GORDON RIVER IMPROVEMENTS MASTER PLAN & GOODLETTE-FRANK ROAD STORMWATER OUTFALL IMPROVEMENTS MODELING UPDATE & FEASIBILITY ENGINEERING STUDY

FINAL
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Prepared for: Collier County Stormwater Management

Executive Summary

The Gordon River watershed consists of approximately 4,432 acres and is bounded by the Crossings to the north, the Conservancy of Southwest Florida to the south, Airport Pulling Rd to the east, and US 41 to the west. Various areas throughout the Gordon River Extension (GRE) basin experience high water inundation conditions during heavy rainfall events. These areas include the Country Club of Naples, Forest Lakes, Pine Ridge Industrial Park, Poinciana Village, Golden Gate Parkway, and the properties west of GF Rd, north of Golden Gate Parkway, and south of Pine Ridge Rd. A hydrologic/hydraulic modeling analysis was performed on the basin to determine various solutions to eliminate or effectively reduce the inundation conditions. The existing conditions model indicated a poorly maintained stormwater infrastructure serving the GRE basin. After the modeling and analysis of various proposed scenarios, it is ABB's recommendation to implement the following eight improvements to relieve flooding scenarios throughout the basin; the Golden Gate Parkway AMIL Gate Weir Replacement, Goodlette-Frank Supplemental Outfall, Freedom Park Stormwater Pump Station, Freedom Park Bypass Ditch & Spreader Swale, Goodlette-Frank Ditch Improvements, Solana/Burning Tree Box Culvert Extension, Maintenance Access Road/ Seawall, and the Forest Lakes Rock Weir Replacement. The implementation of the proposed improvements provided a flood area reduction of approximately 400 acres within the basin. A cost benefit analysis for the proposed improvements is included within this document.

Appendix A. - Exhibits

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Appendix B. - Model Results

Appendix C. - Stage Reduction Tables

Appendix D. - Stage Reduction Charts

Appendix E. - Conceptual Engineer's Opinion of Probable Costs & Cost Benefit Analysis

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Introduction

Collier County entered into contract with Agnoli, Barber, & Brundage (ABB) for the development of a stormwater improvements master plan for the Gordon River Extension (GRE) basin. The Gordon River originates north of Pine Ridge Industrial complex and ultimately outfalls into the Naples Bay. The goal of this master plan was to develop a conceptual design for necessary improvements along the Gordon River that would help remedy flood prone areas within the basin. During the process of developing the hydrologic-hydraulic model, Hurricane Irma hit Southwest Florida and caused significant flooding throughout the basin. Some homes flooded and many streets were submerged for days after the storm event. Historic flooding within the basin in conjunction with the impact of Hurricane Irma resulted in a slight change in direction for scope items in this master plan. Additional focus was given to expand the existing model for the Goodlette-Frank Rd (GF Rd) ditch and its neighboring communities. The outfall location of the Gordon River was extended further south between the Naples Zoo and the Conservancy of Southwest Florida. An additional outfall from GF Rd was also included to connect to the Gordon River between the Naples Zoo and the Conservancy to increase the accuracy of the basin modeling. A separate work order arose for the update of the GF Rd ditch portion of the existing model and improvements conceptual design. However, both the Goodlette-Frank Road Stormwater Outfall Improvements and Gordon River Improvements Master Plan projects were modeled simultaneously to create the most accurate analysis of the Gordon River Basin, both projects are addressed in this report.

For ease of reference, both the Goodlette-Frank Road Stormwater Outfall Improvements and Gordon River Improvements Master Plan projects have been broken down into sections in the *Gordon River Extension Project Sections & Construction Phasing Sequence* (**Exhibit 1.**) in **Appendix A.** The *Gordon River Extension Drainage Basin Map* (**Exhibit 2.**) illustrates the Gordon River Extension Basin, all of its sub-basins, each sub-basin's runoff area, and the approximate locations of each sub-basins outfall.

Model Information

The existing conditions model was updated from the August 2015 model developed for the *Hydrologic Modeling Summary – Gordon River Extension* by ABB. XP Stormwater & Wastewater Management Model (XPSWMM) is the hydrologic and hydraulic modeling software used to model the GRE basin. All elevation information was input into the model in the National Geodetic Vertical Datum of 1929 (NGVD 29). Furthermore, the *LIDAR Map* (**Exhibit 4.**) data was converted from the North American Vertical

Datum of 1988 (NAVD 88) to NGVD 29 prior to input into the model. The various rainfall events simulated within each model are provided in the table below:

Storm Event	Total Rainfall (in)
10 Year - 3 Day	9.51
25 Year - 3 Day	11.55

The August 2017 rainfall event prior to Hurricane Irma and the associated stage data was used for the model calibration. Furthermore, the existing conditions model was calibrated according to the road crown elevations, edge of pavement, and highwater marks presented in the *Gordon River Extension Road Crown Elevation Map* (**Exhibit 3.**) in **Appendix A.** All stormwater structures in the existing conditions model were updated either from Collier County's Stormwater GIS or survey data. Survey data was collected along the Gordon River from north of Pine Ridge Rd, approximately 360ft south of J&C Blvd, down to Golden Gate Pkwy, along the GF Rd ditch from Pine Ridge Rd down to Fleischman Park, through the Conservancy of Southwest Florida outfall into the Gordon River, and through the Freedom Park ditch outfall into the Gordon River. The existing condition model's natural cross-sections were updated with the recent survey data.

A canal is located on the west side of GF Rd to the east of Fleischmann Park. Flow from this canal can either continue further south along GF Rd or under GF Rd to the outfall at the Conservancy through triple ellