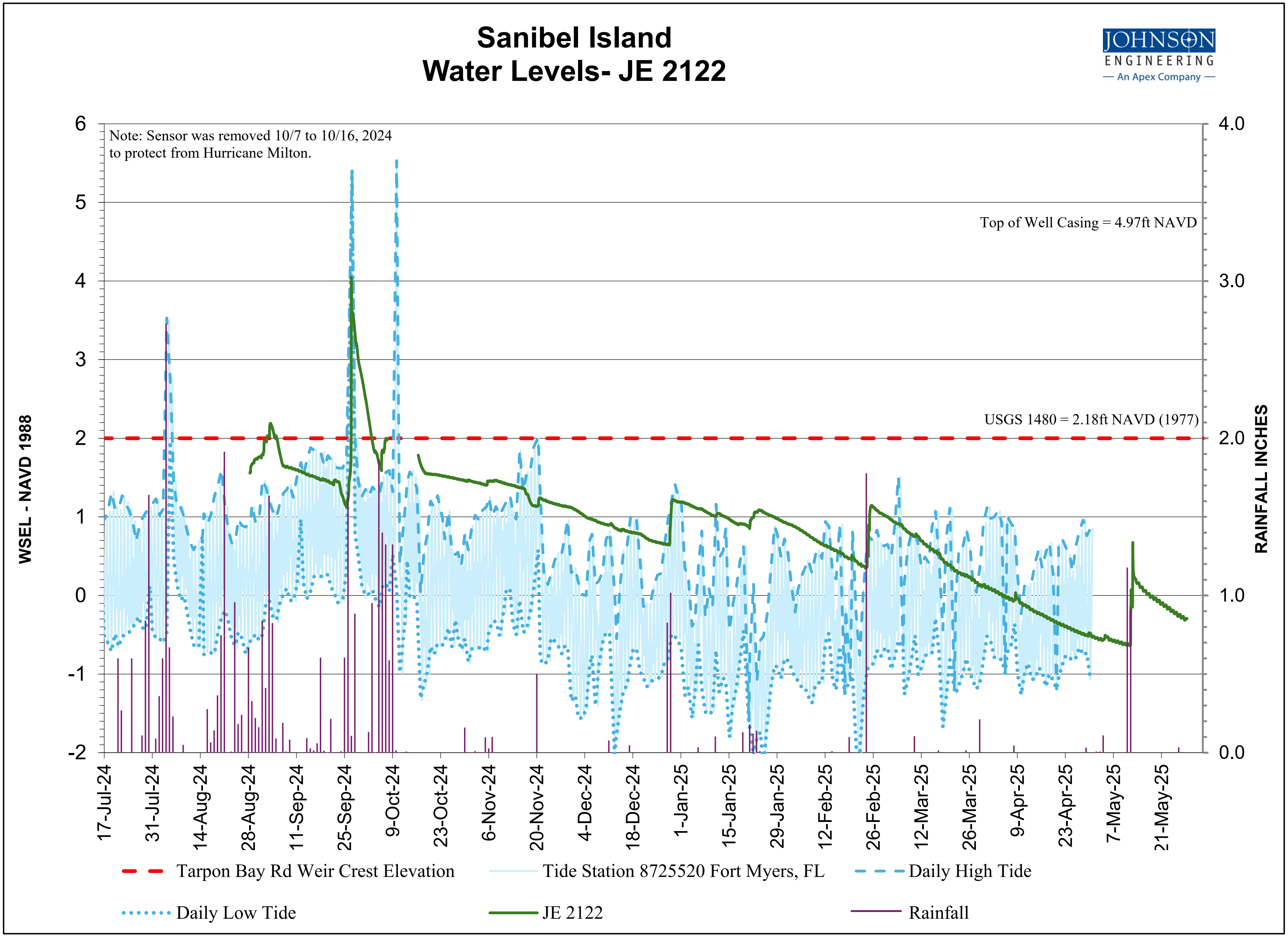
12-Feb-25
26-Feb-25
12-Mar-25
26-Mar-25
9-Apr-25
23-Apr-25
7-May-25
21-May-25
Tarpon Bay Rd Weir Crest Elevation
Tide Station 8725520 Fort Myers, FL
Daily High Tide
Daily Low Tide
JE 2121
Rainfall



Sanibel Island
Water Levels- JE 2122
JOHNSON ENGINEERING
— An Apex Company —
Note: Sensor was removed 10/7 to 10/16, 2024
to protect from Hurricane Milton.
Top of Well Casing = 4.97ft NAVD
USGS 1480 = 2.18ft NAVD (1977)
WSEL - NAVD 1988
RAINFALL INCHES
6
5
4
3
2
1
0
-1
-2
4.0
3.0
2.0
1.0
0.0
17-Jul-24
31-Jul-24
14-Aug-24
28-Aug-24
11-Sep-24
25-Sep-24
9-Oct-24
23-Oct-24
6-Nov-24
20-Nov-24
4-Dec-24
18-Dec-24
1-Jan-25
15-Jan-25
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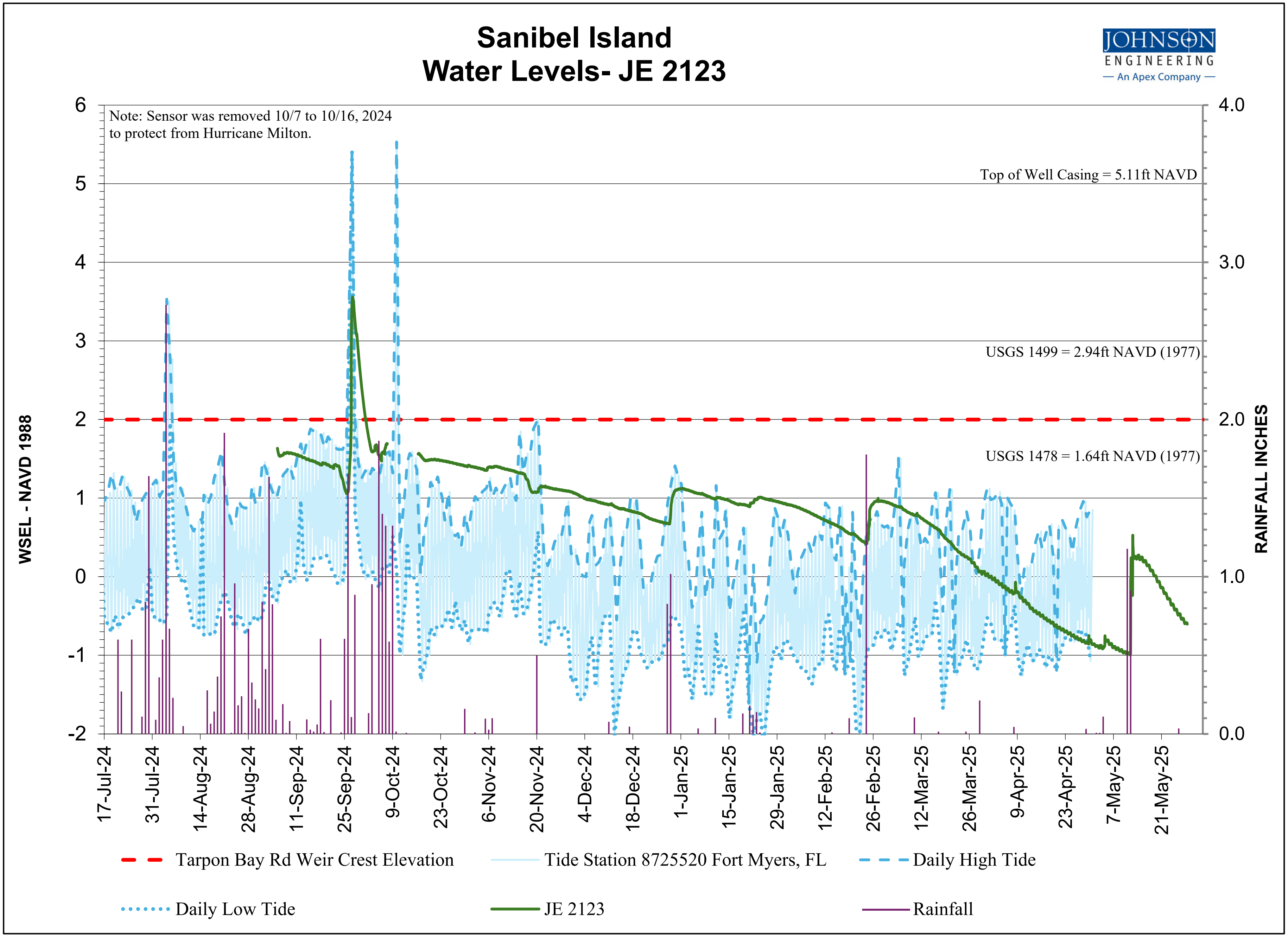
12-Mar-25
26-Mar-25
9-Apr-25
23-Apr-25
7-May-25
21-May-25
Tarpon Bay Rd Weir Crest Elevation
Tide Station 8725520 Fort Myers, FL
Daily High Tide
Daily Low Tide
JE 2122
Rainfall


Sanibel Island
Water Levels- JE 2123
JOHNSON ENGINEERING — An Apex Company —
Note: Sensor was removed 10/7 to 10/16, 2024
to protect from Hurricane Milton.
Top of Well Casing = 5.11ft NAVD
USGS 1499 = 2.94ft NAVD (1977)
USGS 1478 = 1.64ft NAVD (1977)
WSEL - NAVD 1988
RAINFALL INCHES
6
5
4
3
2
1
0
-1
-2
4.0
3.0
2.0
1.0
0.0
17-Jul-24
31-Jul-24
14-Aug-24
28-Aug-24
11-Sep-24
25-Sep-24
9-Oct-24
23-Oct-24
6-Nov-24
20-Nov-24
4-Dec-24
18-Dec-24
1-Jan-25
15-Jan-25
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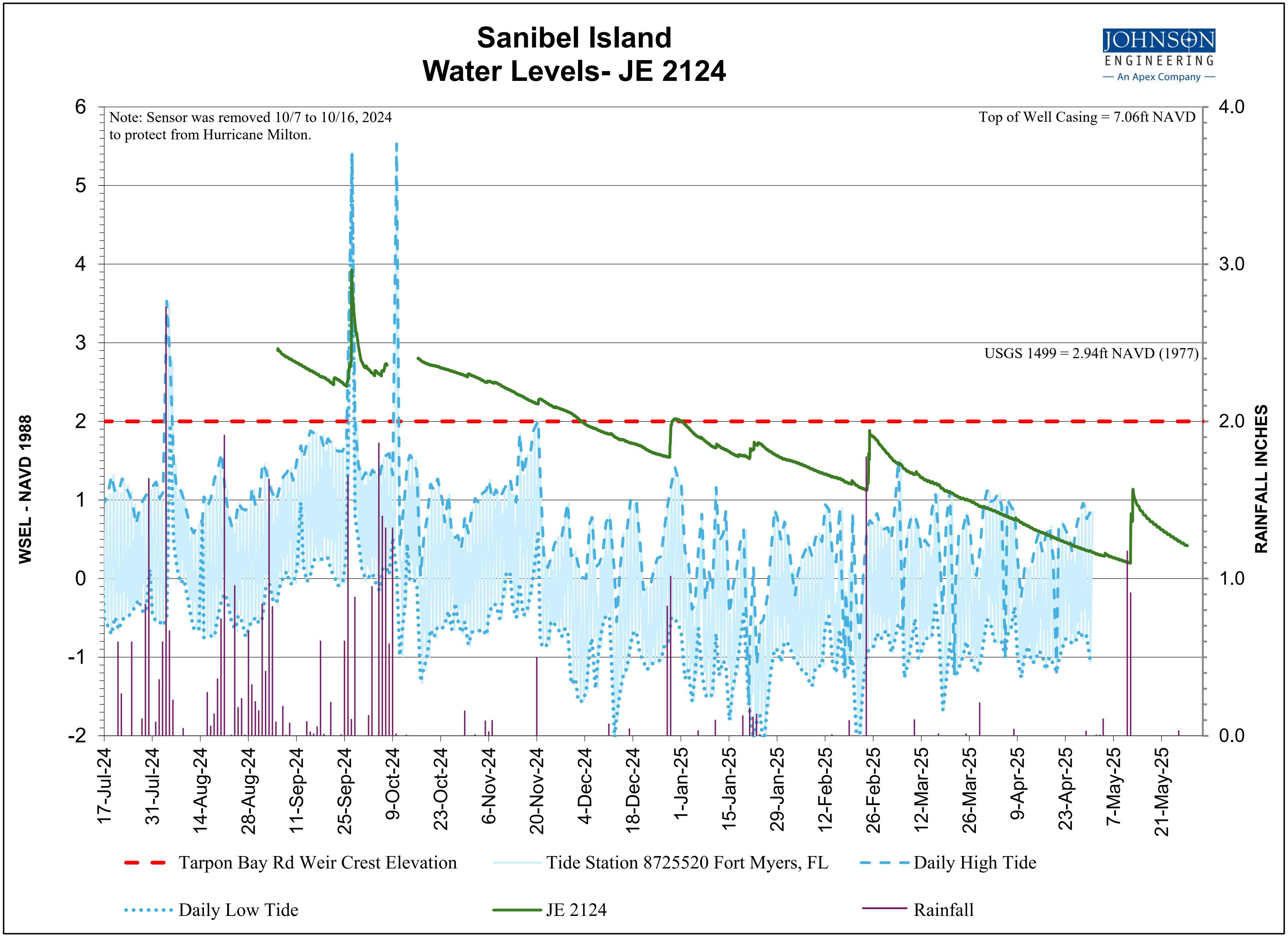
26-Feb-25
12-Mar-25
26-Mar-25
9-Apr-25
23-Apr-25
7-May-25
21-May-25
Tarpon Bay Rd Weir Crest Elevation
Tide Station 8725520 Fort Myers, FL
Daily High Tide
Daily Low Tide
JE 2123
Rainfall



Sanibel Island
Water Levels- JE 2124
JOHNSON ENGINEERING
— An Apex Company —
Note: Sensor was removed 10/7 to 10/16, 2024
to protect from Hurricane Milton.
Top of Well Casing = 7.06ft NAVD
USGS 1499 = 2.94ft NAVD (1977)
WSEL - NAVD 1988
RAINFALL INCHES
6
5
4
3
2
1
0
-1
-2
4.0
3.0
2.0
1.0
0.0
17-Jul-24
31-Jul-24
14-Aug-24
28-Aug-24
11-Sep-24
25-Sep-24
9-Oct-24
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6-Nov-24
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9-Apr-25
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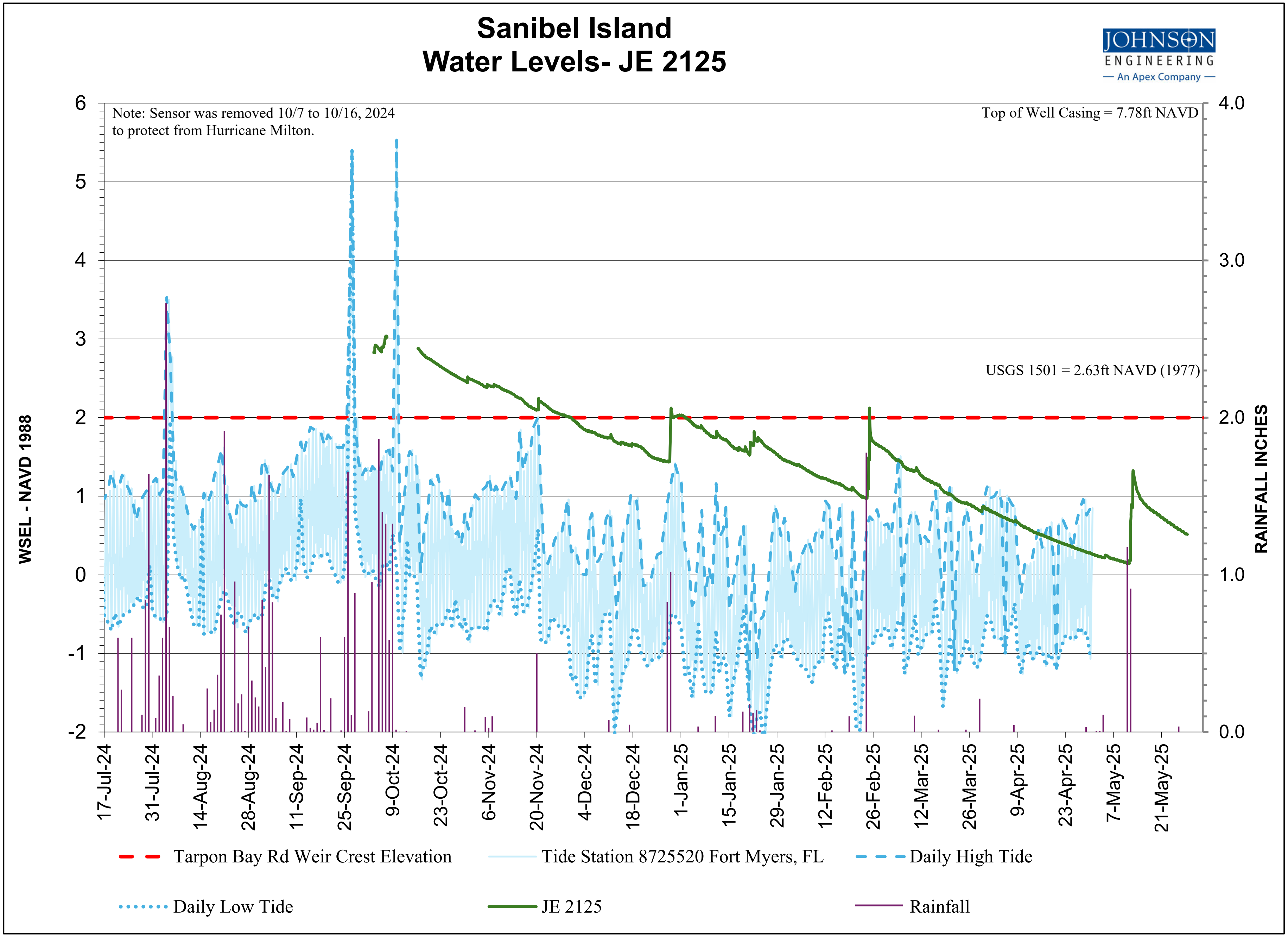
Tide Station 8725520 Fort Myers, FL
Daily High Tide
Daily Low Tide
JE 2124
Rainfall



Sanibel Island
Water Levels- JE 2125
JOHNSON ENGINEERING — An Apex Company
Note: Sensor was removed 10/7 to 10/16, 2024 to protect from Hurricane Milton.
Top of Well Casing = 7.78ft NAVD
USGS 1501 = 2.63ft NAVD (1977)
WSEL - NAVD 1988
RAINFALL INCHES
6
5
4
3
2
1
0
-1
-2
4.0
3.0
2.0
1.0
0.0
17-Jul-24
31-Jul-24
14-Aug-24
28-Aug-24
11-Sep-24
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9-Oct-24
23-Oct-24
6-Nov-24
20-Nov-24
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12-Mar-25
26-Mar-25
9-Apr-25
23-Apr-25
7-May-25
21-May-25
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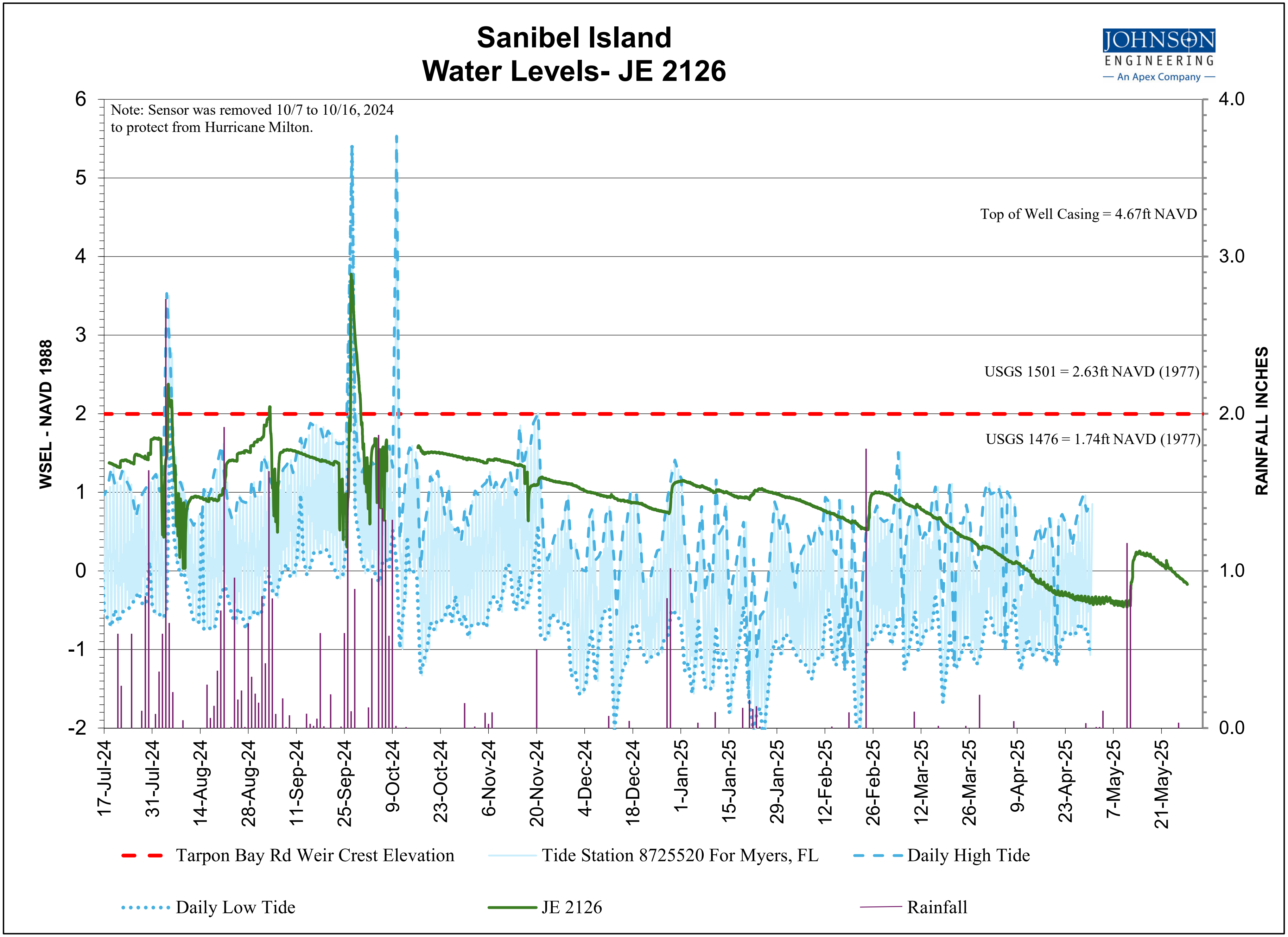
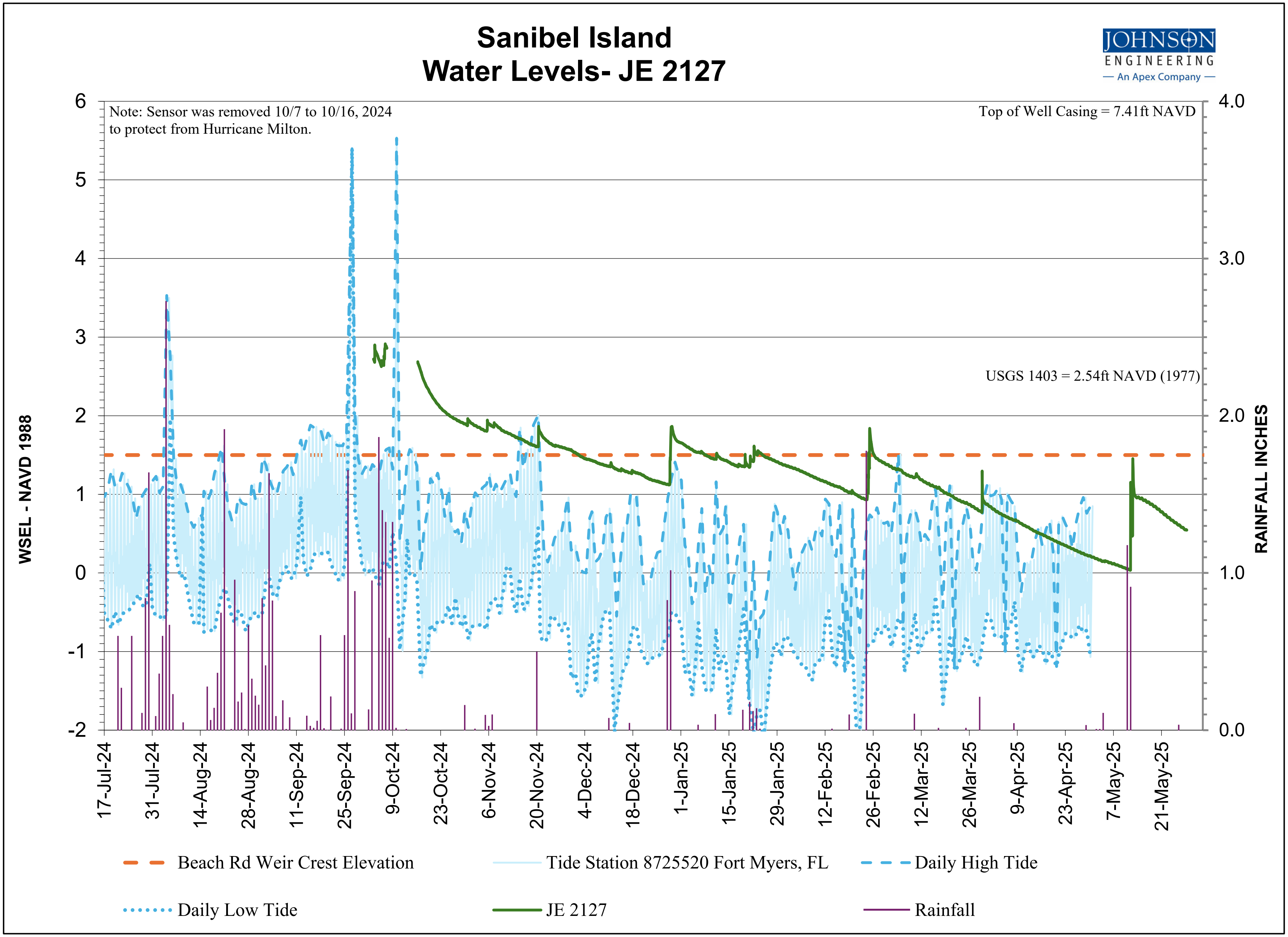
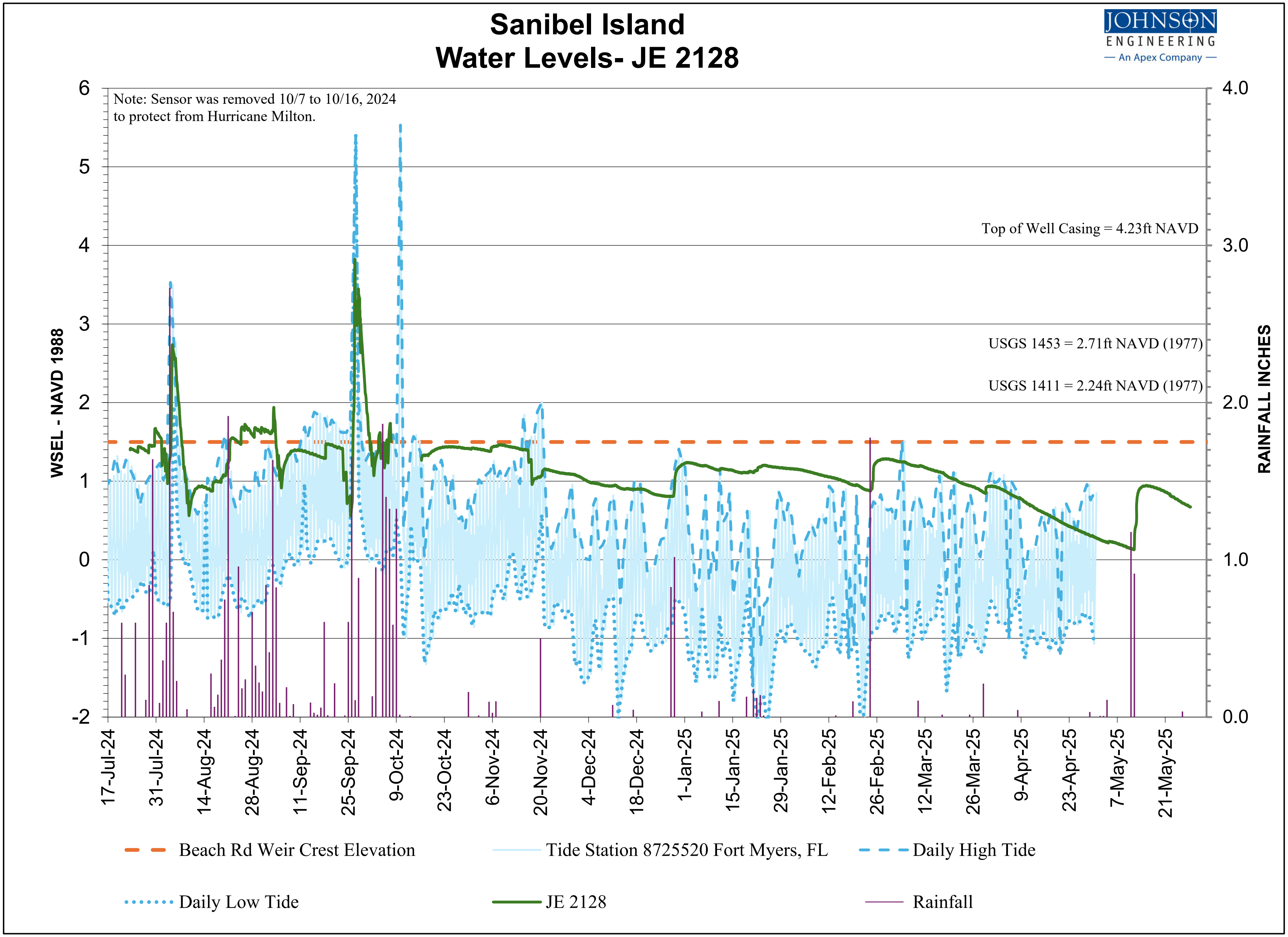
Tide Station 8725520 Fort Myers, FL
Daily High Tide
Daily Low Tide
JE 2125
Rainfall

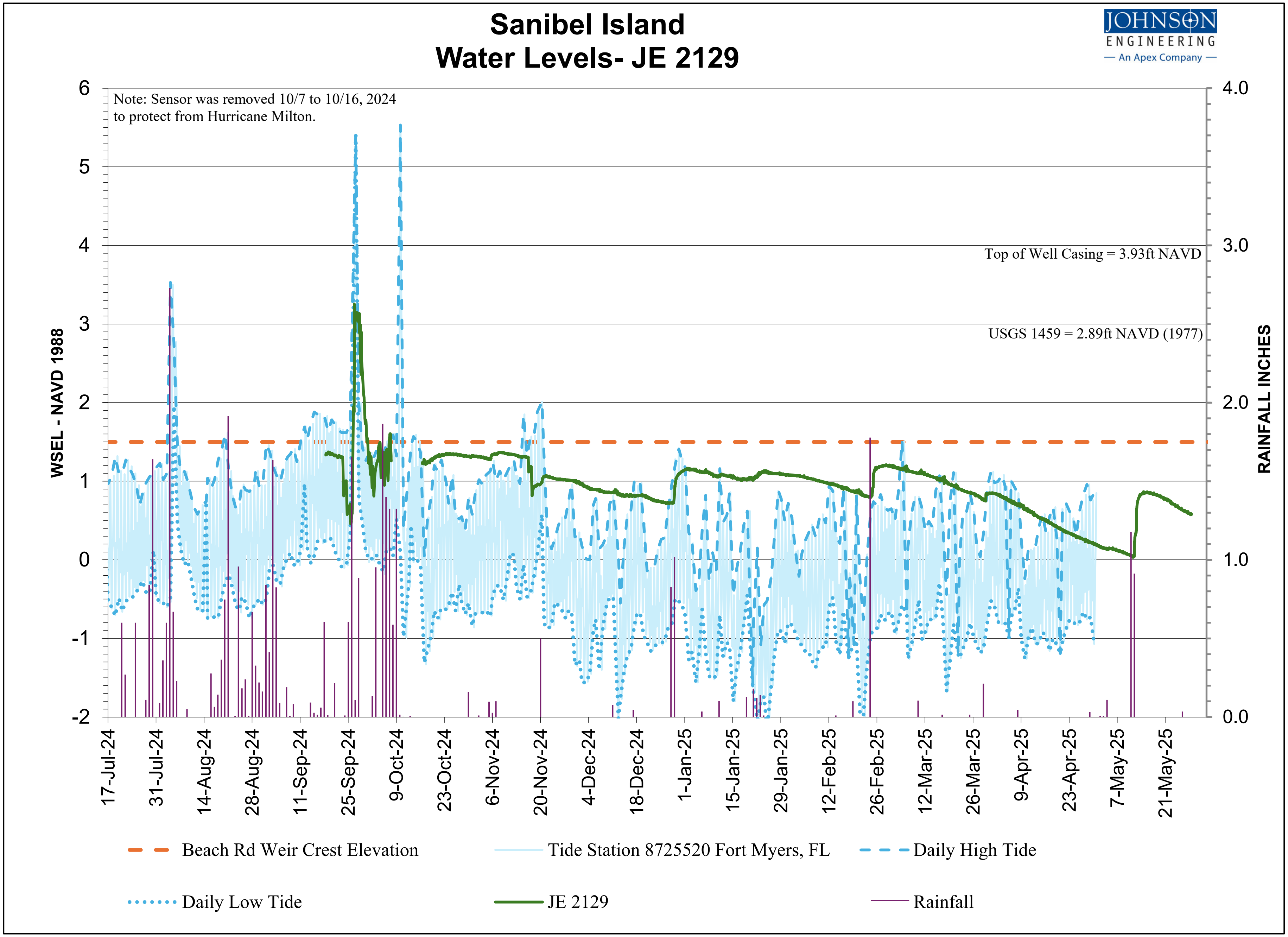


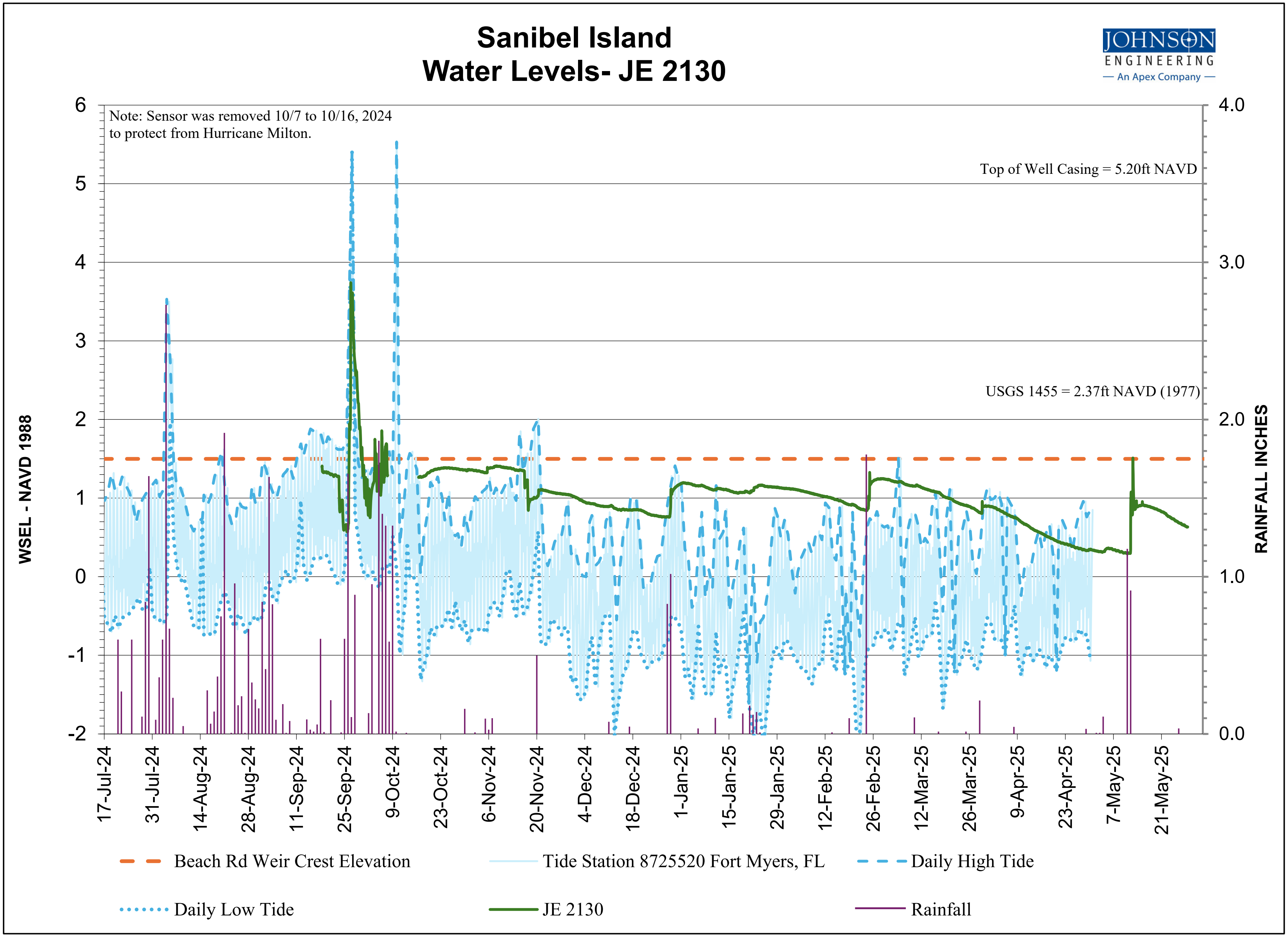
Sanibel Island
Water Levels- JE 2126
JOHNSON ENGINEERING
— An Apex Company —
Note: Sensor was removed 10/7 to 10/16, 2024 to protect from Hurricane Milton.
Top of Well Casing = 4.67ft NAVD
USGS 1501 = 2.63ft NAVD (1977)
USGS 1476 = 1.74ft NAVD (1977)
WSEL - NAVD 1988
RAINFALL INCHES
6
5
4
3
2
1
0
-1
-2
4.0
3.0
2.0
1.0
0.0
17-Jul-24
31-Jul-24
14-Aug-24
28-Aug-24
11-Sep-24
25-Sep-24
9-Oct-24
23-Oct-24
6-Nov-24
20-Nov-24
4-Dec-24
18-Dec-24
1-Jan-25
15-Jan-25
29-Jan-25
12-Feb-25
26-Feb-25
12-Mar-25
26-Mar-25
9-Apr-25
23-Apr-25
7-May-25
21-May-25
Tarpon Bay Rd Weir Crest Elevation
Tide Station 8725520 For Myers, FL
Daily High Tide
Daily Low Tide
JE 2126
Rainfall


Sanibel Island
Water Levels- JE 2127
JOHNSON ENGINEERING
— An Apex Company —
Note: Sensor was removed 10/7 to 10/16, 2024
to protect from Hurricane Milton.
Top of Well Casing = 7.41ft NAVD
USGS 1403 = 2.54ft NAVD (1977)
WSEL - NAVD 1988
RAINFALL INCHES
6
5
4
3
2
1
0
-1
-2
4.0
3.0
2.0
1.0
0.0
17-Jul-24
31-Jul-24
14-Aug-24
28-Aug-24
11-Sep-24
25-Sep-24
9-Oct-24
23-Oct-24
6-Nov-24
20-Nov-24
4-Dec-24
18-Dec-24
1-Jan-25
15-Jan-25
29-Jan-25
12-Feb-25
26-Feb-25
12-Mar-25
26-Mar-25
9-Apr-25
23-Apr-25
7-May-25
21-May-25
Beach Rd Weir Crest Elevation
Tide Station 8725520 Fort Myers, FL
Daily High Tide
Daily Low Tide
JE 2127
Rainfall

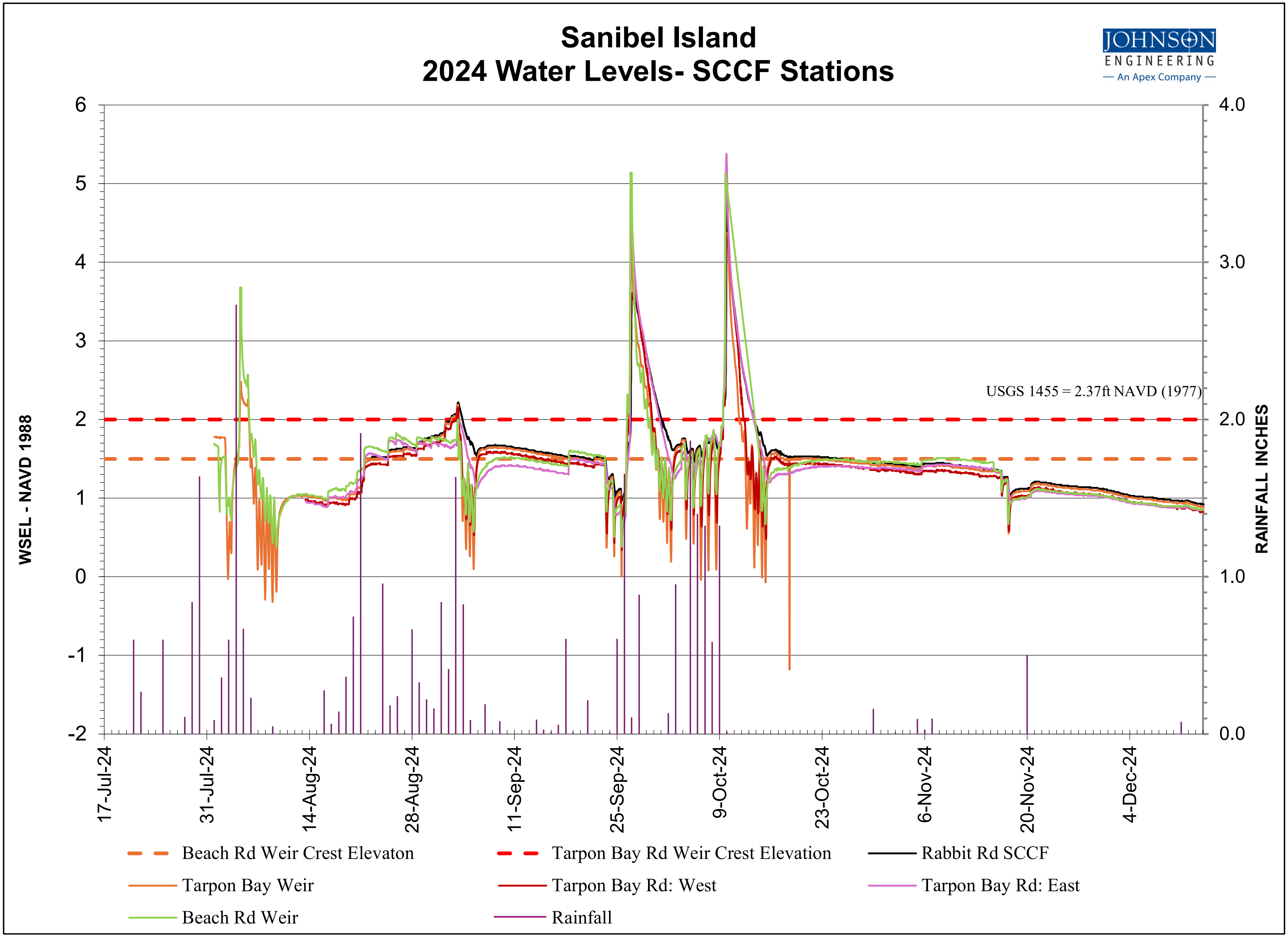


Sanibel Island
Water Levels- JE 2128
JOHNSON ENGINEERING
— An Apex Company —
Note: Sensor was removed 10/7 to 10/16, 2024
to protect from Hurricane Milton.
Top of Well Casing = 4.23ft NAVD
USGS 1453 = 2.71ft NAVD (1977)
USGS 1411 = 2.24ft NAVD (1977)
WSEL - NAVD 1988
RAINFALL INCHES
6
5
4
3
2
1
0
-1
-2
4.0
3.0
2.0
1.0
0.0
17-Jul-24
31-Jul-24
14-Aug-24
28-Aug-24
11-Sep-24
25-Sep-24
9-Oct-24
23-Oct-24
6-Nov-24
20-Nov-24
4-Dec-24
18-Dec-24
1-Jan-25
15-Jan-25
29-Jan-25
12-Feb-25
26-Feb-25
12-Mar-25
26-Mar-25
9-Apr-25
23-Apr-25
7-May-25
21-May-25
Beach Rd Weir Crest Elevation
Tide Station 8725520 Fort Myers, FL
Daily High Tide
Daily Low Tide
JE 2128
Rainfall


Sanibel Island
Water Levels- JE 2129
JOHNSON ENGINEERING
— An Apex Company —
Note: Sensor was removed 10/7 to 10/16, 2024
to protect from Hurricane Milton.
Top of Well Casing = 3.93ft NAVD
USGS 1459 = 2.89ft NAVD (1977)
WSEL - NAVD 1988
RAINFALL INCHES
6
5
4
3
2
1
0
-1
-2
4.0
3.0
2.0
1.0
0.0
17-Jul-24
31-Jul-24
14-Aug-24
28-Aug-24
11-Sep-24
25-Sep-24
9-Oct-24
23-Oct-24
6-Nov-24
20-Nov-24
4-Dec-24
18-Dec-24
1-Jan-25
15-Jan-25
29-Jan-25
12-Feb-25
26-Feb-25
12-Mar-25
26-Mar-25
9-Apr-25
23-Apr-25
7-May-25
21-May-25
Beach Rd Weir Crest Elevation
Tide Station 8725520 Fort Myers, FL
Daily High Tide
Daily Low Tide
JE 2129
Rainfall



Sanibel Island
Water Levels- JE 2130
JOHNSON ENGINEERING
— An Apex Company —
Note: Sensor was removed 10/7 to 10/16, 2024
to protect from Hurricane Milton.
Top of Well Casing = 5.20ft NAVD
USGS 1455 = 2.37ft NAVD (1977)
WSEL - NAVD 1988
RAINFALL INCHES
6
5
4
3
2
1
0
-1
-2
4.0
3.0
2.0
1.0
0.0
17-Jul-24
31-Jul-24
14-Aug-24
28-Aug-24
11-Sep-24
25-Sep-24
9-Oct-24
23-Oct-24
6-Nov-24
20-Nov-24
4-Dec-24
18-Dec-24
1-Jan-25
15-Jan-25
29-Jan-25
12-Feb-25
26-Feb-25
12-Mar-25
26-Mar-25
9-Apr-25
23-Apr-25
7-May-25
21-May-25
Beach Rd Weir Crest Elevation
Tide Station 8725520 Fort Myers, FL
Daily High Tide
Daily Low Tide
JE 2130
Rainfall



Sanibel Island
2024 Water Levels- SCCF Stations
JOHNSON ENGINEERING
— An Apex Company —
WSEL - NAVD 1988
RAINFALL INCHES
USGS 1455 = 2.37ft NAVD (1977)
6
5
4
3
2
1
0
-1
-2
4.0
3.0
2.0
1.0
0.0
17-Jul-24
31-Jul-24
14-Aug-24
28-Aug-24
11-Sep-24
25-Sep-24
9-Oct-24
23-Oct-24
6-Nov-24
20-Nov-24
4-Dec-24
Beach Rd Weir Crest Elevaton
Tarpon Bay Rd Weir Crest Elevation
Rabbit Rd SCCF
Tarpon Bay Weir
Tarpon Bay Rd: West
Tarpon Bay Rd: East
Beach Rd Weir
Rainfall

JOHNSON ENGINEERING
— An Apex Company —

SINCE 1946

TO:	Oisin Dolley, P.E.; Scott Krawczuk: City of Sanibel	DATE:	July 8, 2025
FROM:	Jordan L. Varble, P.E.; Gabriella Santucci: Johnson Engineering, Inc.	RE:	Hydrologic & Hydraulic Analysis of the Sanibel River System

Background

The information in this document was drawn from the draft 2018 Stormwater Master Plan. Sanibel contains two large freshwater basins – the Sanibel River West Basin and the Sanibel River East Basin – which serve as freshwater reservoirs for the island. The Sanibel River system is analogous to two separate river systems controlled by dams (weirs) and operable gates at their downstream ends. Upstream of the dams are sections of river (Sanibel) and a series of lakes (pools). Along these river routes, crossings occur at many roads.

The primary objective of this memo is to evaluate the effects of rainfall-based storm events with the following frequency and duration: 3-year, 1-hour; 5-year, 1-day; 25-year, 3-day; and the 100-year, 3-day. If constrictions that cause flooding in the 25-year, 3-day event are identified, the model will be adjusted with a replacement structure or other modification(s) to determine how much improvement could be realized with one or more alterations to remove the constriction.

Figure 1 illustrates the location of the basins within the Sanibel River System as determined by use of aerial photographs and existing topography. The SCS Unit Hydrograph method was selected for the hydrologic analysis. The parameters required for each basin are drainage area, runoff curve number (CN), and time of concentration. The CN was estimated using values from TR-55. All soils within the watershed basin are from hydrological soil group D (according to NRCS Soil Survey).

Stormwater runoff generally flows west to east within the two drainage basins that make up the Sanibel River. The westerly basin, between Jamaica Road and Tarpon Bay Road, has two points of discharge, one into Tarpon Bay via the Tarpon Bay Weir and one across Tarpon Bay Road via the Tarpon Bay Road Weir. The Tarpon Bay Road Weir separates the two basins and has a crest elevation of 2.32 feet (ft). NAVD. The Tarpon Bay Weir that allows discharge to Tarpon Bay has an elevation of 1.98 ft. NAVD.

The easterly basin of the river flows east from Tarpon Bay Road toward Beach Road, and discharges into a tidal canal within Sanibel Estates. The Beach Road Weir has a crest elevation of 1.51 ft. NAVD.

Although flows within the watershed are generally west to east, this may be reversed during high flows, depending on the timing and location of the rainfall, as well as the water levels and tide.

Many of the residential subdivisions on Sanibel have ground elevations ranging from 2 feet to 5 feet NAVD, allowing very little slope to give the water a downhill gradient on which to run. Generally, a slope gradient in Southwest Florida is considered "flat" if it is less than one foot per mile and Sanibel falls within this definition. This extremely flat slope creates many problems in developing a comprehensive Surface Water Management Plan that provides adequate drainage in developed areas without adversely impacting natural areas.

Location

The Sanibel River is located on the central portion of Sanibel Island and is bounded by the following roadways:

- Periwinkle Way (north limit)
- Beach Road (east limit)
- East Gulf Drive (south limit)
- Middle Gulf Drive (south limit)
- West Gulf Drive (south limit)
- Jamaica Drive (west limit)
- Sanibel-Captiva Road (north limit)

Figure 1 illustrates the roadways listed above. The watershed map further divides the river into basins that are used in the model. A summary of the structures included in the model is shown in **Table 1**. These structures are identified by numbers in the leftmost column of **Table 1**, and their locations are shown in **Figure 2**.

Table 1. Structures included in ICPR model.

ID	MODEL LINK NAME	ROAD CULVERTS*	LENGTH (FT.)**	INVERT ELEVATION (FT. NAVD)	ROADWAY NAME	ROAD ELEVATION (FT. NAVD)	ROAD ELEVATION (FT. NAVD)***
1	SAN-CAP_ROAD	EX. (4) 10'X6' BOX CULVERTS	54	-4.17	SANIBEL-CAPTIVA ROAD	4.28	-
2	PIPE_3-4_RABBIT	EX. (2) 12'X5' BOX CULVERTS	44	-4.18	RABBIT ROAD	3.71	3.77
3	PIPE_2-3	EX. (2) 48" RCP	40	-	GULF PINES DRIVE	-	4.64
4	PIPE_1-2	EX. (2) 48" RCP	40	-	WHITE IBIS DRIVE	-	4.74
5	PIPE_4-4A_ISLAN	EX. (1) 10'X6' BOX CULVERT	40	-3.68	ISLAND INN ROAD	4.12	3.56
6	-	EX. (2) 8'X5' BOX CULVERTS	28	-3.13	BEACH ROAD	-	-
7	PIPE_7A-7B_ELIN	EX. (2) 10'X4' BOX CULVERTS	32	-3.17	ELINOR WAY	2.81	-
8	PIPE_6-7A_DONAX	EX. (2) 10'X4' BOX CULVERTS	60	-3.24	DONAX STREET	3.58	3.53
9	PIPE_5A-5_YBEL	EX. (1) 34"X53" RCP	85	-1.18	CASA YBEL ROAD		5.58
10	PIPE_5-6_YBEL	EX. (1) 10'X5' BOX CULVERT	46	-3.17****	CASA YBEL ROAD	-	4.38
11	-	EX. (1) 10'X6' BOX CULVERT	46	-3.68	TARPON BAY ROAD	4.31	4.06

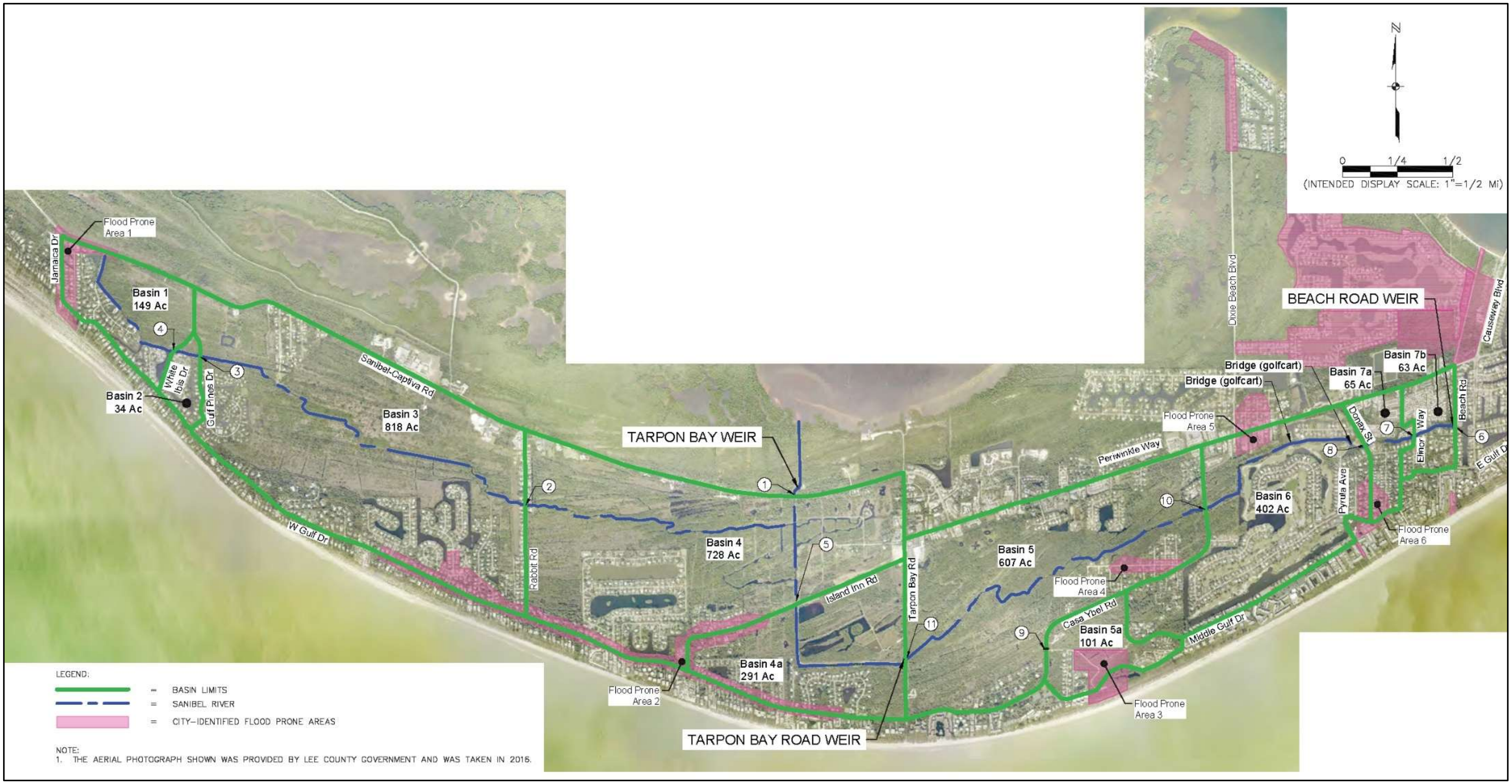


Figure 1. Sanibel River watershed.

Model Selection

AdICPR and HEC-RAS are two commonly used computer programs for analyses like this. AdICPR (Advanced Interconnected Channel and Pond Routing) has the capability of computing hydrology and hydraulics. HEC-RAS (Hydrologic Engineering Center – River Analysis System) can compute hydraulic information, but a separate analysis is required to calculate the hydrology.

AdICPR was chosen to simulate the rainfall-runoff process in the Sanibel River watershed to take advantage of its capabilities of modeling both the hydrology and the hydraulics associated with this project within the model. This modeling software has been accepted by the Federal Emergency Management Agency (FEMA) for use on floodplain investigations associated with flood insurance applications and is widely used throughout Florida and the United States.

The AdICPR software consists of a network of open channel segments, culverts, bridges, weirs and lakes. AdICPR uses a link-node concept to idealize the "real world" drainage system. A node is a discrete location in the drainage system where conservation of mass (continuity) is maintained. Links, or "reaches", are the connections between nodes and are used to convey water through the system. The entire network of nodes and reaches forms the hydraulic model network and serves as the computational framework for AdICPR.

The level-pool method approach has been assumed for the majority of the nodes, with the exception of the two easternmost basins (7a and 7b) that have been modeled as canals given the relatively small floodplain storage provided due to development adjacent to the Sanibel River. Local runoff within these basins is routed to the upstream end of the canals.

Storm Events

A variety of storm events were modeled to assess the impacts of any improvement on the Sanibel River System. Each storm event and a brief discussion of why it was chosen for this analysis follows:

- 3-year, 1-hour is for water quality and wetland inundation duration.
- 5-year, 1-day is used to check against the elevation of secondary roads and parking lots.
- 25-year, 3-day is used to assess flooding of major roads and emergency access
- 100-year, 3-day is used to assess freshwater flooding of critical infrastructure, dwellings and businesses.

The rainfall depth of the 3-year, 1-hour event is estimated at 2.4 inches. This value was obtained from plotting the depths for the 1-year, 1-hour; the 2-year, 1-hour; and the 5-year, 1-hour from the TP-40 Rainfall Frequency Atlas of the United States, U.S. Department of Commerce Weather Bureau, and interpolating. See **Figure 2**.

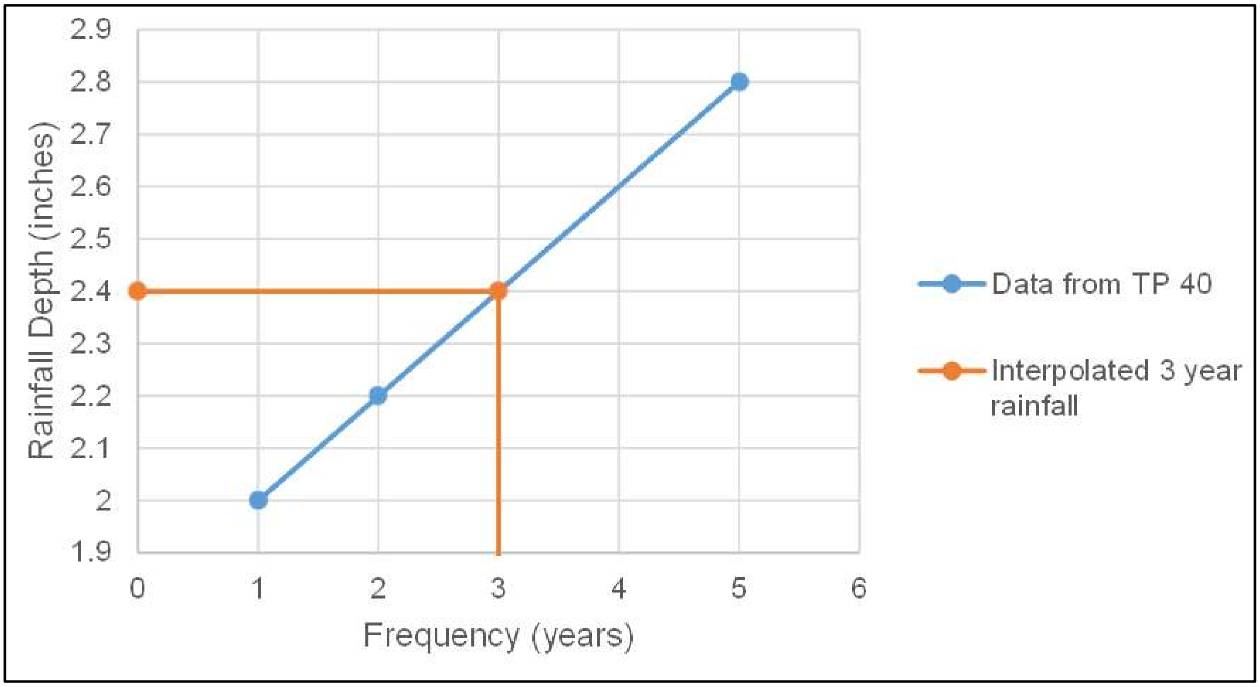


Figure 2. 3-Year, 1-Hour Rainfall Depth.

The rainfall depths for the 5-year, 1-day; 25-year, 3-day; and 100-year, 3-day were obtained from the SFWMD Environmental Resource Permitting Information Manual Volume IV and were 5.5 inches, 11.2 inches and 14.0 inches, respectively.

Existing Conditions Model

The Sanibel River system was separated into 10 basins and 10 nodes. The basins are the hydrology of the system where flow is generated and conveyed to their containing node. The nodes provide storage for the system and a connection between conveyance elements (links).

Existing Hydraulics

The AdICPR model includes channels, culverts, weirs and gates present within the Sanibel River Watershed. A summary of the structures included in the model is shown in **Table 1**. Not all the structures found within the watershed were modeled. Only the structures that provide connectivity to "pools" were modeled. The Sanibel River watershed has several bridges, but they are not included in the model, because they are much less restrictive to flow than the culverts.

The model also includes Stage vs. Area tables that were estimated for every basin using the LIDAR elevation dataset. There are two segments (7a and 7b) located near the east end of the Sanibel River that were modelled as channels to account for the limited floodplain that exists between Donax Street and Beach Road.

Tailwater and Initial Water Level Scenarios

The points of discharge of the Sanibel River into the Bay are the Tarpon Bay Weir and the Beach Road Weir. Both weir structures have gates that provide flexibility in the operation of the system. All the gates stay closed most of the year. Before certain storm events, one or several gates may be opened to lower the water level in the river system when a considerable amount of rain is anticipated and/or the water surface elevation in the pool system is deemed high. The tailwater values used in the ICPR models include the following assumptions:

1) The analysis assumed constant tailwater elevations during the entire simulation, disregarding the tidal fluctuations that occur daily. This is a conservative assumption.
2) The analysis does not take into account storm surge effects and disregarded the coastal stillwater elevations used by FEMA. This is a practical assumption that keeps the analysis from considering most of the island under water during the simulation.

Several tailwater elevations were modeled separately to evaluate scenarios that represent either present conditions related to the crest elevation of the outfall weirs or projections of the sea level rise as discussed in Section 3.4 of this report.

- Gates Closed: When the gates are closed at both discharge locations, the assumed tailwater elevation on the model for the "Gates Closed" scenario is at elevation 1.51 ft, NAVD (the Beach Road Weir crest). The assumed starting water elevations on the model for this scenario are:
  - Nodes 1,2,3,4 and 4a: 1.98 ft, NAVD (the Tarpon Bay and weir crest elevation).
  - Nodes 5, 5a, 6, 7a and 7b: 1.51 ft, NAVD (the Beach Road weir crest elevation).
- Gates Open: Several scenarios model when all gates are open at both discharge locations.

A summary of the tailwater elevations and starting water elevation associated with each scenario is shown in Table 2.

Table 2. Tailwater and Starting Water Elevation (ft, NAVD).

	Scenario				
		Gates Open			
Parameter	**Gates Closed**	**2017 MHHW**	**TBW Crest 1.98**	**BRW Top of Flap 2.5**	**2100 MSL 3.42**
Tailwater	1.51	0.72	1.98	2.5	3.42
Starting Water Elevation	1.98 and 1.51	0.72	1.98	2.5	3.42

Notes for **Table 2**.

- TBW = Tarpon Bay Weir
- BRW = Beach Road Weir
- MHHW = Mean High High Water
- MSL = Mean Sea Level

Model Results

A summary of the peak stages is shown graphically in **Figure 3** through **Figure 6**.

The performance of the main connecting elements (canal, pipes, culverts, gates and weirs) was evaluated by establishing the headloss across each element. The results of this evaluation are summarized in **Table 3** and **Table 4**.

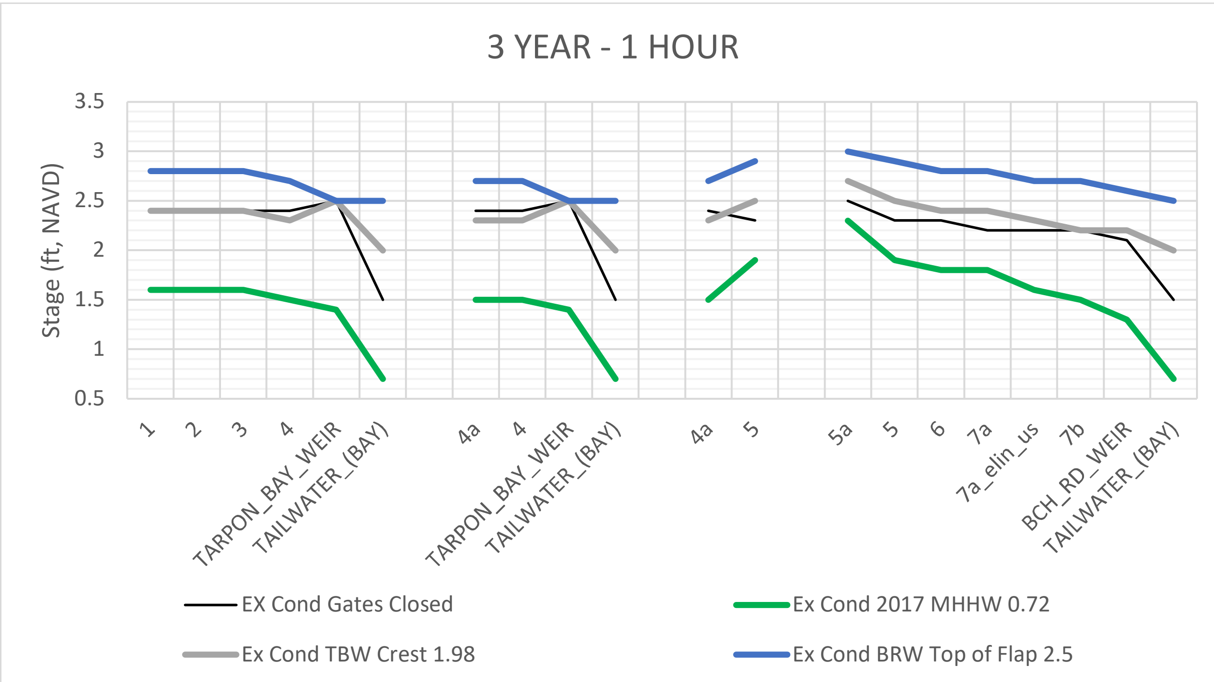


Figure 3. Existing Condition 3-Year, 1-Hour Peak Stages.

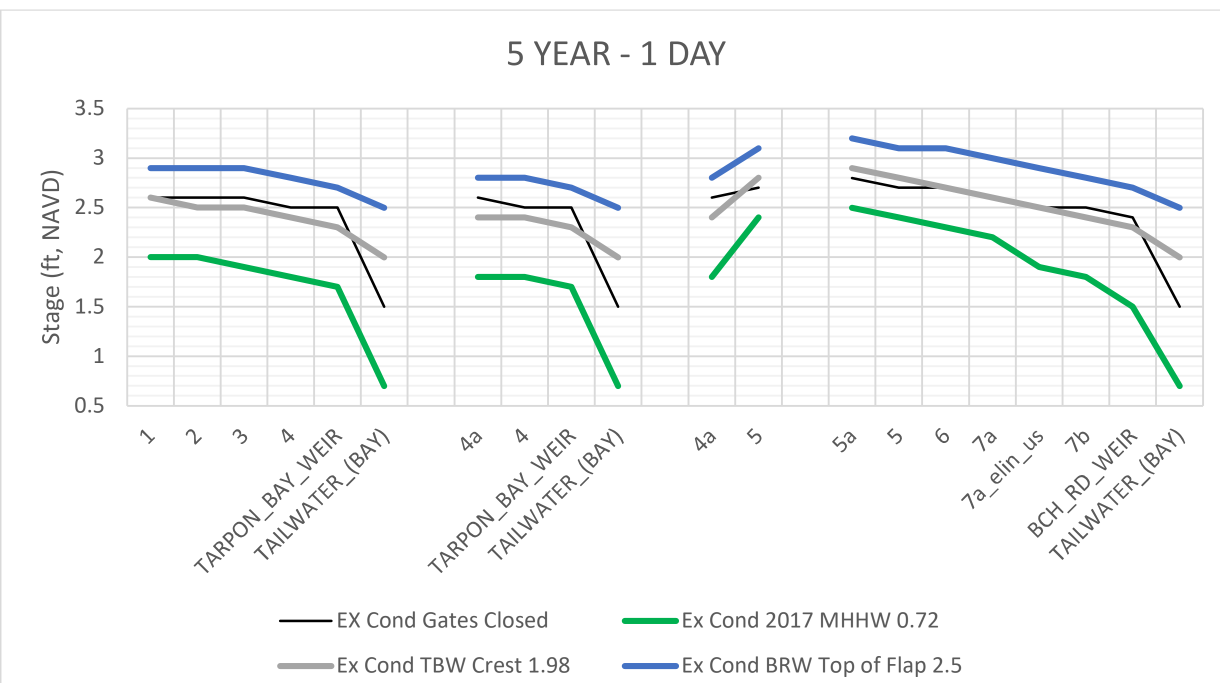


Figure 4. Existing Condition 5-Year, 1-Day Peak Stages.

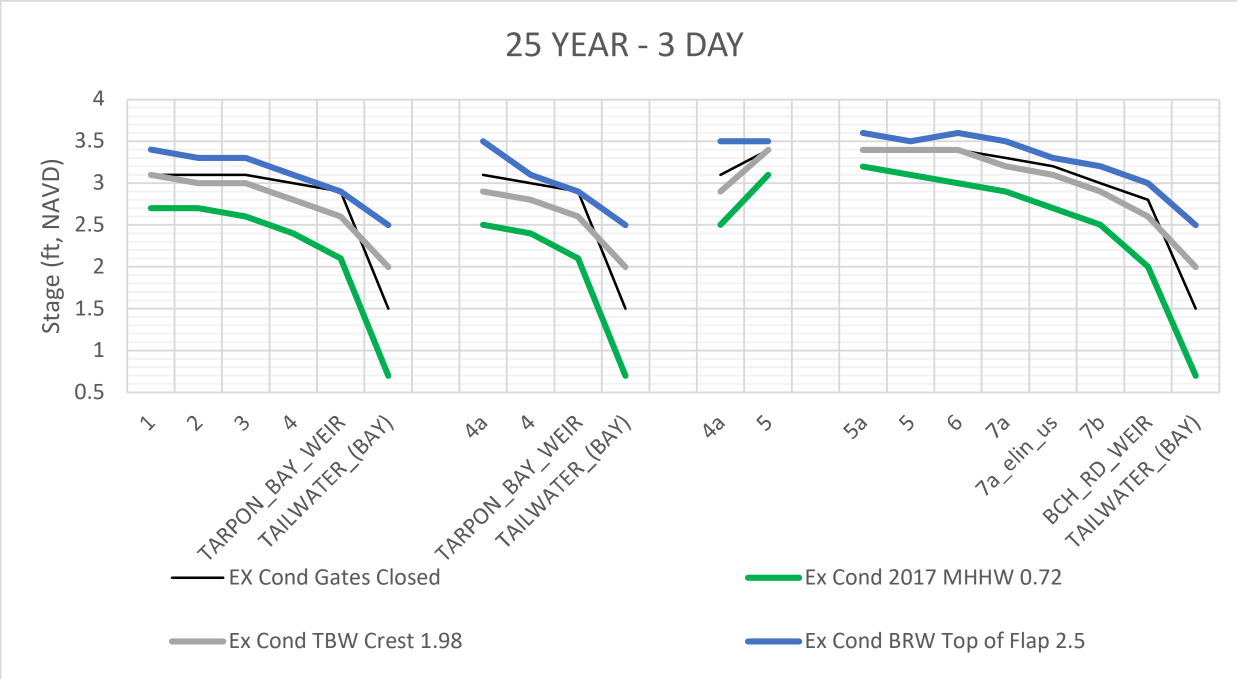


Figure 5. Existing Condition 25-Year, 3-Day Peak Stages.

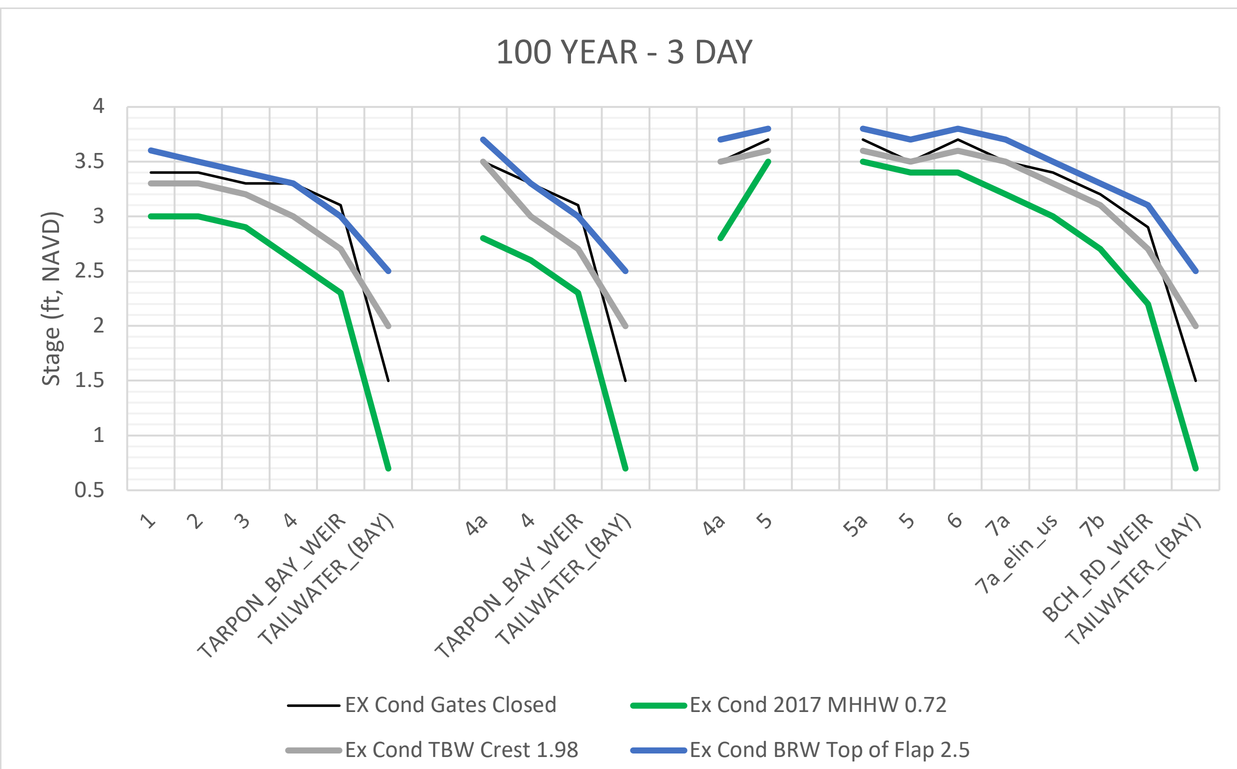


Figure 6. Existing Condition 100-Year, 3-Day Peak Stages.

Table 3. Headlosses for the 3-Year and 5-Year Storms (ft).

Storm	Link	EX Cond Gates Closed	Ex Cond 2017 MHHW 0.72	Ex Cond TBW Crest 1.98	Ex Cond BRW Top of Flap 2.5
3YEAR-1HOUR	White Ibis	0	0	0	0
3YEAR-1HOUR	Gulf Pines Dr	0	0	0	0
3YEAR-1HOUR	Rabbit Rd	0	0.1	0.1	0.1
3YEAR-1HOUR	San-Cap Rd	0	0.1	0	0.2
3YEAR-1HOUR	Tarpon Bay Weir	1	0.7	0.5	0
3YEAR-1HOUR	Island Inn	0	0	0	0
3YEAR-1HOUR	Casa Ybel Rd ERCP	0.2	0.4	0.2	0.1
3YEAR-1HOUR	Casa Ybel Rd Box	0	0.1	0.1	0.1
3YEAR-1HOUR	Donax St	0.1	0	0	0
3YEAR-1HOUR	Canal Downstream of Donax	0	0.2	0.1	0.1
3YEAR-1HOUR	Elinor Way	0	0.1	0.1	0
3YEAR-1HOUR	Canal Downstream of Elinor Way	0.1	0.2	0	0.1
3YEAR-1HOUR	Beach Road Weir	0.6	0.6	0.2	0.1
5YR-1DAY	White Ibis	0	0	0.1	0
5YR-1DAY	Gulf Pines Dr	0	0.1	0	0
5YR-1DAY	Rabbit Rd	0.1	0.1	0.1	0.1
5YR-1DAY	San-Cap Rd	0	0.1	0.1	0.1
5YR-1DAY	Tarpon Bay Weir	1	1	0.3	0.2
5YR-1DAY	Island Inn	0.1	0	0	0
5YR-1DAY	Casa Ybel Rd ERCP	0.1	0.1	0.1	0.1
5YR-1DAY	Casa Ybel Rd Box	0	0.1	0.1	0
5YR-1DAY	Donax St	0.1	0.1	0.1	0.1
5YR-1DAY	Canal Downstream of Donax	0.1	0.3	0.1	0.1
5YR-1DAY	Elinor Way	0	0.1	0.1	0.1
5YR-1DAY	Canal Downstream of Elinor Way	0.1	0.3	0.1	0.1
5YR-1DAY	Beach Road Weir	0.9	0.8	0.3	0.2

Table 4. Headlosses for the 25-Year and 100-Year Storms (ft).

Storm	Link	EX Cond Gates Closed	Ex Cond 2017 MHHW 0.72	Ex Cond TBW Crest 1.98	Ex Cond BRW Top of Flap 2.5
025YR-3DAY	White Ibis	0	0	0.1	0.1
025YR-3DAY	Gulf Pines Dr	0	0.1	0	0
025YR-3DAY	Rabbit Rd	0.1	0.2	0.2	0.2
025YR-3DAY	San-Cap Rd	0.1	0.3	0.2	0.2
025YR-3DAY	Tarpon Bay Weir	1.4	1.4	0.6	0.4
025YR-3DAY	Island Inn	0.1	0.1	0.1	0.4
025YR-3DAY	Casa Ybel Rd ERCP	0	0.1	0	0.1
025YR-3DAY	Casa Ybel Rd Box	0	0.1	0	0
025YR-3DAY	Donax St	0.1	0.1	0.2	0.1
025YR-3DAY	Canal Downstream of Donax	0.1	0.2	0.1	0.2
025YR-3DAY	Elinor Way	0.2	0.2	0.2	0.1
025YR-3DAY	Canal Downstream of Elinor Way	0.2	0.5	0.3	0.2
025YR-3DAY	Beach Road Weir	1.3	1.3	0.6	0.5
100YR-3DAY	White Ibis	0	0	0	0.1
100YR-3DAY	Gulf Pines Dr	0.1	0.1	0.1	0.1
100YR-3DAY	Rabbit Rd	0	0.3	0.2	0.1
100YR-3DAY	San-Cap Rd	0.2	0.3	0.3	0.3
100YR-3DAY	Tarpon Bay Weir	1.6	1.6	0.7	0.5
100YR-3DAY	Island Inn	0.2	0.2	0.5	0.4
100YR-3DAY	Casa Ybel Rd ERCP	0.2	0.1	0.1	0.1
100YR-3DAY	Casa Ybel Rd Box	0	0	0	0
100YR-3DAY	Donax St	0.2	0.2	0.1	0.1
100YR-3DAY	Canal Downstream of Donax	0.1	0.2	0.2	0.2
100YR-3DAY	Elinor Way	0.2	0.3	0.2	0.2
100YR-3DAY	Canal Downstream of Elinor Way	0.3	0.5	0.4	0.2
100YR-3DAY	Beach Road Weir	1.4	1.5	0.7	0.6

In general, the results obtained indicate previous Capital Improvement Projects by the City of Sanibel to reduce flooding are working. There are only a few links that have relatively larger headlosses as highlighted in **Table 4.** The following section addresses the analysis of performance improvements at some of the highlighted nodes.

Proposed Conditions

The potential improvements analyzed consisted of adding two additional box culverts under Sanibel-Captiva Road (for a total of six barrels) and performing a dredge on approximately 1,100 LF of canal between Elinor Road and Beach Road. The dredging project is already underway, and it is expected to be completed by fiscal year 2026. The canal improvements target a portion of the River that has limited undeveloped floodplain, and the flow is confined mostly to within the river banks. The proposed change to the cross section is shown in **Figure 7**.

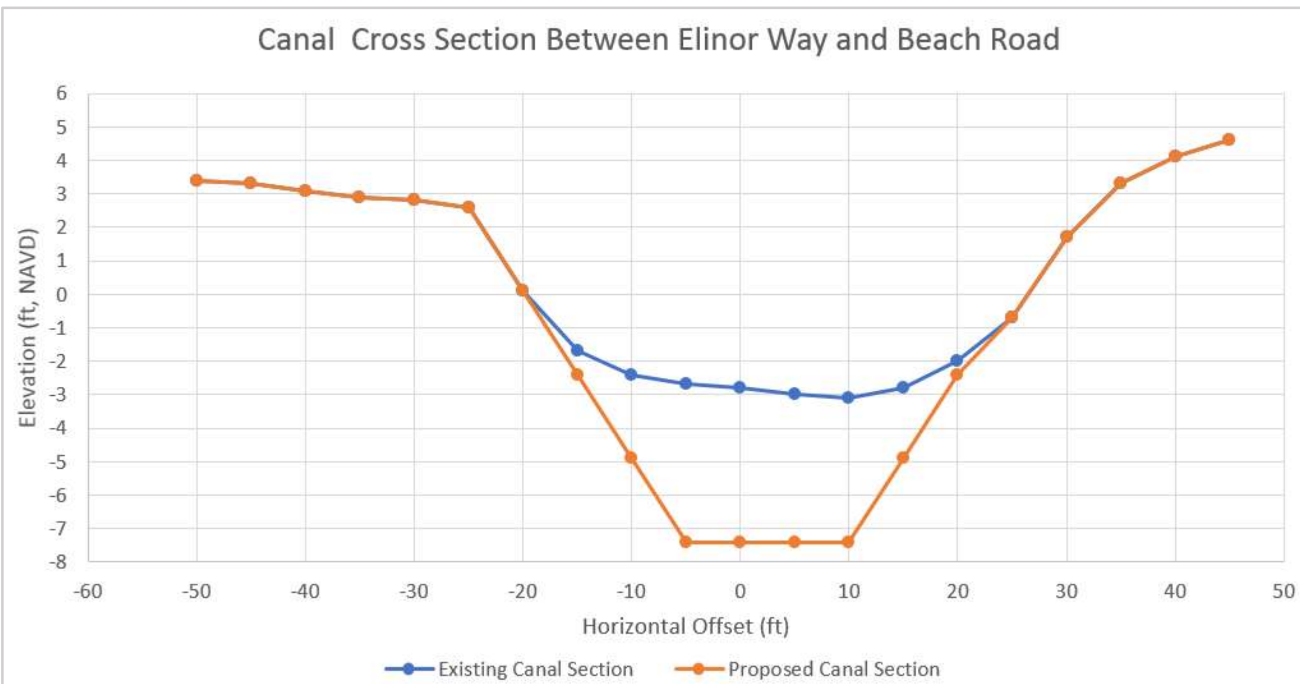


Figure 7. Proposed channel improvements.

The potential improvements were added to the existing conditions modeled previously and modeled in ICPR. A summary of the peak stages is shown graphically in **Figure 8** through **Figure 11**.

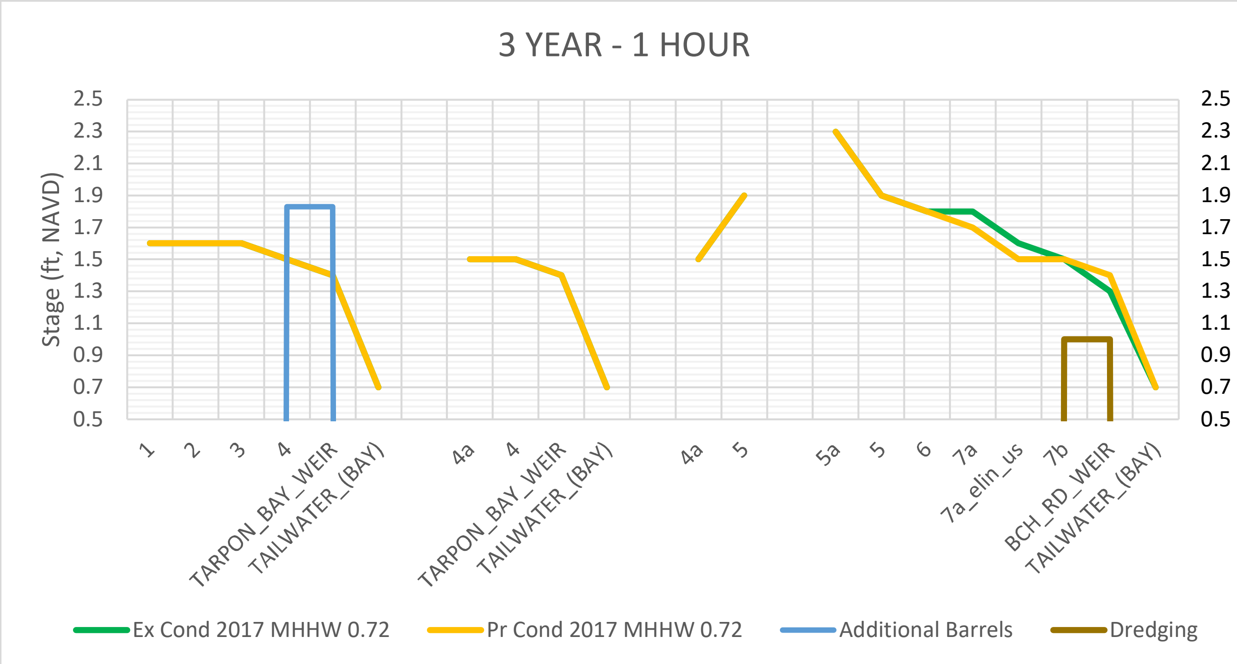


Figure 8. Proposed Improvements 3-Year Peak Stages.

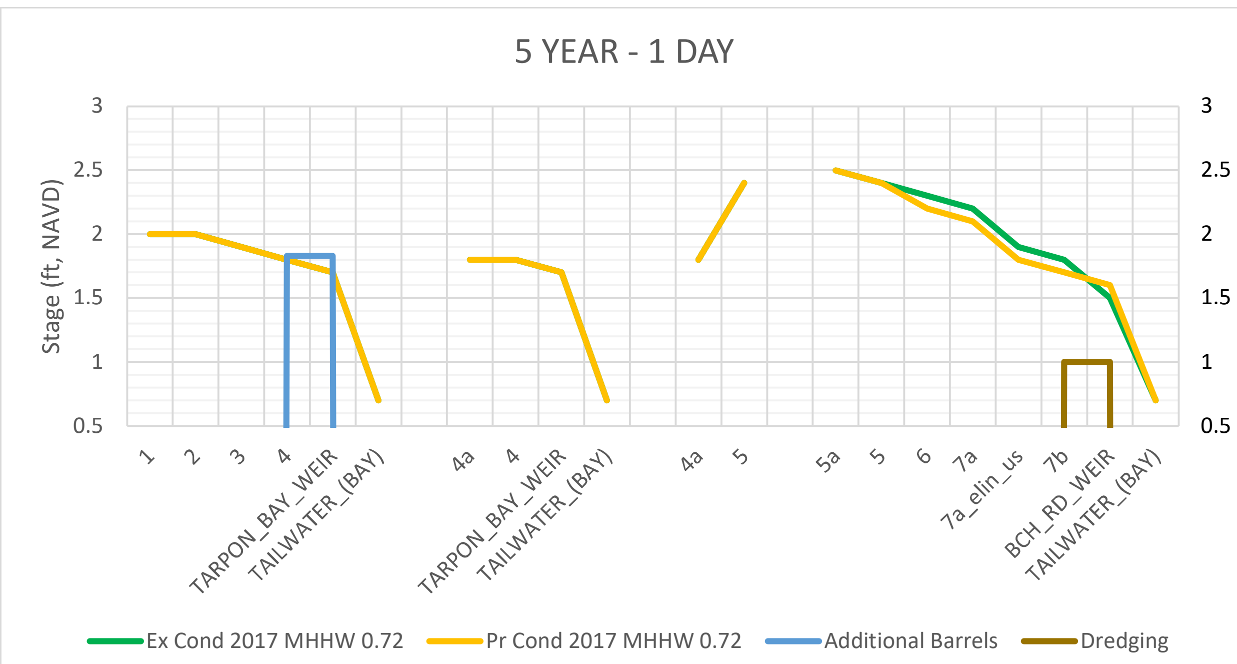


Figure 9. Proposed Improvements 5-Year Peak Stages.

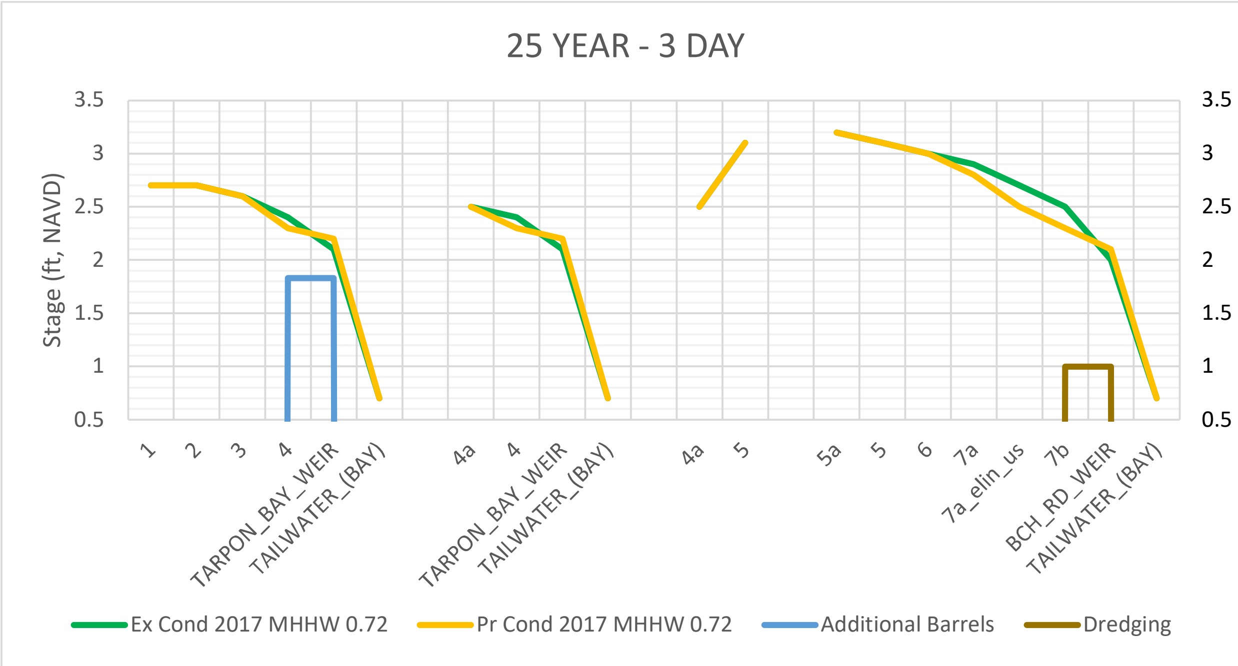


Figure 10. Proposed Improvements 25-Year Peak Stages.

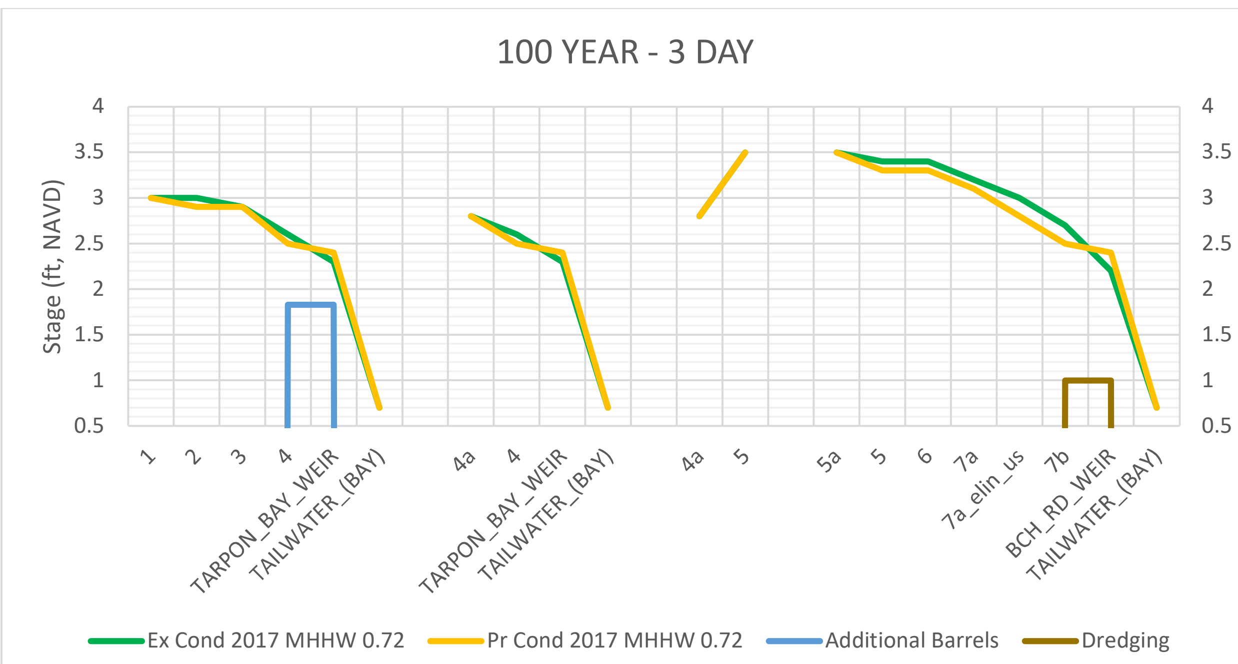


Figure 11. Proposed Improvements 100-Year Peak Stages.

The performance of the main connecting elements (canal, pipes, culverts, gates and weirs) was evaluated by establishing the headloss across each element. The results of this evaluation are summarized in **Table 5** and **Table 6**. Maximum flow at the weirs for each storm is also included.

Table 5. Existing and Proposed Headloss for the 3-Year and 5-Year Storms (ft).

Storm	Link	Ex Cond 2017 MHHW 0.72	Pr Cond 2017 MHHW 0.72	Flow at Outfall (cfs)
003YEAR-1HOUR	White Ibis	0	0	N/A
003YEAR-1HOUR	Gulf Pines Dr	0	0	N/A
003YEAR-1HOUR	Rabbit Rd	0.1	0.1	N/A
003YEAR-1HOUR	San-Cap Rd	0.1	0.1	N/A
003YEAR-1HOUR	Tarpon Bay Weir	0.7	0.7	411
003YEAR-1HOUR	Island Inn	0	0	N/A
003YEAR-1HOUR	Casa Ybel Rd ERCP	0.4	0.4	N/A
003YEAR-1HOUR	Casa Ybel Rd Box	0.1	0.1	N/A
003YEAR-1HOUR	Donax St	0	0.1	N/A
003YEAR-1HOUR	Canal Downstream of Donax	0.2	0.2	N/A
003YEAR-1HOUR	Elinor Way	0.1	0	N/A
003YEAR-1HOUR	Canal Downstream of Elinor Way	0.2	0.1	N/A
003YEAR-1HOUR	Beach Road Weir	0.6	0.7	156
005YR-1DAY	White Ibis	0	0	N/A
005YR-1DAY	Gulf Pines Dr	0.1	0.1	N/A
005YR-1DAY	Rabbit Rd	0.1	0.1	N/A
005YR-1DAY	San-Cap Rd	0.1	0.1	N/A
005YR-1DAY	Tarpon Bay Weir	1	1	547
005YR-1DAY	Island Inn	0	0	N/A
005YR-1DAY	Casa Ybel Rd ERCP	0.1	0.1	N/A
005YR-1DAY	Casa Ybel Rd Box	0.1	0.2	N/A
005YR-1DAY	Donax St	0.1	0.1	N/A
005YR-1DAY	Canal Downstream of Donax	0.3	0.3	N/A
005YR-1DAY	Elinor Way	0.1	0.1	N/A
005YR-1DAY	Canal Downstream of Elinor Way	0.3	0.1	N/A
005YR-1DAY	Beach Road Weir	0.8	0.9	219

Table 6. Existing and Proposed Headloss for the 25-Year and 100-Year Storms (ft).

Storm	Link	Ex Cond 2017 MHHW 0.72	Pr Cond 2017 MHHW 0.72	Flow at Outfall
025YR-3DAY	White Ibis	0	0	N/A
025YR-3DAY	Gulf Pines Dr	0.1	0.1	N/A
025YR-3DAY	Rabbit Rd	0.2	0.3	N/A
025YR-3DAY	San-Cap Rd	0.3	0.1	N/A
025YR-3DAY	Tarpon Bay Weir	1.4	1.5	764
025YR-3DAY	Island Inn	0.1	0.2	N/A
025YR-3DAY	Casa Ybel Rd ERCP	0.1	0.1	N/A
025YR-3DAY	Casa Ybel Rd Box	0.1	0.1	N/A
025YR-3DAY	Donax St	0.1	0.2	N/A
025YR-3DAY	Canal Downstream of Donax	0.2	0.3	N/A
025YR-3DAY	Elinor Way	0.2	0.2	N/A
025YR-3DAY	Canal Downstream of Elinor Way	0.5	0.2	N/A
025YR-3DAY	Beach Road Weir	1.3	1.4	329
100YR-3DAY	White Ibis	0	0.1	N/A
100YR-3DAY	Gulf Pines Dr	0.1	0	N/A
100YR-3DAY	Rabbit Rd	0.3	0.4	N/A
100YR-3DAY	San-Cap Rd	0.3	0.1	N/A
100YR-3DAY	Tarpon Bay Weir	1.6	1.7	869
100YR-3DAY	Island Inn	0.2	0.3	N/A
100YR-3DAY	Casa Ybel Rd ERCP	0.1	0.2	N/A
100YR-3DAY	Casa Ybel Rd Box	0	0	N/A
100YR-3DAY	Donax St	0.2	0.2	N/A
100YR-3DAY	Canal Downstream of Donax	0.2	0.3	N/A
100YR-3DAY	Elinor Way	0.3	0.3	N/A
100YR-3DAY	Canal Downstream of Elinor Way	0.5	0.1	N/A
100YR-3DAY	Beach Road Weir	1.5	1.7	377

Conclusions

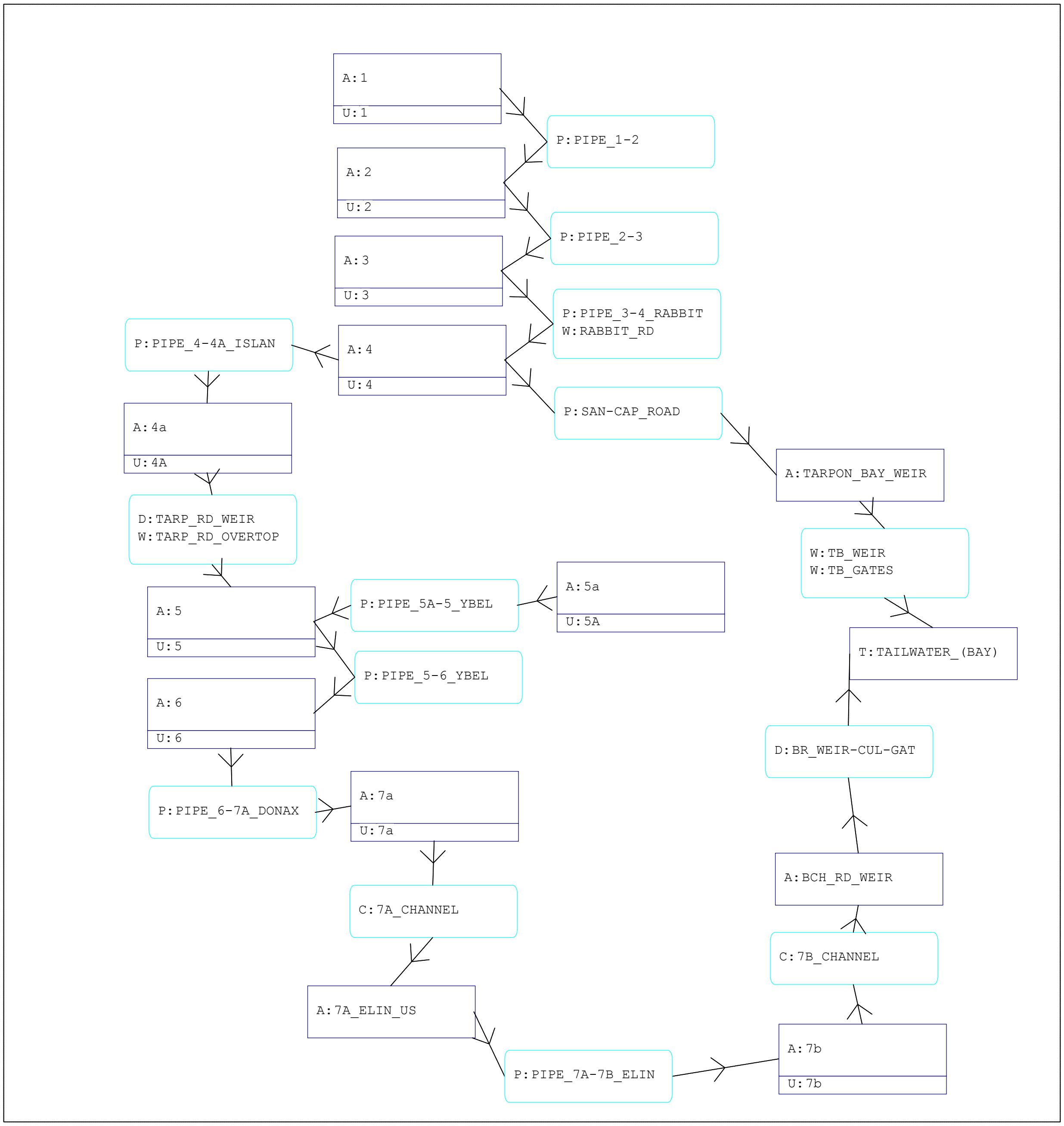
The dredging activities near the downstream end of the easterly basin result in the most significant reductions in peak stages and increased capacity for the system. The additional barrels under Sanibel Captiva Road do not appear to provide significant reductions in peak stages and are not recommended at this time. None of the improvements are anticipated to have significant effects on the repetitive flooding conditions in the areas identified by City Staff or storm surge flooding, so alternative solutions for those areas are recommended.

SANIBEL RIVER
EXISTING CONDITION - 2100 MSL
NODE DIAGRAM
JUNE 2018

Nodes
A Stage/Area
V Stage/Volume
T Time/Stage
M Manhole

Basins
O Overland Flow
U SCS Unit CN
S SBUH CN
Y SCS Unit GA
Z SBUH GA

Links
P Pipe
W Weir
C Channel
D Drop Structure
B Bridge
R Rating Curve
H Breach
E Percolation
F Filter
X Exfil Trench



```
==========================================================================================
==== Basins ==============================================================================
==========================================================================================

        Name: 1                        Node: 1                       Status: Onsite
       Group: BASE                     Type: SCS Unit Hydrograph CN

       Unit Hydrograph: Uh256                    Peaking Factor: 256.0
         Rainfall File:                      Storm Duration(hrs): 0.00
   Rainfall Amount(in): 0.000                  Time of Conc(min): 66.00
              Area(ac): 149.000                  Time Shift(hrs): 0.00
         Curve Number: 91.00               Max Allowable Q(cfs): 999999.000
               DCIA(%): 0.00

----------------------------------------------------------------------------------------------------
        Name: 2                        Node: 2                       Status: Onsite
       Group: BASE                     Type: SCS Unit Hydrograph CN

       Unit Hydrograph: Uh256                    Peaking Factor: 256.0
         Rainfall File:                      Storm Duration(hrs): 0.00
   Rainfall Amount(in): 0.000                  Time of Conc(min): 32.00
              Area(ac): 34.000                   Time Shift(hrs): 0.00
         Curve Number: 89.00               Max Allowable Q(cfs): 999999.000
               DCIA(%): 0.00

----------------------------------------------------------------------------------------------------
        Name: 3                        Node: 3                       Status: Onsite
       Group: BASE                     Type: SCS Unit Hydrograph CN

       Unit Hydrograph: Uh256                    Peaking Factor: 256.0
         Rainfall File:                      Storm Duration(hrs): 0.00
   Rainfall Amount(in): 0.000                  Time of Conc(min): 81.00
              Area(ac): 813.000                  Time Shift(hrs): 0.00
         Curve Number: 94.00               Max Allowable Q(cfs): 999999.000
               DCIA(%): 0.00

----------------------------------------------------------------------------------------------------
        Name: 4                        Node: 4                       Status: Onsite
       Group: BASE                     Type: SCS Unit Hydrograph CN

       Unit Hydrograph: Uh256                    Peaking Factor: 256.0
         Rainfall File:                      Storm Duration(hrs): 0.00
   Rainfall Amount(in): 0.000                  Time of Conc(min): 30.00
              Area(ac): 728.000                  Time Shift(hrs): 0.00
         Curve Number: 94.00               Max Allowable Q(cfs): 999999.000
               DCIA(%): 0.00

----------------------------------------------------------------------------------------------------
        Name: 4A                       Node: 4a                      Status: Onsite
       Group: BASE                     Type: SCS Unit Hydrograph CN

       Unit Hydrograph: Uh256                    Peaking Factor: 256.0
         Rainfall File:                      Storm Duration(hrs): 0.00
   Rainfall Amount(in): 0.000                  Time of Conc(min): 35.00
              Area(ac): 291.000                  Time Shift(hrs): 0.00
         Curve Number: 93.00               Max Allowable Q(cfs): 999999.000
               DCIA(%): 0.00

----------------------------------------------------------------------------------------------------
        Name: 5                        Node: 5                       Status: Onsite
       Group: BASE                     Type: SCS Unit Hydrograph CN

       Unit Hydrograph: Uh256                    Peaking Factor: 256.0
         Rainfall File:                      Storm Duration(hrs): 0.00
   Rainfall Amount(in): 0.000                  Time of Conc(min): 54.00
              Area(ac): 607.000                  Time Shift(hrs): 0.00
         Curve Number: 95.00               Max Allowable Q(cfs): 999999.000
               DCIA(%): 0.00

----------------------------------------------------------------------------------------------------
        Name: 5A                       Node: 5a                      Status: Onsite
       Group: BASE                     Type: SCS Unit Hydrograph CN
```

```
       Unit Hydrograph: Uh256                 Peaking Factor: 256.0
         Rainfall File:                   Storm Duration(hrs): 0.00
   Rainfall Amount(in): 0.000               Time of Conc(min): 24.00
              Area(ac): 101.000               Time Shift(hrs): 0.00
          Curve Number: 97.00            Max Allowable Q(cfs): 999999.000
               DCIA(%): 0.00

----------------------------------------------------------------------------------------------------
        Name: 6                       Node: 6                     Status: Onsite
       Group: BASE                    Type: SCS Unit Hydrograph CN

       Unit Hydrograph: Uh256                 Peaking Factor: 256.0
         Rainfall File:                   Storm Duration(hrs): 0.00
   Rainfall Amount(in): 0.000               Time of Conc(min): 45.00
              Area(ac): 402.000               Time Shift(hrs): 0.00
          Curve Number: 91.00            Max Allowable Q(cfs): 999999.000
               DCIA(%): 0.00

----------------------------------------------------------------------------------------------------
        Name: 7a                      Node: 7a                    Status: Onsite
       Group: BASE                    Type: SCS Unit Hydrograph CN

       Unit Hydrograph: Uh256                 Peaking Factor: 256.0
         Rainfall File:                   Storm Duration(hrs): 0.00
   Rainfall Amount(in): 0.000               Time of Conc(min): 40.00
              Area(ac): 64.000                Time Shift(hrs): 0.00
          Curve Number: 92.00            Max Allowable Q(cfs): 999999.000
               DCIA(%): 0.00

----------------------------------------------------------------------------------------------------
        Name: 7b                      Node: 7b                    Status: Onsite
       Group: BASE                    Type: SCS Unit Hydrograph CN

       Unit Hydrograph: Uh256                 Peaking Factor: 256.0
         Rainfall File:                   Storm Duration(hrs): 0.00
   Rainfall Amount(in): 0.000               Time of Conc(min): 40.00
              Area(ac): 64.000                Time Shift(hrs): 0.00
          Curve Number: 92.00            Max Allowable Q(cfs): 999999.000
               DCIA(%): 0.00

==========================================================================================
==== Nodes ===============================================================================
==========================================================================================

     Name: 1                  Base Flow(cfs): 0.000         Init Stage(ft): 3.420
    Group: BASE                                             Warn Stage(ft): 0.000
     Type: Stage/Area
```

Stage(ft)	Area(ac)
0.5	11.0
1.0	15.0
1.5	25.0
2.0	48.0
2.5	69.0
3.0	80.0
3.5	90.0
4.0	106.0
4.5	121.0
5.0	133.0
5.5	140.0
6.0	146.0
6.5	148.0
7.0	149.0

```
------------------------------------------------------------------------------------------
     Name: 2                  Base Flow(cfs): 0.000         Init Stage(ft): 3.420
    Group: BASE                                             Warn Stage(ft): 0.000
     Type: Stage/Area
```

Stage(ft)	Area(ac)
0.5	7.0
1.0	7.0

1.5	8.0
2.0	9.0
2.5	11.0
3.0	13.0
3.5	15.0
4.0	17.0
4.5	18.0
5.0	21.0
5.5	26.0
6.0	30.0
6.5	33.0
7.0	34.0

Name: 3 Base Flow(cfs): 0.000 Init Stage(ft): 3.420
Group: BASE Warn Stage(ft): 0.000
Type: Stage/Area

Stage(ft)	Area(ac)
0.5	49.0
1.0	61.0
1.5	87.0
2.0	175.0
2.5	338.0
3.0	467.0
3.5	562.0
4.0	631.0
4.5	687.0
5.0	740.0
5.5	773.0
6.0	793.0
6.5	805.0
7.0	813.0

Name: 4 Base Flow(cfs): 0.000 Init Stage(ft): 3.420
Group: BASE Warn Stage(ft): 0.000
Type: Stage/Area

Stage(ft)	Area(ac)
0.5	66.0
1.0	77.0
1.5	106.0
2.0	198.0
2.5	344.0
3.0	455.0
3.5	547.0
4.0	591.0
4.5	615.0
5.0	629.0
5.5	647.0
6.0	673.0
6.5	700.0
7.0	719.0

Name: 4a Base Flow(cfs): 0.000 Init Stage(ft): 3.420
Group: BASE Warn Stage(ft): 0.000
Type: Stage/Area

Stage(ft)	Area(ac)
0.5	32.0
1.0	37.0
1.5	47.0
2.0	70.0
2.5	113.0
3.0	165.0
3.5	209.0
4.0	241.0
4.5	265.0
5.0	280.0
5.5	288.0
6.0	290.0
6.5	291.0
7.0	291.0

Name: 5 Base Flow(cfs): 0.000 Init Stage(ft): 3.420
Group: BASE Warn Stage(ft): 0.000
Type: Stage/Area

Stage(ft)	Area(ac)
0.5	16.0
1.0	29.0
1.5	56.0
2.0	130.0
2.5	237.0
3.0	340.0
3.5	437.0
4.0	509.0
4.5	561.0
5.0	591.0
5.5	602.0
6.0	605.0
6.5	606.0
7.0	606.0

Name: 5a Base Flow(cfs): 0.000 Init Stage(ft): 3.420
Group: BASE Warn Stage(ft): 0.000
Type: Stage/Area

Stage(ft)	Area(ac)
0.5	2.0
1.0	3.0
1.5	5.0
2.0	9.0
2.5	20.0
3.0	40.0
3.5	61.0
4.0	79.0
4.5	91.0
5.0	97.0
5.5	99.0
6.0	100.0
6.5	101.0
7.0	101.0

Name: 6 Base Flow(cfs): 0.000 Init Stage(ft): 3.420
Group: BASE Warn Stage(ft): 0.000
Type: Stage/Area

Stage(ft)	Area(ac)
0.5	25.0
1.0	51.0
1.5	56.0
2.0	62.0
2.5	71.0
3.0	91.0
3.5	135.0
4.0	195.0
4.5	254.0
5.0	303.0
5.5	345.0
6.0	376.0
6.5	390.0
7.0	395.0

Name: 7a Base Flow(cfs): 0.000 Init Stage(ft): 3.420
Group: BASE Warn Stage(ft): 0.000
Type: Stage/Area

Stage(ft)	Area(ac)
0.5	0.1
1.0	0.6
1.5	1.6
2.0	2.4
2.5	3.7
3.0	13.0

3.5	26.8
4.0	39.4
4.5	48.9
5.0	55.3
5.5	59.9
6.0	62.1
6.5	63.2
7.0	63.6
7.5	64.1

Name: 7A_ELIN_US   Base Flow(cfs): 0.000   Init Stage(ft): 3.420
Group: BASE   Warn Stage(ft): 0.000
Type: Stage/Area

Stage(ft)	Area(ac)

Name: 7b   Base Flow(cfs): 0.000   Init Stage(ft): 3.420
Group: BASE   Warn Stage(ft): 0.000
Type: Stage/Area

Stage(ft)	Area(ac)
0.5	0.1
1.0	0.6
1.5	1.6
2.0	2.4
2.5	3.7
3.0	13.0
3.5	26.8
4.0	39.4
4.5	48.9
5.0	55.3
5.5	59.9
6.0	62.1
6.5	63.2
7.0	63.6
7.5	64.1

Name: BCH_RD_WEIR   Base Flow(cfs): 0.000   Init Stage(ft): 3.420
Group: BASE   Warn Stage(ft): 0.000
Type: Stage/Area

Stage(ft)	Area(ac)
-5.0	0.0
5.0	0.0

Name: TAILWATER_(BAY)   Base Flow(cfs): 0.000   Init Stage(ft): 3.420
Group: BASE   Warn Stage(ft): 0.000
Type: Time/Stage

THE STAGES WILL BE ADJUSTED DEPENDING ON THE SCENARIO, STARTING WATER ELEVATIONS AND GATE POSITIONS.

SET FLOW TO "BOTH OR NONE" TO OPEN OR CLOSE THE GATES AS NECESSARY IN THE FOLLOWING LINKS:
- BR_WEIR-CUL-GAT: MANIPULATE WEIR 2 OF 2 - REPRESENTS THE (2) GATES
- TB_GATES

Time(hrs)	Stage(ft)
0.00	3.4
1000.00	3.4

Name: TARPON_BAY_WEIR   Base Flow(cfs): 0.000   Init Stage(ft): 3.420
Group: BASE   Warn Stage(ft): 0.000
Type: Stage/Area

Stage(ft)	Area(ac)
-5.0	0.0
5.0	0.0

```
==========================================================================================
==== Cross Sections ======================================================================
==========================================================================================

             Name: B7_CHANNEL                    Group: BASE
      Encroachment: No


    Station(ft)   Elevation(ft)     Manning's N
--------------- --------------- ---------------
        -50.000           3.400        0.500000
        -45.000           3.300        0.500000
        -40.000           3.100        0.500000
        -35.000           2.900        0.500000
        -30.000           2.800        0.500000
        -25.000           2.600        0.050000
        -20.000           0.100        0.050000
        -15.000          -1.700        0.050000
        -10.000          -2.400        0.050000
         -5.000          -2.700        0.050000
          0.000          -2.800        0.050000
          5.000          -3.000        0.050000
         10.000          -3.100        0.050000
         15.000          -2.800        0.050000
         20.000          -2.000        0.050000
         25.000          -0.700        0.050000
         30.000           1.700        0.050000
         35.000           3.300        0.500000
         40.000           4.100        0.500000
         45.000           4.600        0.500000

---------------------------------------------------------------------
             Name: RABBIT_RD                     Group: BASE
      Encroachment: No


    Station(ft)   Elevation(ft)     Manning's N
--------------- --------------- ---------------
          0.000           3.600        0.000000
        250.000           3.600        0.000000
       1040.000           3.500        0.000000
       2140.000           3.400        0.000000
       2750.000           3.300        0.000000
       2910.000           3.200        0.000000
       3120.000           3.100        0.000000
       3210.000           3.000        0.000000

---------------------------------------------------------------------
             Name: TARP_BAY_RD                   Group: BASE
      Encroachment: No


    Station(ft)   Elevation(ft)     Manning's N
--------------- --------------- ---------------
          0.000           3.600        0.000000
         40.000           3.600        0.000000
        270.000           3.500        0.000000
        640.000           3.400        0.000000
       1260.000           3.300        0.000000
       1450.000           3.200        0.000000
       1560.000           3.100        0.000000
       1580.000           3.000        0.000000

==========================================================================================
==== Pipes ===============================================================================
==========================================================================================

         Name: PIPE_1-2           From Node: 1                Length(ft): 40.00
        Group: BASE                 To Node: 2                     Count: 2
                                                       Friction Equation: Automatic
              UPSTREAM       DOWNSTREAM               Solution Algorithm: Most Restrictive
     Geometry: Circular       Circular                               Flow: Both
     Span(in): 48.00          48.00                   Entrance Loss Coef: 0.50
     Rise(in): 48.00          48.00                       Exit Loss Coef: 1.00
   Invert(ft): -4.180         -4.180                      Bend Loss Coef: 0.00
  Manning's N: 0.013000       0.013000                  Outlet Ctrl Spec: Use dc or tw
 Top Clip(in): 0.000          0.000                      Inlet Ctrl Spec: Use dc
 Bot Clip(in): 0.000          0.000                    Stabilizer Option: None


Upstream FHWA Inlet Edge Description:
```

```
Circular Concrete: Square edge w/ headwall

Downstream FHWA Inlet Edge Description:
Circular Concrete: Square edge w/ headwall

NUMBER OF PIPES AND DIAMETERS FIELD VERIFIED ON 4-18-2017.
ASSUMED PIPE INVERT ELEVATION OF -4.18 NAVD (-3.00 NGVD).
PIPE LENGTHS ESTIMATED FROM AERIAL IMAGE.


----------------------------------------------------------------------------------------------------
         Name: PIPE_2-3           From Node: 2                Length(ft): 40.00
        Group: BASE                 To Node: 3                     Count: 2
                                                       Friction Equation: Automatic
               UPSTREAM       DOWNSTREAM              Solution Algorithm: Most Restrictive
     Geometry: Circular       Circular                              Flow: Both
     Span(in): 48.00          48.00                   Entrance Loss Coef: 0.50
     Rise(in): 48.00          48.00                       Exit Loss Coef: 1.00
   Invert(ft): -4.180         -4.180                      Bend Loss Coef: 0.00
  Manning's N: 0.013000       0.013000                  Outlet Ctrl Spec: Use dc or tw
 Top Clip(in): 0.000          0.000                      Inlet Ctrl Spec: Use dc
 Bot Clip(in): 0.000          0.000                    Stabilizer Option: None


Upstream FHWA Inlet Edge Description:
Circular Concrete: Square edge w/ headwall

Downstream FHWA Inlet Edge Description:
Circular Concrete: Square edge w/ headwall

NUMBER OF PIPES AND DIAMETERS FIELD VERIFIED ON 4-18-2017.
ASSUMED PIPE INVERT ELEVATION OF -4.18 NAVD (-3.00 NGVD).
PIPE LENGTHS ESTIMATED FROM AERIAL IMAGE.

----------------------------------------------------------------------------------------------------
         Name: PIPE_3-4_RABBIT    From Node: 3                Length(ft): 44.00
        Group: BASE                 To Node: 4                     Count: 2
                                                       Friction Equation: Automatic
               UPSTREAM       DOWNSTREAM              Solution Algorithm: Most Restrictive
     Geometry: Rectangular    Rectangular                           Flow: Both
     Span(in): 144.00         144.00                  Entrance Loss Coef: 0.50
     Rise(in): 60.00          60.00                       Exit Loss Coef: 1.00
   Invert(ft): -4.180         -4.180                      Bend Loss Coef: 0.00
  Manning's N: 0.013000       0.013000                  Outlet Ctrl Spec: Use dc or tw
 Top Clip(in): 0.000          0.000                      Inlet Ctrl Spec: Use dc
 Bot Clip(in): 0.000          0.000                    Stabilizer Option: None


Upstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

Downstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

INFORMATION OBTAINED FROM RABBIT ROAD CULVERT REPLACEMENT
ASBUILTS DATED 11-22-1994.
PIPE LENGTH ESTIMATED FROM AERIAL IMAGE.


----------------------------------------------------------------------------------------------------
         Name: PIPE_4-4A_ISLAN    From Node: 4                Length(ft): 40.00
        Group: BASE                 To Node: 4a                    Count: 1
                                                       Friction Equation: Automatic
               UPSTREAM       DOWNSTREAM              Solution Algorithm: Most Restrictive
     Geometry: Rectangular    Rectangular                           Flow: Both
     Span(in): 120.00         120.00                  Entrance Loss Coef: 0.50
     Rise(in): 72.00          72.00                       Exit Loss Coef: 1.00
   Invert(ft): -3.680         -3.680                      Bend Loss Coef: 0.00
  Manning's N: 0.013000       0.013000                  Outlet Ctrl Spec: Use dc or tw
 Top Clip(in): 0.000          0.000                      Inlet Ctrl Spec: Use dc
 Bot Clip(in): 0.000          0.000                    Stabilizer Option: None


Upstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

Downstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

INFORMATION OBTAINED FROM ISLAND INN ROAD BOX CULVERT
ASBUILTS DATED 2-21-1996.
PIPE LENGTH ESTIMATED FROM AERIAL IMAGE.
```

```
----------------------------------------------------------------------------------------------------
         Name: PIPE_5-6_YBEL       From Node: 5                  Length(ft): 46.00
        Group: BASE                  To Node: 6                       Count: 1
                                                          Friction Equation: Automatic
              UPSTREAM       DOWNSTREAM                  Solution Algorithm: Most Restrictive
     Geometry: Rectangular    Rectangular                              Flow: Both
     Span(in): 120.00         120.00                     Entrance Loss Coef: 0.50
     Rise(in): 60.00          60.00                          Exit Loss Coef: 1.00
   Invert(ft): -3.170         -3.170                         Bend Loss Coef: 0.00
  Manning's N: 0.013000       0.013000                     Outlet Ctrl Spec: Use dc or tw
 Top Clip(in): 0.000          0.000                         Inlet Ctrl Spec: Use dc
 Bot Clip(in): 0.000          0.000                       Stabilizer Option: None
```

Upstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

Downstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

INFORMATION OBTAINED FROM CASA YBEL BOX CULVERT DESIGN PLANS
DATED 4-1990, REVISED 11-1993.
PIPE LENGTHS ESTIMATED FROM AERIAL IMAGE.

```
----------------------------------------------------------------------------------------------------
         Name: PIPE_5A-5_YBEL      From Node: 5a                 Length(ft): 85.00
        Group: BASE                  To Node: 5                       Count: 1
                                                          Friction Equation: Automatic
              UPSTREAM       DOWNSTREAM                  Solution Algorithm: Most Restrictive
     Geometry: Horz Ellipse   Horz Ellipse                             Flow: Both
     Span(in): 53.00          53.00                      Entrance Loss Coef: 0.50
     Rise(in): 34.00          34.00                          Exit Loss Coef: 1.00
   Invert(ft): -1.180         -1.180                         Bend Loss Coef: 0.00
  Manning's N: 0.013000       0.013000                     Outlet Ctrl Spec: Use dc or tw
 Top Clip(in): 0.000          0.000                         Inlet Ctrl Spec: Use dc
 Bot Clip(in): 0.000          0.000                       Stabilizer Option: None
```

Upstream FHWA Inlet Edge Description:
Horizontal Ellipse Concrete: Square edge with headwall

Downstream FHWA Inlet Edge Description:
Horizontal Ellipse Concrete: Square edge with headwall

PIPE SIZE FIELD VERIFIED ON 4-18-2017.
PIPE LENGTH ESTIMATED FROM AERIAL IMAGE.
INVERT ASSUMED FROM ERP RECORDS

```
----------------------------------------------------------------------------------------------------
         Name: PIPE_6-7A_DONAX     From Node: 6                  Length(ft): 60.00
        Group: BASE                  To Node: 7a                      Count: 2
                                                          Friction Equation: Automatic
              UPSTREAM       DOWNSTREAM                  Solution Algorithm: Most Restrictive
     Geometry: Rectangular    Rectangular                              Flow: Both
     Span(in): 120.00         120.00                     Entrance Loss Coef: 0.50
     Rise(in): 48.00          48.00                          Exit Loss Coef: 1.00
   Invert(ft): -3.240         -3.240                         Bend Loss Coef: 0.00
  Manning's N: 0.013000       0.013000                     Outlet Ctrl Spec: Use dc or tw
 Top Clip(in): 0.000          0.000                         Inlet Ctrl Spec: Use dc
 Bot Clip(in): 0.000          0.000                       Stabilizer Option: None
```

Upstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

Downstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

INFORMATION OBTAINED FROM DONAX STREET CULVERT REPLACEMENTS
RECORD DRAWINGS DATED 1-1994.
PIPE LENGTH ESTIMATED FROM AERIAL IMAGE.

```
----------------------------------------------------------------------------------------------------
         Name: PIPE_7A-7B_ELIN     From Node: 7A_ELIN_US         Length(ft): 32.00
        Group: BASE                  To Node: 7b                      Count: 2
                                                          Friction Equation: Automatic
              UPSTREAM       DOWNSTREAM                  Solution Algorithm: Most Restrictive
     Geometry: Rectangular    Rectangular                              Flow: Both
     Span(in): 120.00         120.00                     Entrance Loss Coef: 0.50
     Rise(in): 48.00          48.00                          Exit Loss Coef: 1.00
   Invert(ft): -3.170         -3.170                         Bend Loss Coef: 0.00
  Manning's N: 0.013000       0.013000                     Outlet Ctrl Spec: Use dc or tw
```

```
 Top Clip(in): 0.000          0.000                          Inlet Ctrl Spec: Use dc
 Bot Clip(in): 0.000          0.000                        Stabilizer Option: None


Upstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

Downstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

INFORMATION OBTAINED FROM ELINOR WAY CULVERT REPLACEMENTS
RECORD DRAWINGS DATED 1-1994.
PIPE LENGTH ESTIMATED FROM AERIAL IMAGE.

----------------------------------------------------------------------------------------------------
         Name: SAN-CAP_ROAD        From Node: 4                     Length(ft): 54.00
        Group: BASE                  To Node: TARPON_BAY_WEIR            Count: 4
                                                           Friction Equation: Automatic
              UPSTREAM       DOWNSTREAM                   Solution Algorithm: Most Restrictive
     Geometry: Rectangular    Rectangular                               Flow: Both
     Span(in): 120.00         120.00                      Entrance Loss Coef: 0.50
     Rise(in): 72.00          72.00                           Exit Loss Coef: 1.00
   Invert(ft): -4.170         -4.170                          Bend Loss Coef: 0.00
  Manning's N: 0.013000       0.013000                      Outlet Ctrl Spec: Use dc or tw
 Top Clip(in): 0.000          0.000                          Inlet Ctrl Spec: Use dc
 Bot Clip(in): 0.000          0.000                        Stabilizer Option: None


Upstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

Downstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

INFORMATION OBTAINED FROM SANIBEL-CAPTIVA ROAD BOX CULVERT
ASBUILTS DATED 5-1995.
PIPE LENGTHS ESTIMATED FROM AERIAL IMAGE.

==========================================================================================
==== Channels ============================================================================
==========================================================================================

          Name: 7A_CHANNEL          From Node: 7a                    Length(ft): 1200.00
         Group: BASE                  To Node: 7A_ELIN_US                 Count: 1

               UPSTREAM       DOWNSTREAM                   Friction Equation: Automatic
      Geometry: Irregular      Irregular                  Solution Algorithm: Automatic
    Invert(ft): -3.100         -3.200                                   Flow: Both
 TClpInitZ(ft): 9999.000       9999.000                     Contraction Coef: 0.100
   Manning's N:                                               Expansion Coef: 0.300
  Top Clip(ft):                                           Entrance Loss Coef: 1.000
  Bot Clip(ft):                                               Exit Loss Coef: 1.000
     Main XSec: B7_CHANNEL     B7_CHANNEL                   Outlet Ctrl Spec: Use dc or tw
  AuxElev1(ft): 0.000          0.000                         Inlet Ctrl Spec: Use dc
     Aux XSec1:                                            Stabilizer Option: None
  AuxElev2(ft): 0.000          0.000
     Aux XSec2:
 Top Width(ft):
     Depth(ft):
 Bot Width(ft):
  LtSdSlp(h/v):
  RtSdSlp(h/v):


----------------------------------------------------------------------------------------------------
          Name: 7B_CHANNEL          From Node: 7b                    Length(ft): 1100.00
         Group: BASE                  To Node: BCH_RD_WEIR                Count: 1

               UPSTREAM       DOWNSTREAM                   Friction Equation: Automatic
      Geometry: Irregular      Irregular                  Solution Algorithm: Automatic
    Invert(ft): -3.100         -3.200                                   Flow: Both
 TClpInitZ(ft): 9999.000       9999.000                     Contraction Coef: 0.100
   Manning's N:                                               Expansion Coef: 0.300
  Top Clip(ft):                                           Entrance Loss Coef: 1.000
  Bot Clip(ft):                                               Exit Loss Coef: 1.000
     Main XSec: B7_CHANNEL     B7_CHANNEL                   Outlet Ctrl Spec: Use dc or tw
  AuxElev1(ft): 0.000          0.000                         Inlet Ctrl Spec: Use dc
     Aux XSec1:                                            Stabilizer Option: None
  AuxElev2(ft): 0.000          0.000
     Aux XSec2:
 Top Width(ft):
     Depth(ft):
 Bot Width(ft):
```

```
  LtSdSlp(h/v):
  RtSdSlp(h/v):


===========================================================================================
==== Drop Structures ======================================================================
===========================================================================================

         Name: BR_WEIR-CUL-GAT     From Node: BCH_RD_WEIR       Length(ft): 28.00
        Group: BASE                  To Node: TAILWATER_(BAY)        Count: 2

               UPSTREAM       DOWNSTREAM                 Friction Equation: Automatic
     Geometry: Rectangular    Rectangular               Solution Algorithm: Most Restrictive
     Span(in): 96.00          96.00                                   Flow: Both
     Rise(in): 60.00          60.00                     Entrance Loss Coef: 0.500
   Invert(ft): -3.130         -3.130                        Exit Loss Coef: 1.000
  Manning's N: 0.013000       0.013000                    Outlet Ctrl Spec: Use dc or tw
 Top Clip(in): 0.000          0.000                        Inlet Ctrl Spec: Use dc
 Bot Clip(in): 0.000          0.000                          Solution Incs: 10

Upstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

Downstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

WEIR AND GATE INFORMATION OBTAINED FROM WATER CONTROL STRUCTURE
RECORD DRAWINGS DATED 2-1993.
PIPE LENGTHS ESTIMATED FROM AERIAL IMAGE.

*** Weir 1 of 2 for Drop Structure BR_WEIR-CUL-GAT ***
                                                                                 TABLE
                  Count: 1                     Bottom Clip(in): 0.000
                   Type: Vertical: Mavis          Top Clip(in): 0.000
                   Flow: Both                   Weir Disc Coef: 3.200
               Geometry: Rectangular          Orifice Disc Coef: 0.600

               Span(in): 720.00                     Invert(ft): 1.510
               Rise(in): 999.00               Control Elev(ft): 1.510

*** Weir 2 of 2 for Drop Structure BR_WEIR-CUL-GAT ***
                                                                                 TABLE
                  Count: 2                     Bottom Clip(in): 0.000
                   Type: Vertical: Mavis          Top Clip(in): 0.000
                   Flow: Both                   Weir Disc Coef: 3.200
               Geometry: Rectangular          Orifice Disc Coef: 0.600

               Span(in): 72.00                      Invert(ft): -4.060
               Rise(in): 60.00                Control Elev(ft): -4.060


-----------------------------------------------------------------------------------------------------
         Name: TARP_RD_WEIR        From Node: 4a                Length(ft): 46.00
        Group: BASE                  To Node: 5                      Count: 1

               UPSTREAM       DOWNSTREAM                 Friction Equation: Automatic
     Geometry: Rectangular    Rectangular               Solution Algorithm: Most Restrictive
     Span(in): 120.00         120.00                                  Flow: Both
     Rise(in): 72.00          72.00                     Entrance Loss Coef: 0.500
   Invert(ft): -3.680         -3.680                        Exit Loss Coef: 1.000
  Manning's N: 0.013000       0.013000                    Outlet Ctrl Spec: Use dc or tw
 Top Clip(in): 0.000          0.000                        Inlet Ctrl Spec: Use dc
 Bot Clip(in): 0.000          0.000                          Solution Incs: 10

Upstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

Downstream FHWA Inlet Edge Description:
Rectangular Box: 30° to 75° wingwall flares

INFORMATION OBTAINED FROM TARPON BAY ROAD BOX CULVERT ASBUILTS DATED 2-21-1996.
WEIR INVERT IS THE AVERAGE OF CREST ELEVATIONS.
PIPE LENGTH ESTIMATED FROM AERIAL IMAGE.

*** Weir 1 of 2 for Drop Structure TARP_RD_WEIR ***
                                                                                 TABLE
                  Count: 1                     Bottom Clip(in): 0.000
                   Type: Vertical: Mavis          Top Clip(in): 0.000
                   Flow: Both                   Weir Disc Coef: 3.200
               Geometry: Rectangular          Orifice Disc Coef: 0.600

               Span(in): 252.00                     Invert(ft): 2.320
               Rise(in): 999.00               Control Elev(ft): 2.320

*** Weir 2 of 2 for Drop Structure TARP_RD_WEIR ***
```

```
                                                                                 TABLE
                Count: 1                       Bottom Clip(in): 0.000
                 Type: Vertical: Mavis            Top Clip(in): 0.000
                 Flow: Both                     Weir Disc Coef: 3.200
             Geometry: Rectangular           Orifice Disc Coef: 0.600

             Span(in): 120.00                      Invert(ft): 3.000
             Rise(in): 999.00                Control Elev(ft): 3.000
```

```
==========================================================================================
==== Weirs ===============================================================================
==========================================================================================

         Name: RABBIT_RD           From Node: 3
        Group: BASE                  To Node: 4
         Flow: Both                    Count: 1
         Type: Vertical: Paved      Geometry: Irregular

                     XSec: RABBIT_RD
               Invert(ft): 3.000
      Control Elevation(ft): 3.000
     Struct Opening Dim(ft): 9999.00
                                                TABLE
           Bottom Clip(ft): 0.000
              Top Clip(ft): 0.000
        Weir Discharge Coef: 3.200
     Orifice Discharge Coef: 0.600



----------------------------------------------------------------------------------------------------
         Name: TARP_RD_OVERTOP     From Node: 4a
        Group: BASE                  To Node: 5
         Flow: Both                    Count: 1
         Type: Vertical: Paved      Geometry: Irregular

                     XSec: TARP_BAY_RD
               Invert(ft): 3.000
      Control Elevation(ft): 3.000
     Struct Opening Dim(ft): 9999.00
                                                TABLE
           Bottom Clip(ft): 0.000
              Top Clip(ft): 0.000
        Weir Discharge Coef: 3.200
     Orifice Discharge Coef: 0.600



----------------------------------------------------------------------------------------------------
         Name: TB_GATES            From Node: TARPON_BAY_WEIR
        Group: BASE                  To Node: TAILWATER_(BAY)
         Flow: Both                    Count: 4
         Type: Vertical: Mavis      Geometry: Rectangular

                 Span(in): 72.00
                 Rise(in): 60.00
               Invert(ft): -4.170
      Control Elevation(ft): -4.170
                                                TABLE
           Bottom Clip(in): 0.000
              Top Clip(in): 0.000
        Weir Discharge Coef: 3.200
     Orifice Discharge Coef: 0.600

INFORMATION OBTAINED FROM TARPON BAY WATER CONTROL STRUCURE
ASBUILTS DATED 5-1995.

----------------------------------------------------------------------------------------------------
         Name: TB_WEIR             From Node: TARPON_BAY_WEIR
        Group: BASE                  To Node: TAILWATER_(BAY)
         Flow: Both                    Count: 1
         Type: Vertical: Mavis      Geometry: Rectangular

                 Span(in): 1680.00
                 Rise(in): 999.00
               Invert(ft): 1.980
      Control Elevation(ft): 1.980
                                                TABLE
           Bottom Clip(in): 0.000
              Top Clip(in): 0.000
        Weir Discharge Coef: 3.200
     Orifice Discharge Coef: 0.600

INFORMATION OBTAINED FROM TARPON BAY WATER CONTROL STRUCURE
WEIR INVERT IS THE AVERAGE OF CREST ELEVATIONS, PER ASBUILTS DATED 5-1995.
```

```
==========================================================================================
==== Hydrology Simulations ===============================================================
==========================================================================================

         Name: 003YEAR-1HOUR
     Filename: \\FTMS01\Proj-fma\20150000\20150244-004 - City of Sanibel (SWMP Update - Ph 3)\ICPR\Ex Cond_4-2100\003YEAR-1HOUR.

      Override Defaults: Yes
    Storm Duration(hrs): 1.00
          Rainfall File: Fdot-1
    Rainfall Amount(in): 2.40

Time(hrs)       Print Inc(min)
--------------- ---------------
30.000          5.00

----------------------------------------------------------------------------------------------------
         Name: 005YR-1DAY
     Filename: \\FTMS01\Proj-fma\20150000\20150244-004 - City of Sanibel (SWMP Update - Ph 3)\ICPR\Ex Cond_4-2100\005YR-1DAY.R32

      Override Defaults: Yes
    Storm Duration(hrs): 24.00
          Rainfall File: Scsi-24
    Rainfall Amount(in): 5.50

Time(hrs)       Print Inc(min)
--------------- ---------------
30.000          5.00

----------------------------------------------------------------------------------------------------
         Name: 025YR-3DAY
     Filename: \\FTMS01\Proj-fma\20150000\20150244-004 - City of Sanibel (SWMP Update - Ph 3)\ICPR\Ex Cond_4-2100\025YR-3DAY.R32

      Override Defaults: Yes
    Storm Duration(hrs): 72.00
          Rainfall File: Sfwmd72
    Rainfall Amount(in): 11.20

Time(hrs)       Print Inc(min)
--------------- ---------------
72.000          5.00

----------------------------------------------------------------------------------------------------
         Name: 100YR-3DAY
     Filename: \\FTMS01\Proj-fma\20150000\20150244-004 - City of Sanibel (SWMP Update - Ph 3)\ICPR\Ex Cond_4-2100\100YR-3DAY.R32

      Override Defaults: Yes
    Storm Duration(hrs): 72.00
          Rainfall File: Sfwmd72
    Rainfall Amount(in): 14.00

Time(hrs)       Print Inc(min)
--------------- ---------------
80.000          5.00

==========================================================================================
==== Routing Simulations =================================================================
==========================================================================================

         Name: 003YEAR-1HOUR       Hydrology Sim: 003YEAR-1HOUR
     Filename: \\FTMS01\Proj-fma\20150000\20150244-004 - City of Sanibel (SWMP Update - Ph 3)\ICPR\Ex Cond_4-2100\003YEAR-1HOUR.

      Execute: Yes         Restart: No            Patch: No
  Alternative: No

        Max Delta Z(ft): 0.10                     Delta Z Factor: 0.00500
    Time Step Optimizer: 10.000
        Start Time(hrs): 0.000                     End Time(hrs): 4.00
     Min Calc Time(sec): 0.5000               Max Calc Time(sec): 60.0000
        Boundary Stages:                          Boundary Flows:


Time(hrs)       Print Inc(min)
--------------- ---------------
999.000         15.000

Group           Run
--------------- -----
BASE            Yes


----------------------------------------------------------------------------------------------------
         Name: 005YR-1DAY          Hydrology Sim: 005YR-1DAY
     Filename: \\FTMS01\Proj-fma\20150000\20150244-004 - City of Sanibel (SWMP Update - Ph 3)\ICPR\Ex Cond_4-2100\005YR-1DAY.I32
```

```
      Execute: No          Restart: No            Patch: No
  Alternative: No

        Max Delta Z(ft): 0.10                     Delta Z Factor: 0.00500
    Time Step Optimizer: 10.000
        Start Time(hrs): 0.000                     End Time(hrs): 30.00
     Min Calc Time(sec): 0.5000               Max Calc Time(sec): 60.0000
        Boundary Stages:                          Boundary Flows:


Time(hrs)       Print Inc(min)
--------------- ---------------
999.000         60.000

Group           Run
--------------- -----
BASE            Yes

----------------------------------------------------------------------------------------------------
         Name: 025YR-3DAY          Hydrology Sim: 025YR-3DAY
     Filename: \\FTMS01\Proj-fma\20150000\20150244-004 - City of Sanibel (SWMP Update - Ph 3)\ICPR\Ex Cond_4-2100\025YR-3DAY.I32

      Execute: No          Restart: No            Patch: No
  Alternative: No

        Max Delta Z(ft): 0.10                     Delta Z Factor: 0.00100
    Time Step Optimizer: 1.000
        Start Time(hrs): 0.000                     End Time(hrs): 100.00
     Min Calc Time(sec): 0.5000               Max Calc Time(sec): 60.0000
        Boundary Stages:                          Boundary Flows:


Time(hrs)       Print Inc(min)
--------------- ---------------
999.000         60.000

Group           Run
--------------- -----
BASE            Yes

----------------------------------------------------------------------------------------------------
         Name: 100YR-3DAY          Hydrology Sim: 100YR-3DAY
     Filename: \\FTMS01\Proj-fma\20150000\20150244-004 - City of Sanibel (SWMP Update - Ph 3)\ICPR\Ex Cond_4-2100\100YR-3DAY.I32

      Execute: No          Restart: No            Patch: No
  Alternative: No

        Max Delta Z(ft): 0.10                     Delta Z Factor: 0.00100
    Time Step Optimizer: 1.000
        Start Time(hrs): 0.000                     End Time(hrs): 100.00
     Min Calc Time(sec): 0.5000               Max Calc Time(sec): 60.0000
        Boundary Stages:                          Boundary Flows:


Time(hrs)       Print Inc(min)
--------------- ---------------
999.000         60.000

Group           Run
--------------- -----
BASE            Yes
```

```
           Basin Name: 1
           Group Name: BASE
           Simulation: 003YEAR-1HOUR
            Node Name: 1
           Basin Type: SCS Unit Hydrograph

      Unit Hydrograph: Uh256
        Peaking Fator: 256.0
  Spec Time Inc (min): 8.80
  Comp Time Inc (min): 5.00
        Rainfall File: Fdot-1
 Rainfall Amount (in): 2.400
 Storm Duration (hrs): 1.00
               Status: Onsite
   Time of Conc (min): 66.00
     Time Shift (hrs): 0.00
            Area (ac): 149.000
 Vol of Unit Hyd (in): 1.000
         Curve Number: 91.000
             DCIA (%): 0.000

       Time Max (hrs): 1.25
       Flow Max (cfs): 115.74
   Runoff Volume (in): 1.520
  Runoff Volume (ft3): 821907

--------------------------------------------------------------------------------

           Basin Name: 2
           Group Name: BASE
           Simulation: 003YEAR-1HOUR
            Node Name: 2
           Basin Type: SCS Unit Hydrograph

      Unit Hydrograph: Uh256
        Peaking Fator: 256.0
  Spec Time Inc (min): 4.27
  Comp Time Inc (min): 4.27
        Rainfall File: Fdot-1
 Rainfall Amount (in): 2.400
 Storm Duration (hrs): 1.00
               Status: Onsite
   Time of Conc (min): 32.00
     Time Shift (hrs): 0.00
            Area (ac): 34.000
 Vol of Unit Hyd (in): 1.000
         Curve Number: 89.000
             DCIA (%): 0.000

       Time Max (hrs): 0.92
       Flow Max (cfs): 43.47
   Runoff Volume (in): 1.367
  Runoff Volume (ft3): 168680

--------------------------------------------------------------------------------

           Basin Name: 3
           Group Name: BASE
           Simulation: 003YEAR-1HOUR
            Node Name: 3
           Basin Type: SCS Unit Hydrograph

      Unit Hydrograph: Uh256
        Peaking Fator: 256.0
  Spec Time Inc (min): 10.80
  Comp Time Inc (min): 5.00
        Rainfall File: Fdot-1
 Rainfall Amount (in): 2.400
 Storm Duration (hrs): 1.00
               Status: Onsite
   Time of Conc (min): 81.00
     Time Shift (hrs): 0.00
            Area (ac): 813.000
 Vol of Unit Hyd (in): 1.000
         Curve Number: 94.000
             DCIA (%): 0.000

       Time Max (hrs): 1.42
       Flow Max (cfs): 610.86
   Runoff Volume (in): 1.773
  Runoff Volume (ft3): 5232711

--------------------------------------------------------------------------------
```

```
            Basin Name: 4
            Group Name: BASE
            Simulation: 003YEAR-1HOUR
             Node Name: 4
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 4.00
   Comp Time Inc (min): 4.00
         Rainfall File: Fdot-1
  Rainfall Amount (in): 2.400
  Storm Duration (hrs): 1.00
                Status: Onsite
    Time of Conc (min): 30.00
      Time Shift (hrs): 0.00
             Area (ac): 728.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 94.000
              DCIA (%): 0.000

        Time Max (hrs): 0.87
        Flow Max (cfs): 1241.10
    Runoff Volume (in): 1.773
   Runoff Volume (ft3): 4686539
```

```
            Basin Name: 4A
            Group Name: BASE
            Simulation: 003YEAR-1HOUR
             Node Name: 4a
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 4.67
   Comp Time Inc (min): 4.67
         Rainfall File: Fdot-1
  Rainfall Amount (in): 2.400
  Storm Duration (hrs): 1.00
                Status: Onsite
    Time of Conc (min): 35.00
      Time Shift (hrs): 0.00
             Area (ac): 291.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 93.000
              DCIA (%): 0.000

        Time Max (hrs): 0.93
        Flow Max (cfs): 425.00
    Runoff Volume (in): 1.677
   Runoff Volume (ft3): 1771922
```

```
            Basin Name: 5
            Group Name: BASE
            Simulation: 003YEAR-1HOUR
             Node Name: 5
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 7.20
   Comp Time Inc (min): 5.00
         Rainfall File: Fdot-1
  Rainfall Amount (in): 2.400
  Storm Duration (hrs): 1.00
                Status: Onsite
    Time of Conc (min): 54.00
      Time Shift (hrs): 0.00
             Area (ac): 607.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 95.000
              DCIA (%): 0.000

        Time Max (hrs): 1.17
        Flow Max (cfs): 684.74
    Runoff Volume (in): 1.865
   Runoff Volume (ft3): 4109392
```

```
            Basin Name: 5A
            Group Name: BASE
            Simulation: 003YEAR-1HOUR
             Node Name: 5a
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 3.20
   Comp Time Inc (min): 3.20
         Rainfall File: Fdot-1
  Rainfall Amount (in): 2.400
  Storm Duration (hrs): 1.00
                Status: Onsite
    Time of Conc (min): 24.00
      Time Shift (hrs): 0.00
             Area (ac): 101.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 97.000
              DCIA (%): 0.000

        Time Max (hrs): 0.80
        Flow Max (cfs): 227.85
    Runoff Volume (in): 2.060
   Runoff Volume (ft3): 755103
```

```
            Basin Name: 6
            Group Name: BASE
            Simulation: 003YEAR-1HOUR
             Node Name: 6
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 6.00
   Comp Time Inc (min): 5.00
         Rainfall File: Fdot-1
  Rainfall Amount (in): 2.400
  Storm Duration (hrs): 1.00
                Status: Onsite
    Time of Conc (min): 45.00
      Time Shift (hrs): 0.00
             Area (ac): 402.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 91.000
              DCIA (%): 0.000

        Time Max (hrs): 1.08
        Flow Max (cfs): 433.61
    Runoff Volume (in): 1.519
   Runoff Volume (ft3): 2216658
```

```
            Basin Name: 7a
            Group Name: BASE
            Simulation: 003YEAR-1HOUR
             Node Name: 7a
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 5.33
   Comp Time Inc (min): 5.00
         Rainfall File: Fdot-1
  Rainfall Amount (in): 2.400
  Storm Duration (hrs): 1.00
                Status: Onsite
    Time of Conc (min): 40.00
      Time Shift (hrs): 0.00
             Area (ac): 64.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 92.000
              DCIA (%): 0.000

        Time Max (hrs): 1.00
        Flow Max (cfs): 79.64
    Runoff Volume (in): 1.597
   Runoff Volume (ft3): 371114
```

```
         Basin Name: 7b
         Group Name: BASE
         Simulation: 003YEAR-1HOUR
          Node Name: 7b
         Basin Type: SCS Unit Hydrograph

    Unit Hydrograph: Uh256
      Peaking Fator: 256.0
Spec Time Inc (min): 5.33
Comp Time Inc (min): 5.00
      Rainfall File: Fdot-1
Rainfall Amount (in): 2.400
Storm Duration (hrs): 1.00
             Status: Onsite
 Time of Conc (min): 40.00
   Time Shift (hrs): 0.00
          Area (ac): 64.000
Vol of Unit Hyd (in): 1.000
       Curve Number: 92.000
           DCIA (%): 0.000

     Time Max (hrs): 1.00
     Flow Max (cfs): 79.64
 Runoff Volume (in): 1.597
Runoff Volume (ft3): 371114
```

```
         Basin Name: 1
         Group Name: BASE
         Simulation: 005YR-1DAY
          Node Name: 1
         Basin Type: SCS Unit Hydrograph

    Unit Hydrograph: Uh256
      Peaking Fator: 256.0
Spec Time Inc (min): 8.80
Comp Time Inc (min): 5.00
      Rainfall File: Scsi-24
Rainfall Amount (in): 5.500
Storm Duration (hrs): 24.00
             Status: Onsite
 Time of Conc (min): 66.00
   Time Shift (hrs): 0.00
          Area (ac): 149.000
Vol of Unit Hyd (in): 1.000
       Curve Number: 91.000
           DCIA (%): 0.000

     Time Max (hrs): 10.67
     Flow Max (cfs): 117.21
 Runoff Volume (in): 4.468
Runoff Volume (ft3): 2416814
```

```
         Basin Name: 2
         Group Name: BASE
         Simulation: 005YR-1DAY
          Node Name: 2
         Basin Type: SCS Unit Hydrograph

    Unit Hydrograph: Uh256
      Peaking Fator: 256.0
Spec Time Inc (min): 4.27
Comp Time Inc (min): 4.27
      Rainfall File: Scsi-24
Rainfall Amount (in): 5.500
Storm Duration (hrs): 24.00
             Status: Onsite
 Time of Conc (min): 32.00
   Time Shift (hrs): 0.00
          Area (ac): 34.000
Vol of Unit Hyd (in): 1.000
       Curve Number: 89.000
           DCIA (%): 0.000

     Time Max (hrs): 10.24
     Flow Max (cfs): 38.10
 Runoff Volume (in): 4.248
Runoff Volume (ft3): 524267
```

```
             Basin Name: 3
             Group Name: BASE
             Simulation: 005YR-1DAY
              Node Name: 3
             Basin Type: SCS Unit Hydrograph

        Unit Hydrograph: Uh256
          Peaking Fator: 256.0
    Spec Time Inc (min): 10.80
    Comp Time Inc (min): 5.00
          Rainfall File: Scsi-24
   Rainfall Amount (in): 5.500
   Storm Duration (hrs): 24.00
                 Status: Onsite
     Time of Conc (min): 81.00
       Time Shift (hrs): 0.00
              Area (ac): 813.000
   Vol of Unit Hyd (in): 1.000
           Curve Number: 94.000
               DCIA (%): 0.000

         Time Max (hrs): 10.83
         Flow Max (cfs): 607.73
     Runoff Volume (in): 4.799
    Runoff Volume (ft3): 14163632
```

```
             Basin Name: 4
             Group Name: BASE
             Simulation: 005YR-1DAY
              Node Name: 4
             Basin Type: SCS Unit Hydrograph

        Unit Hydrograph: Uh256
          Peaking Fator: 256.0
    Spec Time Inc (min): 4.00
    Comp Time Inc (min): 4.00
          Rainfall File: Scsi-24
   Rainfall Amount (in): 5.500
   Storm Duration (hrs): 24.00
                 Status: Onsite
     Time of Conc (min): 30.00
       Time Shift (hrs): 0.00
              Area (ac): 728.000
   Vol of Unit Hyd (in): 1.000
           Curve Number: 94.000
               DCIA (%): 0.000

         Time Max (hrs): 10.20
         Flow Max (cfs): 945.88
     Runoff Volume (in): 4.800
    Runoff Volume (ft3): 12685167
```

```
             Basin Name: 4A
             Group Name: BASE
             Simulation: 005YR-1DAY
              Node Name: 4a
             Basin Type: SCS Unit Hydrograph

        Unit Hydrograph: Uh256
          Peaking Fator: 256.0
    Spec Time Inc (min): 4.67
    Comp Time Inc (min): 4.67
          Rainfall File: Scsi-24
   Rainfall Amount (in): 5.500
   Storm Duration (hrs): 24.00
                 Status: Onsite
     Time of Conc (min): 35.00
       Time Shift (hrs): 0.00
              Area (ac): 291.000
   Vol of Unit Hyd (in): 1.000
           Curve Number: 93.000
               DCIA (%): 0.000

         Time Max (hrs): 10.27
         Flow Max (cfs): 341.67
     Runoff Volume (in): 4.684
```

```
    Runoff Volume (ft3): 4948056

--------------------------------------------------------------------------------

             Basin Name: 5
             Group Name: BASE
             Simulation: 005YR-1DAY
              Node Name: 5
             Basin Type: SCS Unit Hydrograph

        Unit Hydrograph: Uh256
          Peaking Fator: 256.0
    Spec Time Inc (min): 7.20
    Comp Time Inc (min): 5.00
          Rainfall File: Scsi-24
   Rainfall Amount (in): 5.500
   Storm Duration (hrs): 24.00
                 Status: Onsite
     Time of Conc (min): 54.00
       Time Shift (hrs): 0.00
              Area (ac): 607.000
   Vol of Unit Hyd (in): 1.000
           Curve Number: 95.000
               DCIA (%): 0.000

         Time Max (hrs): 10.50
         Flow Max (cfs): 583.46
     Runoff Volume (in): 4.911
    Runoff Volume (ft3): 10820929

--------------------------------------------------------------------------------

             Basin Name: 5A
             Group Name: BASE
             Simulation: 005YR-1DAY
              Node Name: 5a
             Basin Type: SCS Unit Hydrograph

        Unit Hydrograph: Uh256
          Peaking Fator: 256.0
    Spec Time Inc (min): 3.20
    Comp Time Inc (min): 3.20
          Rainfall File: Scsi-24
   Rainfall Amount (in): 5.500
   Storm Duration (hrs): 24.00
                 Status: Onsite
     Time of Conc (min): 24.00
       Time Shift (hrs): 0.00
              Area (ac): 101.000
   Vol of Unit Hyd (in): 1.000
           Curve Number: 97.000
               DCIA (%): 0.000

         Time Max (hrs): 10.13
         Flow Max (cfs): 152.30
     Runoff Volume (in): 5.144
    Runoff Volume (ft3): 1885855

--------------------------------------------------------------------------------

             Basin Name: 6
             Group Name: BASE
             Simulation: 005YR-1DAY
              Node Name: 6
             Basin Type: SCS Unit Hydrograph

        Unit Hydrograph: Uh256
          Peaking Fator: 256.0
    Spec Time Inc (min): 6.00
    Comp Time Inc (min): 5.00
          Rainfall File: Scsi-24
   Rainfall Amount (in): 5.500
   Storm Duration (hrs): 24.00
                 Status: Onsite
     Time of Conc (min): 45.00
       Time Shift (hrs): 0.00
              Area (ac): 402.000
   Vol of Unit Hyd (in): 1.000
           Curve Number: 91.000
               DCIA (%): 0.000

         Time Max (hrs): 10.33
         Flow Max (cfs): 393.82
```

```
     Runoff Volume (in): 4.467
    Runoff Volume (ft3): 6518069

--------------------------------------------------------------------------------

             Basin Name: 7a
             Group Name: BASE
             Simulation: 005YR-1DAY
              Node Name: 7a
             Basin Type: SCS Unit Hydrograph

        Unit Hydrograph: Uh256
          Peaking Fator: 256.0
    Spec Time Inc (min): 5.33
    Comp Time Inc (min): 5.00
          Rainfall File: Scsi-24
   Rainfall Amount (in): 5.500
   Storm Duration (hrs): 24.00
                 Status: Onsite
     Time of Conc (min): 40.00
       Time Shift (hrs): 0.00
              Area (ac): 64.000
   Vol of Unit Hyd (in): 1.000
           Curve Number: 92.000
               DCIA (%): 0.000

         Time Max (hrs): 10.33
         Flow Max (cfs): 68.16
     Runoff Volume (in): 4.569
    Runoff Volume (ft3): 1061462

--------------------------------------------------------------------------------

             Basin Name: 7b
             Group Name: BASE
             Simulation: 005YR-1DAY
              Node Name: 7b
             Basin Type: SCS Unit Hydrograph

        Unit Hydrograph: Uh256
          Peaking Fator: 256.0
    Spec Time Inc (min): 5.33
    Comp Time Inc (min): 5.00
          Rainfall File: Scsi-24
   Rainfall Amount (in): 5.500
   Storm Duration (hrs): 24.00
                 Status: Onsite
     Time of Conc (min): 40.00
       Time Shift (hrs): 0.00
              Area (ac): 64.000
   Vol of Unit Hyd (in): 1.000
           Curve Number: 92.000
               DCIA (%): 0.000

         Time Max (hrs): 10.33
         Flow Max (cfs): 68.16
     Runoff Volume (in): 4.569
    Runoff Volume (ft3): 1061462

--------------------------------------------------------------------------------

             Basin Name: 1
             Group Name: BASE
             Simulation: 025YR-3DAY
              Node Name: 1
             Basin Type: SCS Unit Hydrograph

        Unit Hydrograph: Uh256
          Peaking Fator: 256.0
    Spec Time Inc (min): 8.80
    Comp Time Inc (min): 5.00
          Rainfall File: Sfwmd72
   Rainfall Amount (in): 11.200
   Storm Duration (hrs): 72.00
                 Status: Onsite
     Time of Conc (min): 66.00
       Time Shift (hrs): 0.00
              Area (ac): 149.000
   Vol of Unit Hyd (in): 1.000
           Curve Number: 91.000
               DCIA (%): 0.000

         Time Max (hrs): 60.58
```

```
        Flow Max (cfs): 277.92
    Runoff Volume (in): 10.086
   Runoff Volume (ft3): 5455174

--------------------------------------------------------------------------------

            Basin Name: 2
            Group Name: BASE
            Simulation: 025YR-3DAY
             Node Name: 2
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 4.27
   Comp Time Inc (min): 4.27
         Rainfall File: Sfwmd72
  Rainfall Amount (in): 11.200
  Storm Duration (hrs): 72.00
                Status: Onsite
    Time of Conc (min): 32.00
      Time Shift (hrs): 0.00
             Area (ac): 34.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 89.000
              DCIA (%): 0.000

        Time Max (hrs): 60.16
        Flow Max (cfs): 98.64
    Runoff Volume (in): 9.835
   Runoff Volume (ft3): 1213869

--------------------------------------------------------------------------------

            Basin Name: 3
            Group Name: BASE
            Simulation: 025YR-3DAY
             Node Name: 3
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 10.80
   Comp Time Inc (min): 5.00
         Rainfall File: Sfwmd72
  Rainfall Amount (in): 11.200
  Storm Duration (hrs): 72.00
                Status: Onsite
    Time of Conc (min): 81.00
      Time Shift (hrs): 0.00
             Area (ac): 813.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 94.000
              DCIA (%): 0.000

        Time Max (hrs): 60.75
        Flow Max (cfs): 1336.93
    Runoff Volume (in): 10.455
   Runoff Volume (ft3): 30854958

--------------------------------------------------------------------------------

            Basin Name: 4
            Group Name: BASE
            Simulation: 025YR-3DAY
             Node Name: 4
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 4.00
   Comp Time Inc (min): 4.00
         Rainfall File: Sfwmd72
  Rainfall Amount (in): 11.200
  Storm Duration (hrs): 72.00
                Status: Onsite
    Time of Conc (min): 30.00
      Time Shift (hrs): 0.00
             Area (ac): 728.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 94.000
              DCIA (%): 0.000
```

```
        Time Max (hrs): 60.20
        Flow Max (cfs): 2236.05
    Runoff Volume (in): 10.465
   Runoff Volume (ft3): 27655743

--------------------------------------------------------------------------------

            Basin Name: 4A
            Group Name: BASE
            Simulation: 025YR-3DAY
             Node Name: 4a
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 4.67
   Comp Time Inc (min): 4.67
         Rainfall File: Sfwmd72
  Rainfall Amount (in): 11.200
  Storm Duration (hrs): 72.00
                Status: Onsite
    Time of Conc (min): 35.00
      Time Shift (hrs): 0.00
             Area (ac): 291.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 93.000
              DCIA (%): 0.000

        Time Max (hrs): 60.20
        Flow Max (cfs): 816.60
    Runoff Volume (in): 10.336
   Runoff Volume (ft3): 10917912

--------------------------------------------------------------------------------

            Basin Name: 5
            Group Name: BASE
            Simulation: 025YR-3DAY
             Node Name: 5
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 7.20
   Comp Time Inc (min): 5.00
         Rainfall File: Sfwmd72
  Rainfall Amount (in): 11.200
  Storm Duration (hrs): 72.00
                Status: Onsite
    Time of Conc (min): 54.00
      Time Shift (hrs): 0.00
             Area (ac): 607.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 95.000
              DCIA (%): 0.000

        Time Max (hrs): 60.42
        Flow Max (cfs): 1308.09
    Runoff Volume (in): 10.575
   Runoff Volume (ft3): 23300951

--------------------------------------------------------------------------------

            Basin Name: 5A
            Group Name: BASE
            Simulation: 025YR-3DAY
             Node Name: 5a
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 3.20
   Comp Time Inc (min): 3.20
         Rainfall File: Sfwmd72
  Rainfall Amount (in): 11.200
  Storm Duration (hrs): 72.00
                Status: Onsite
    Time of Conc (min): 24.00
      Time Shift (hrs): 0.00
             Area (ac): 101.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 97.000
              DCIA (%): 0.000
```

```
        Time Max (hrs): 60.11
       Flow Max (cfs): 352.30
    Runoff Volume (in): 10.833
   Runoff Volume (ft3): 3971872
```

```
            Basin Name: 6
            Group Name: BASE
            Simulation: 025YR-3DAY
             Node Name: 6
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
        Peaking Fator: 256.0
   Spec Time Inc (min): 6.00
   Comp Time Inc (min): 5.00
        Rainfall File: Sfwmd72
  Rainfall Amount (in): 11.200
  Storm Duration (hrs): 72.00
               Status: Onsite
    Time of Conc (min): 45.00
      Time Shift (hrs): 0.00
             Area (ac): 402.000
  Vol of Unit Hyd (in): 1.000
         Curve Number: 91.000
             DCIA (%): 0.000

        Time Max (hrs): 60.33
       Flow Max (cfs): 962.80
    Runoff Volume (in): 10.082
   Runoff Volume (ft3): 14712428
```

```
            Basin Name: 7a
            Group Name: BASE
            Simulation: 025YR-3DAY
             Node Name: 7a
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
        Peaking Fator: 256.0
   Spec Time Inc (min): 5.33
   Comp Time Inc (min): 5.00
        Rainfall File: Sfwmd72
  Rainfall Amount (in): 11.200
  Storm Duration (hrs): 72.00
               Status: Onsite
    Time of Conc (min): 40.00
      Time Shift (hrs): 0.00
             Area (ac): 64.000
  Vol of Unit Hyd (in): 1.000
         Curve Number: 92.000
             DCIA (%): 0.000

        Time Max (hrs): 60.25
       Flow Max (cfs): 164.91
    Runoff Volume (in): 10.190
   Runoff Volume (ft3): 2367448
```

```
            Basin Name: 7b
            Group Name: BASE
            Simulation: 025YR-3DAY
             Node Name: 7b
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
        Peaking Fator: 256.0
   Spec Time Inc (min): 5.33
   Comp Time Inc (min): 5.00
        Rainfall File: Sfwmd72
  Rainfall Amount (in): 11.200
  Storm Duration (hrs): 72.00
               Status: Onsite
    Time of Conc (min): 40.00
      Time Shift (hrs): 0.00
             Area (ac): 64.000
  Vol of Unit Hyd (in): 1.000
         Curve Number: 92.000
```

```
              DCIA (%): 0.000

        Time Max (hrs): 60.25
        Flow Max (cfs): 164.91
    Runoff Volume (in): 10.190
   Runoff Volume (ft3): 2367448
```

```
            Basin Name: 1
            Group Name: BASE
            Simulation: 100YR-3DAY
             Node Name: 1
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 8.80
   Comp Time Inc (min): 5.00
         Rainfall File: Sfwmd72
  Rainfall Amount (in): 14.000
  Storm Duration (hrs): 72.00
                Status: Onsite
    Time of Conc (min): 66.00
      Time Shift (hrs): 0.00
             Area (ac): 149.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 91.000
              DCIA (%): 0.000

        Time Max (hrs): 60.58
        Flow Max (cfs): 349.53
    Runoff Volume (in): 12.868
   Runoff Volume (ft3): 6960041
```

```
            Basin Name: 2
            Group Name: BASE
            Simulation: 100YR-3DAY
             Node Name: 2
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 4.27
   Comp Time Inc (min): 4.27
         Rainfall File: Sfwmd72
  Rainfall Amount (in): 14.000
  Storm Duration (hrs): 72.00
                Status: Onsite
    Time of Conc (min): 32.00
      Time Shift (hrs): 0.00
             Area (ac): 34.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 89.000
              DCIA (%): 0.000

        Time Max (hrs): 60.16
        Flow Max (cfs): 124.36
    Runoff Volume (in): 12.610
   Runoff Volume (ft3): 1556327
```

```
            Basin Name: 3
            Group Name: BASE
            Simulation: 100YR-3DAY
             Node Name: 3
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 10.80
   Comp Time Inc (min): 5.00
         Rainfall File: Sfwmd72
  Rainfall Amount (in): 14.000
  Storm Duration (hrs): 72.00
                Status: Onsite
    Time of Conc (min): 81.00
      Time Shift (hrs): 0.00
             Area (ac): 813.000
  Vol of Unit Hyd (in): 1.000
```

```
          Curve Number: 94.000
              DCIA (%): 0.000

        Time Max (hrs): 60.75
        Flow Max (cfs): 1675.96
    Runoff Volume (in): 13.245
   Runoff Volume (ft3): 39088032

--------------------------------------------------------------------------------

            Basin Name: 4
            Group Name: BASE
            Simulation: 100YR-3DAY
             Node Name: 4
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 4.00
   Comp Time Inc (min): 4.00
         Rainfall File: Sfwmd72
  Rainfall Amount (in): 14.000
  Storm Duration (hrs): 72.00
                Status: Onsite
    Time of Conc (min): 30.00
      Time Shift (hrs): 0.00
             Area (ac): 728.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 94.000
              DCIA (%): 0.000

        Time Max (hrs): 60.20
        Flow Max (cfs): 2802.39
    Runoff Volume (in): 13.258
   Runoff Volume (ft3): 35034836

--------------------------------------------------------------------------------

            Basin Name: 4A
            Group Name: BASE
            Simulation: 100YR-3DAY
             Node Name: 4a
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 4.67
   Comp Time Inc (min): 4.67
         Rainfall File: Sfwmd72
  Rainfall Amount (in): 14.000
  Storm Duration (hrs): 72.00
                Status: Onsite
    Time of Conc (min): 35.00
      Time Shift (hrs): 0.00
             Area (ac): 291.000
  Vol of Unit Hyd (in): 1.000
          Curve Number: 93.000
              DCIA (%): 0.000

        Time Max (hrs): 60.20
        Flow Max (cfs): 1024.48
    Runoff Volume (in): 13.124
   Runoff Volume (ft3): 13863434

--------------------------------------------------------------------------------

            Basin Name: 5
            Group Name: BASE
            Simulation: 100YR-3DAY
             Node Name: 5
            Basin Type: SCS Unit Hydrograph

       Unit Hydrograph: Uh256
         Peaking Fator: 256.0
   Spec Time Inc (min): 7.20
   Comp Time Inc (min): 5.00
         Rainfall File: Sfwmd72
  Rainfall Amount (in): 14.000
  Storm Duration (hrs): 72.00
                Status: Onsite
    Time of Conc (min): 54.00
      Time Shift (hrs): 0.00
             Area (ac): 607.000
```

```
   Vol of Unit Hyd (in): 1.000
           Curve Number: 95.000
               DCIA (%): 0.000

         Time Max (hrs): 60.42
         Flow Max (cfs): 1638.32
     Runoff Volume (in): 13.366
    Runoff Volume (ft3): 29450473

--------------------------------------------------------------------------------

             Basin Name: 5A
             Group Name: BASE
             Simulation: 100YR-3DAY
              Node Name: 5a
             Basin Type: SCS Unit Hydrograph

        Unit Hydrograph: Uh256
          Peaking Fator: 256.0
    Spec Time Inc (min): 3.20
    Comp Time Inc (min): 3.20
          Rainfall File: Sfwmd72
   Rainfall Amount (in): 14.000
   Storm Duration (hrs): 72.00
                 Status: Onsite
     Time of Conc (min): 24.00
       Time Shift (hrs): 0.00
              Area (ac): 101.000
   Vol of Unit Hyd (in): 1.000
           Curve Number: 97.000
               DCIA (%): 0.000

         Time Max (hrs): 60.11
         Flow Max (cfs): 440.67
     Runoff Volume (in): 13.631
    Runoff Volume (ft3): 4997478

--------------------------------------------------------------------------------

             Basin Name: 6
             Group Name: BASE
             Simulation: 100YR-3DAY
              Node Name: 6
             Basin Type: SCS Unit Hydrograph

        Unit Hydrograph: Uh256
          Peaking Fator: 256.0
    Spec Time Inc (min): 6.00
    Comp Time Inc (min): 5.00
          Rainfall File: Sfwmd72
   Rainfall Amount (in): 14.000
   Storm Duration (hrs): 72.00
                 Status: Onsite
     Time of Conc (min): 45.00
       Time Shift (hrs): 0.00
              Area (ac): 402.000
   Vol of Unit Hyd (in): 1.000
           Curve Number: 91.000
               DCIA (%): 0.000

         Time Max (hrs): 60.33
         Flow Max (cfs): 1210.67
     Runoff Volume (in): 12.863
    Runoff Volume (ft3): 18771007

--------------------------------------------------------------------------------

             Basin Name: 7a
             Group Name: BASE
             Simulation: 100YR-3DAY
              Node Name: 7a
             Basin Type: SCS Unit Hydrograph

        Unit Hydrograph: Uh256
          Peaking Fator: 256.0
    Spec Time Inc (min): 5.33
    Comp Time Inc (min): 5.00
          Rainfall File: Sfwmd72
   Rainfall Amount (in): 14.000
   Storm Duration (hrs): 72.00
                 Status: Onsite
     Time of Conc (min): 40.00
       Time Shift (hrs): 0.00
```

```
            Area (ac): 64.000
   Vol of Unit Hyd (in): 1.000
         Curve Number: 92.000
             DCIA (%): 0.000

        Time Max (hrs): 60.25
        Flow Max (cfs): 207.12
    Runoff Volume (in): 12.970
   Runoff Volume (ft3): 3013292
```

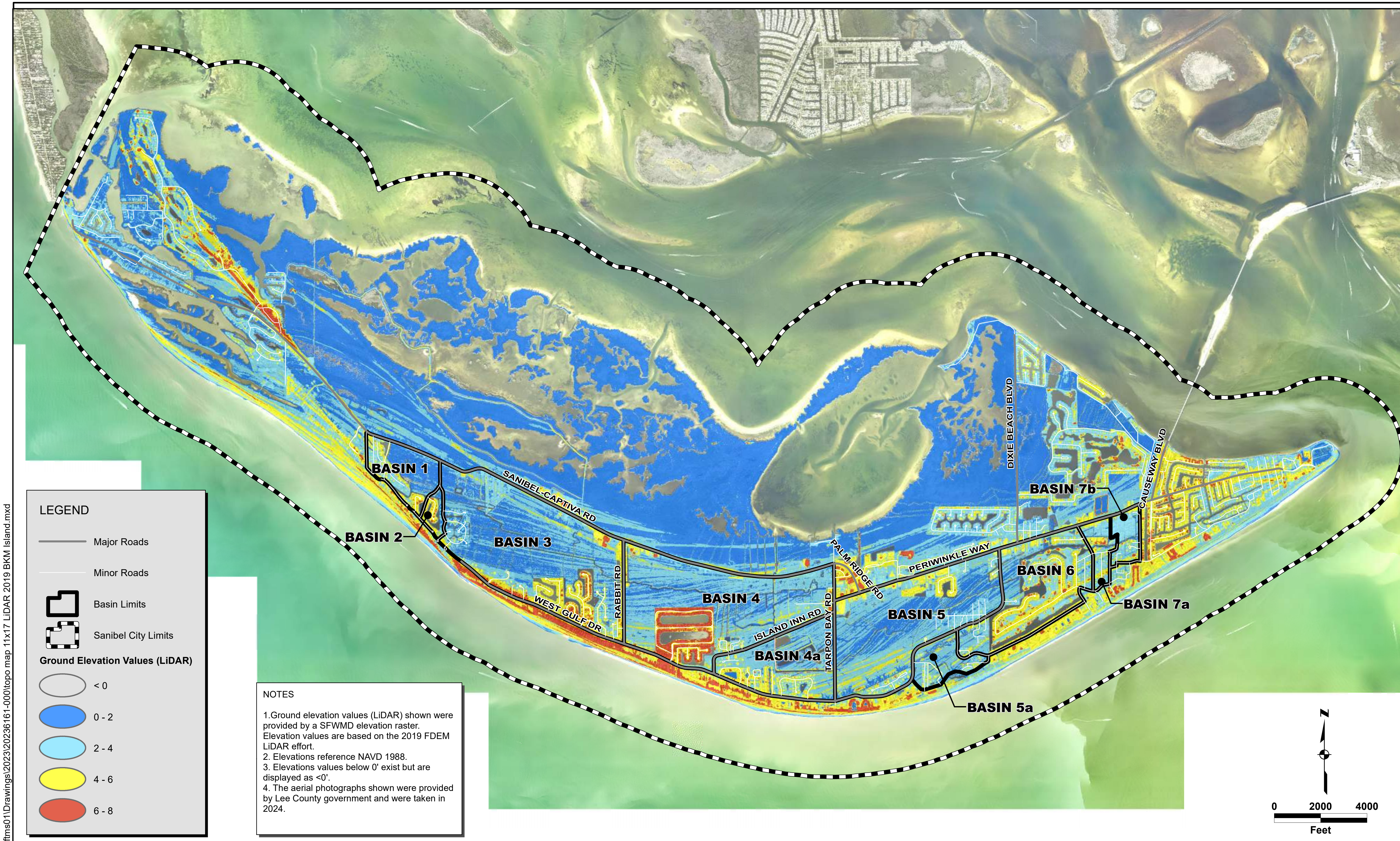
```
           Basin Name: 7b
           Group Name: BASE
           Simulation: 100YR-3DAY
            Node Name: 7b
           Basin Type: SCS Unit Hydrograph

      Unit Hydrograph: Uh256
        Peaking Fator: 256.0
   Spec Time Inc (min): 5.33
   Comp Time Inc (min): 5.00
        Rainfall File: Sfwmd72
  Rainfall Amount (in): 14.000
  Storm Duration (hrs): 72.00
               Status: Onsite
    Time of Conc (min): 40.00
      Time Shift (hrs): 0.00
            Area (ac): 64.000
  Vol of Unit Hyd (in): 1.000
         Curve Number: 92.000
             DCIA (%): 0.000

        Time Max (hrs): 60.25
        Flow Max (cfs): 207.12
    Runoff Volume (in): 12.970
   Runoff Volume (ft3): 3013292
```

SANIBEL RIVER
EXISTING CONDITION - 2100 MSL
NODE PEAK REPORT
JUNE 2018

Name	Group	Simulation	Max Time Stage hrs	Max Stage ft	Warning Stage ft	Max Delta Stage ft	Max Surf Area ft2	Max Time Inflow hrs	Max Inflow cfs	Max Time Outflow hrs	Max Outflow cfs
1	BASE	003YEAR-1HOUR	3.94	3.6	0.0	0.0000	4028154	1.25	115.74	4.00	21.61
2	BASE	003YEAR-1HOUR	3.41	3.6	0.0	0.0000	663786	0.92	27.90	4.00	22.40
3	BASE	003YEAR-1HOUR	3.08	3.5	0.0	0.0000	24732434	1.42	613.57	3.03	256.66
4	BASE	003YEAR-1HOUR	3.08	3.5	0.0	0.0000	23982575	0.83	921.08	2.14	590.50
4a	BASE	003YEAR-1HOUR	3.72	3.6	0.0	0.0000	9396833	0.92	405.44	0.85	93.96
5	BASE	003YEAR-1HOUR	3.72	3.6	0.0	0.0000	19697614	1.00	707.50	4.00	30.42
5a	BASE	003YEAR-1HOUR	2.44	3.7	0.0	0.0000	2896163	0.83	226.00	1.24	17.88
6	BASE	003YEAR-1HOUR	2.38	3.6	0.0	0.0000	6426661	1.00	381.78	4.00	85.30
7a	BASE	003YEAR-1HOUR	2.30	3.6	0.0	0.0000	1310939	1.17	116.66	3.70	93.93
7A_ELIN_US	BASE	003YEAR-1HOUR	2.24	3.6	0.0	0.0000	52421	3.70	93.93	3.71	94.12
7b	BASE	003YEAR-1HOUR	2.08	3.5	0.0	0.0000	1251716	1.17	129.99	2.07	113.52
BCH_RD_WEIR	BASE	003YEAR-1HOUR	2.08	3.5	0.0	0.0000	48176	2.07	113.52	2.08	113.52
TAILWATER_(BAY)	BASE	003YEAR-1HOUR	0.00	3.4	0.0	0.0000	0	3.00	258.24	0.00	0.00
TARPON_BAY_WEIR	BASE	003YEAR-1HOUR	3.08	3.4	0.0	-0.1000	490	3.08	677.13	3.08	149.57
1	BASE	005YR-1DAY	16.35	3.7	0.0	0.0000	4229049	10.67	117.21	18.74	28.51
2	BASE	005YR-1DAY	16.33	3.7	0.0	0.0000	686178	10.78	34.93	18.10	34.01
3	BASE	005YR-1DAY	16.06	3.6	0.0	0.0000	25326378	10.83	626.75	12.67	286.61
4	BASE	005YR-1DAY	16.05	3.6	0.0	0.0000	24364279	10.49	802.12	12.67	599.63
4a	BASE	005YR-1DAY	16.56	3.7	0.0	0.0000	9787676	10.25	270.65	10.08	6.75
5	BASE	005YR-1DAY	16.56	3.7	0.0	0.0000	20575895	10.33	556.29	27.62	56.75
5a	BASE	005YR-1DAY	18.41	3.8	0.0	0.0000	3118156	10.17	150.86	10.68	16.55
6	BASE	005YR-1DAY	15.04	3.7	0.0	0.0000	7085925	10.33	340.91	16.86	114.45
7a	BASE	005YR-1DAY	14.43	3.7	0.0	0.0000	1416049	10.71	127.98	15.74	126.37
7A_ELIN_US	BASE	005YR-1DAY	13.07	3.6	0.0	-0.0005	52739	15.74	126.37	15.75	126.41
7b	BASE	005YR-1DAY	12.63	3.6	0.0	0.0000	1315418	11.12	147.25	12.62	143.35
BCH_RD_WEIR	BASE	005YR-1DAY	12.64	3.5	0.0	0.0001	48336	12.62	143.35	12.64	143.35
TAILWATER_(BAY)	BASE	005YR-1DAY	0.00	3.4	0.0	0.0000	0	13.06	894.63	0.00	0.00
TARPON_BAY_WEIR	BASE	005YR-1DAY	22.73	3.6	0.0	-0.1000	490	12.67	715.04	22.73	757.27
1	BASE	025YR-3DAY	65.34	4.1	0.0	0.0000	4726767	60.58	277.92	69.81	44.15
2	BASE	025YR-3DAY	65.26	4.0	0.0	0.0000	740769	60.17	78.37	68.42	51.99
3	BASE	025YR-3DAY	64.64	3.9	0.0	0.0000	26892285	60.75	1372.05	62.75	511.51
4	BASE	025YR-3DAY	64.64	3.9	0.0	0.0000	25362274	60.17	1692.03	60.19	612.43
4a	BASE	025YR-3DAY	65.03	4.1	0.0	0.0000	10693284	60.25	704.27	60.09	102.41
5	BASE	025YR-3DAY	65.03	4.1	0.0	0.0000	22596768	60.33	1313.84	75.21	85.36
5a	BASE	025YR-3DAY	68.20	4.1	0.0	0.0001	3580435	60.08	348.78	81.81	22.16
6	BASE	025YR-3DAY	62.98	4.1	0.0	0.0001	9032934	60.33	876.31	66.37	168.42
7a	BASE	025YR-3DAY	62.72	4.0	0.0	0.0000	1779583	60.33	258.89	63.77	189.96
7A_ELIN_US	BASE	025YR-3DAY	62.62	4.0	0.0	0.0001	53911	63.77	189.96	63.78	190.39
7b	BASE	025YR-3DAY	62.29	3.8	0.0	0.0000	1566732	60.33	278.64	62.27	231.98
BCH_RD_WEIR	BASE	025YR-3DAY	62.30	3.7	0.0	0.0000	48978	62.27	231.98	62.30	231.98
TAILWATER_(BAY)	BASE	025YR-3DAY	0.00	3.4	0.0	0.0000	0	61.58	1014.82	0.00	0.00
TARPON_BAY_WEIR	BASE	025YR-3DAY	61.58	3.7	0.0	-0.1000	490	64.65	759.56	61.58	786.31
1	BASE	100YR-3DAY	65.63	4.3	0.0	0.0000	4977811	60.58	349.52	73.37	50.84
2	BASE	100YR-3DAY	65.58	4.2	0.0	0.0000	755762	60.17	99.23	70.83	59.27
3	BASE	100YR-3DAY	64.84	4.0	0.0	0.0000	27713570	60.75	1716.39	62.75	611.00
4	BASE	100YR-3DAY	64.84	4.0	0.0	0.0000	25839772	60.33	2118.04	64.28	694.47
4a	BASE	100YR-3DAY	65.37	4.3	0.0	0.0000	11079087	60.25	896.90	60.09	141.94
5	BASE	100YR-3DAY	65.37	4.3	0.0	0.0000	23432595	60.33	1658.68	77.09	95.63
5a	BASE	100YR-3DAY	68.57	4.3	0.0	0.0001	3784418	60.08	436.27	86.60	25.21
6	BASE	100YR-3DAY	63.15	4.3	0.0	0.0001	10003691	60.33	1116.04	67.16	192.46
7a	BASE	100YR-3DAY	62.85	4.2	0.0	0.0001	1913304	60.33	315.11	64.07	217.50
7A_ELIN_US	BASE	100YR-3DAY	62.74	4.1	0.0	0.0001	54692	64.07	217.50	64.07	217.96
7b	BASE	100YR-3DAY	62.35	3.9	0.0	0.0000	1688017	60.33	336.45	62.33	267.03
BCH_RD_WEIR	BASE	100YR-3DAY	62.36	3.8	0.0	0.0000	49294	62.33	267.03	62.36	267.03
TAILWATER_(BAY)	BASE	100YR-3DAY	0.00	3.4	0.0	0.0000	0	63.92	1128.31	0.00	0.00
TARPON_BAY_WEIR	BASE	100YR-3DAY	64.84	3.7	0.0	-0.1000	490	64.85	877.17	64.84	877.05



NOTES

1.Ground elevation values (LiDAR) shown were provided by a SFWMD elevation raster. Elevation values are based on the 2019 FDEM LiDAR effort.
2. Elevations reference NAVD 1988.
3. Elevations values below 0' exist but are displayed as <0'.
4. The aerial photographs shown were provided by Lee County government and were taken in 2024.

\\ftms01\Drawings\2023\20236161-000\topo map 11x17 LiDAR 2019 BKM Island.mxd

City of Sanibel
Lee County, Florida

JOHNSON ENGINEERING
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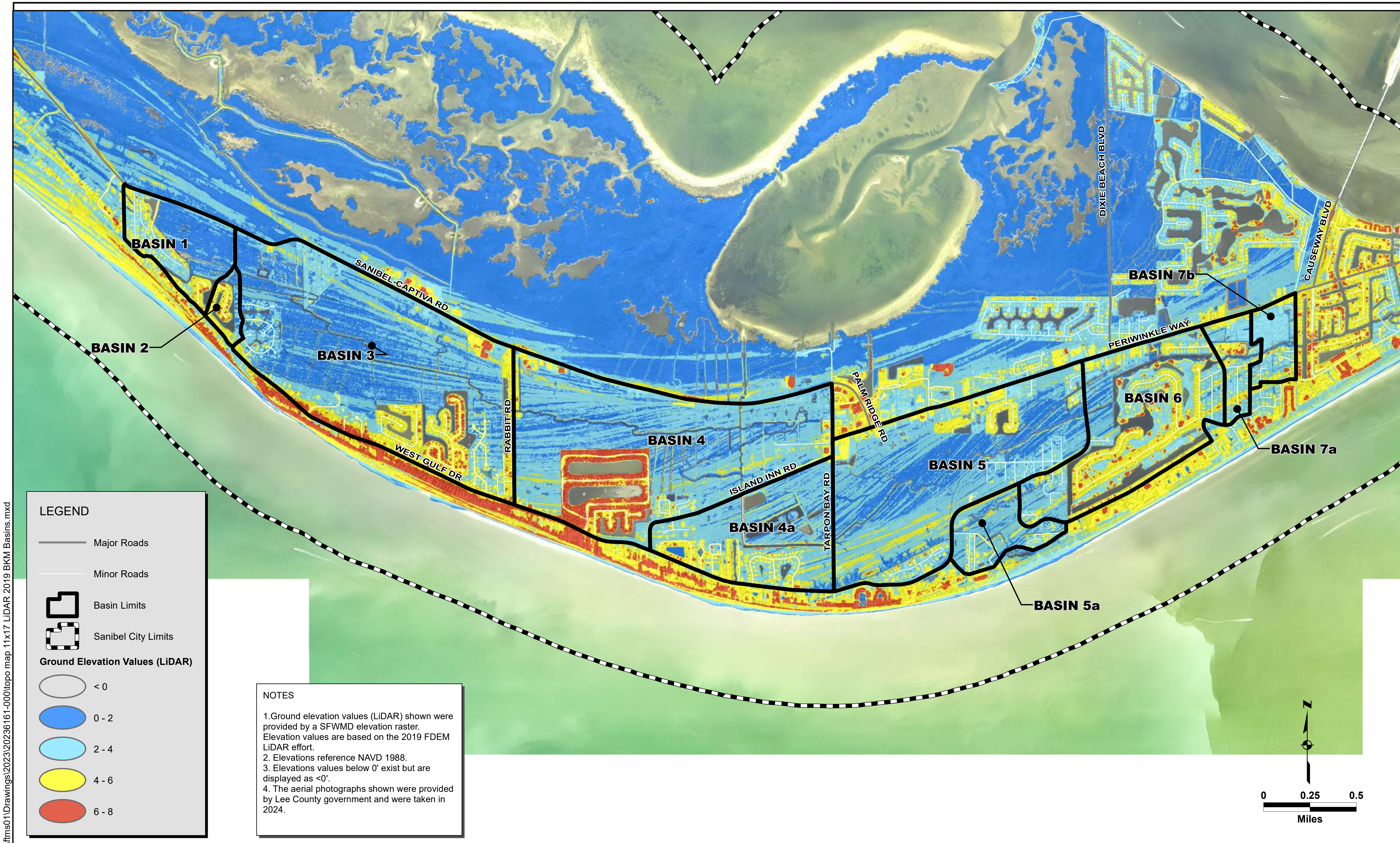
PHONE (239) 334-0046
E.B. #642 & L.B. #642

Topographic Map of Sanibel

DATE	PROJECT NO.	FILE NO.	SCALE	SHEET
Jan 2025	20236161-001	--	As Shown	1



NOTES

1. Ground elevation values (LiDAR) shown were provided by a SFWMD elevation raster. Elevation values are based on the 2019 FDEM LiDAR effort.
2. Elevations reference NAVD 1988.
3. Elevations values below 0' exist but are displayed as <0'.
4. The aerial photographs shown were provided by Lee County government and were taken in 2024.

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Topographic Map of Sanibel Interior

DATE	PROJECT NO.	FILE NO.	SCALE	SHEET
Jan 2025	20236161-001	--	As Shown	2

\\ftms01\Drawings\2023\20236161-000\topo map 11x17 LiDAR 2019 BKM Basins.mxd

NOTES

1. Basin limits were provided by the 2018 Stormwater Master Plan.
2. The aerial photographs shown were provided by Lee County government and were taken in 2024.

\\ftms01\Drawings\2023\20236161-000\Sanibel 11x17 Bottom BKM.mxd

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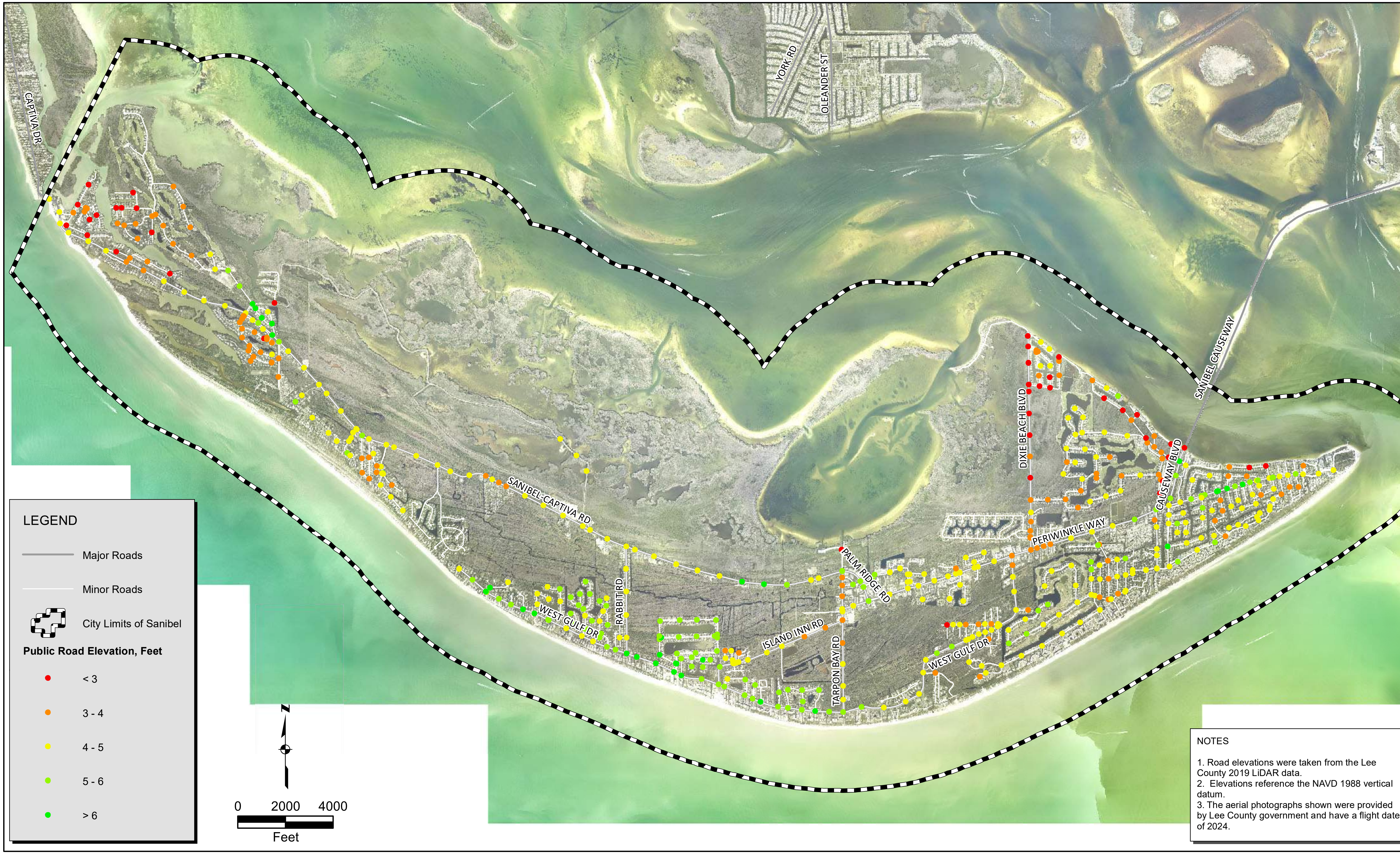
Surface Water and Surficial Aquifer Monitoring Well Locations

DATE	PROJECT NO.	FILE NO.	SCALE	SHEET
Jan 2025	20236161-001	--	As Shown	3



NOTES

1. Road elevations were taken from the Lee County 2019 LiDAR data.
2. Elevations reference the NAVD 1988 vertical datum.
3. The aerial photographs shown were provided by Lee County government and have a flight date of 2024.

Stormwater Master Plan
City of Sanibel, Florida

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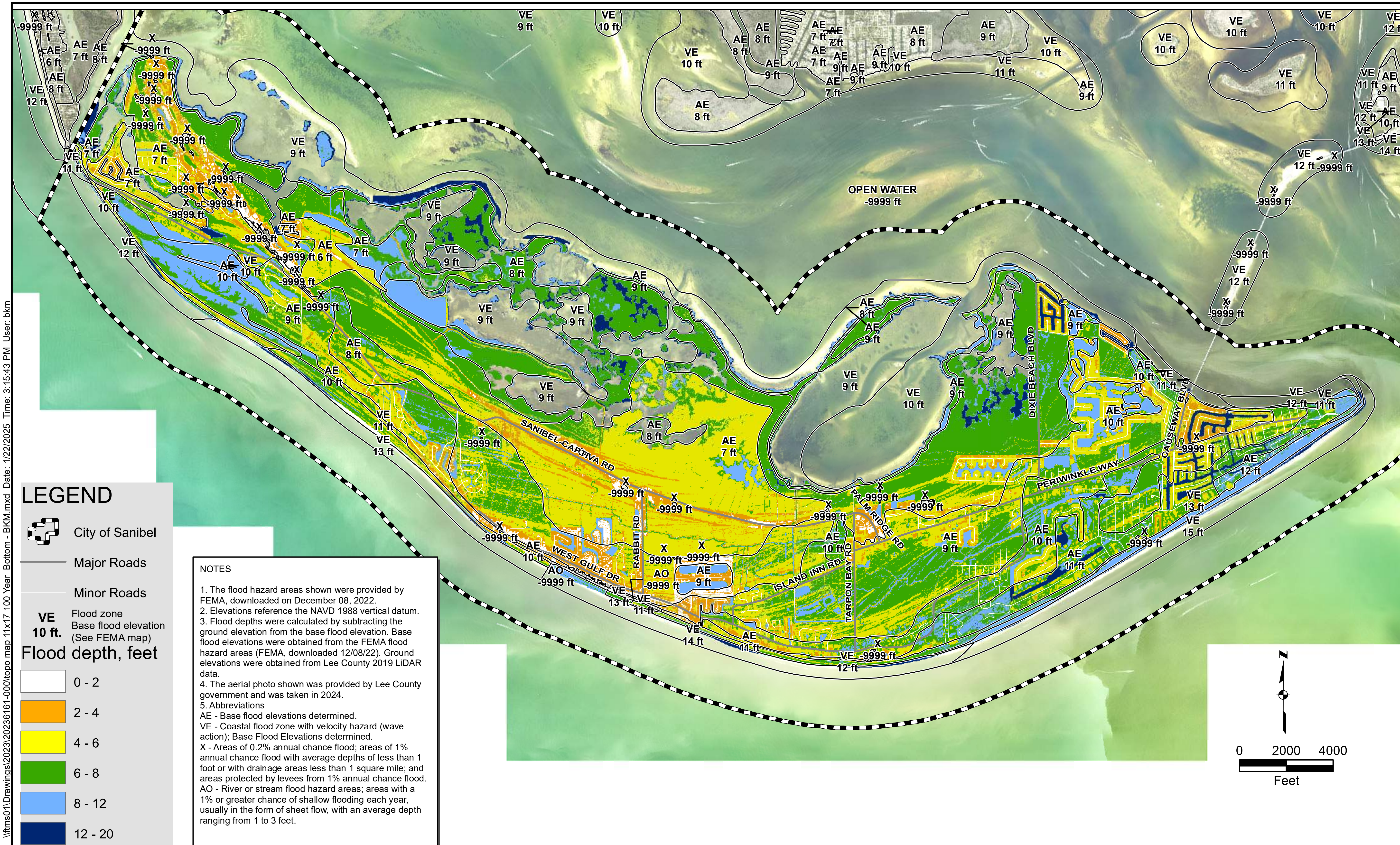
Road Elevation Map
(Existing Public Roads)

DATE	PROJECT NO.	FILE NO.	SCALE	SHEET
Jan 2025	20236161-001	-	As Shown	4



LEGEND

- City of Sanibel
- Major Roads
- Minor Roads
- **VE 10 ft.** Flood zone, Base flood elevation (See FEMA map)

Flood depth, feet

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 12
- 12 - 20

NOTES

1. The flood hazard areas shown were provided by FEMA, downloaded on December 08, 2022.
2. Elevations reference the NAVD 1988 vertical datum.
3. Flood depths were calculated by subtracting the ground elevation from the base flood elevation. Base flood elevations were obtained from the FEMA flood hazard areas (FEMA, downloaded 12/08/22). Ground elevations were obtained from Lee County 2019 LiDAR data.
4. The aerial photo shown was provided by Lee County government and was taken in 2024.
5. Abbreviations
AE - Base flood elevations determined.
VE - Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.
X - Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
AO - River or stream flood hazard areas; areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet.

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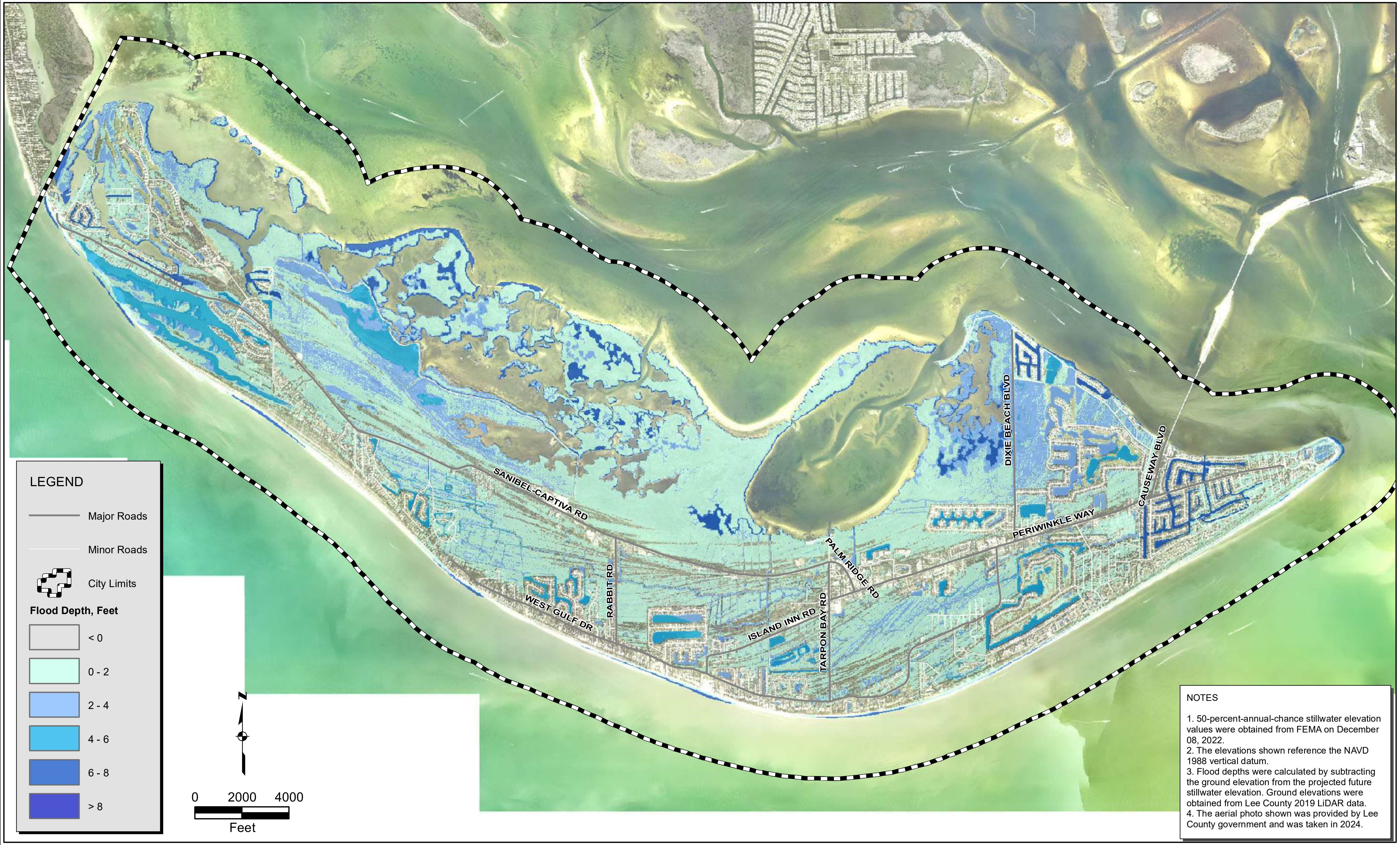
FEMA Flood Depth Map at 100-year Event (2022 Publication Date)

DATE	PROJECT NO.	FILE NO.	SCALE	SHEET
Dec. 2024	20236161-001	–	As Shown	5



NOTES

1. 50-percent-annual-chance stillwater elevation values were obtained from FEMA on December 08, 2022.
2. The elevations shown reference the NAVD 1988 vertical datum.
3. Flood depths were calculated by subtracting the ground elevation from the projected future stillwater elevation. Ground elevations were obtained from Lee County 2019 LiDAR data.
4. The aerial photo shown was provided by Lee County government and was taken in 2024.

\\ftms01\Drawings\2023\20236161-000\50-pct Inundation Bottom BKM_10.0.mxd Date: 1/22/2025 Time: 3:17:56 PM User: bkm

Stormwater Master Plan
City of Sanibel, Florida

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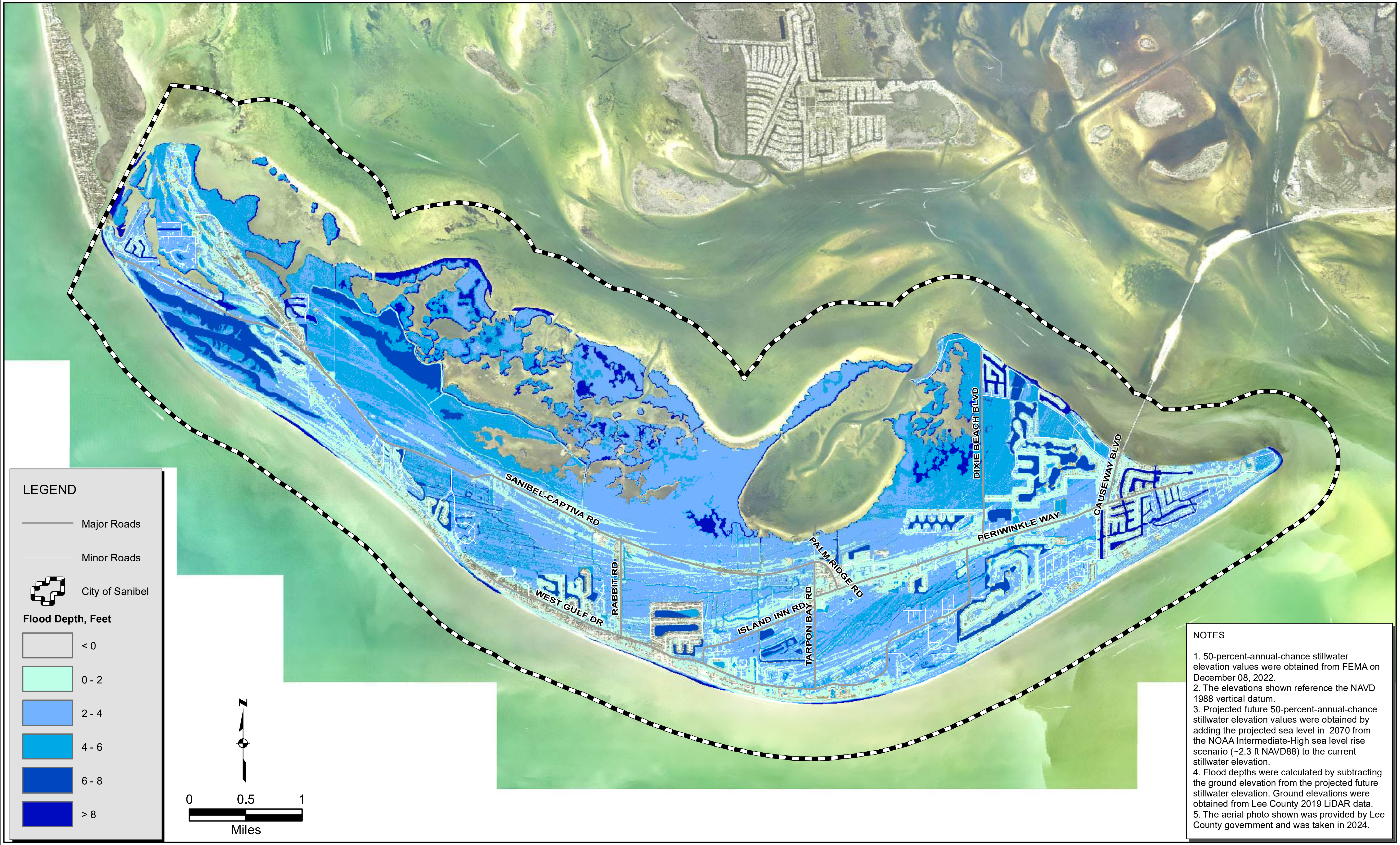
FEMA Coastal Flood Hazard Analysis
2022 Stillwater Flood Depth Map
50-Percent-Annual-Chance Storm Surge

DATE	PROJECT NO.	FILE NO.	SCALE	SHEET
Dec 2024	20236161-001	-	As Shown	6



NOTES

1. 50-percent-annual-chance stillwater elevation values were obtained from FEMA on December 08, 2022.
2. The elevations shown reference the NAVD 1988 vertical datum.
3. Projected future 50-percent-annual-chance stillwater elevation values were obtained by adding the projected sea level in 2070 from the NOAA Intermediate-High sea level rise scenario (~2.3 ft NAVD88) to the current stillwater elevation.
4. Flood depths were calculated by subtracting the ground elevation from the projected future stillwater elevation. Ground elevations were obtained from Lee County 2019 LiDAR data.
5. The aerial photo shown was provided by Lee County government and was taken in 2024.

Stormwater Master Plan
City of Sanibel, Florida

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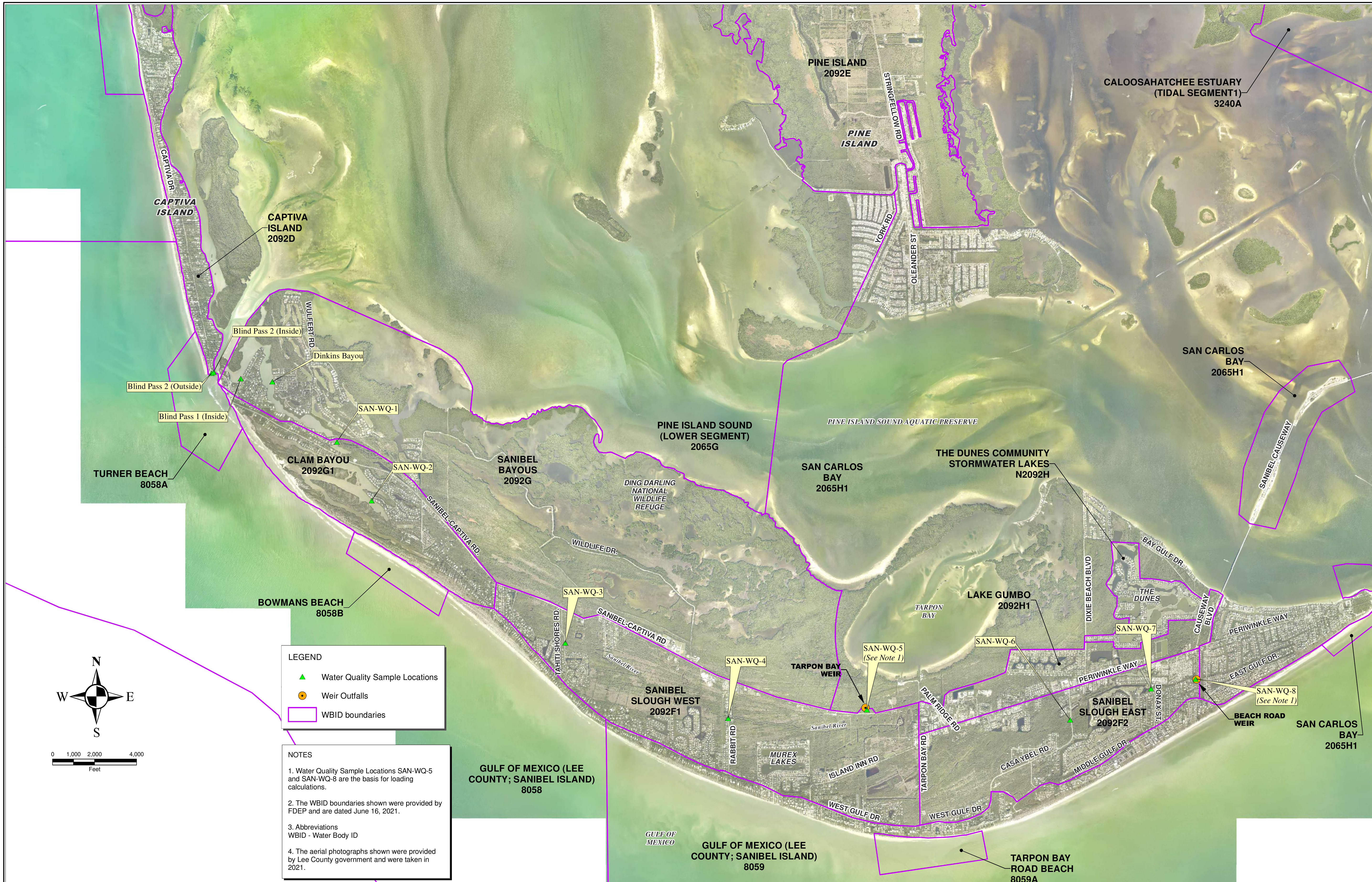
FEMA Coastal Flood Hazard Analysis
2070 Projected Stillwater Flood Depth Map
50-Percent-Annual-Chance Storm Surge

DATE	PROJECT NO.	FILE NO.	SCALE	SHEET
Jan 2025	20236161-001	-	As Shown	7



REVISIONS		

City of Sanibel
Lee County, Florida

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Sample Location Map

DATE	PROJECT NO.	FILE NO.	SCALE	SHEET
JULY 2025	20236161-001	-	As Shown	8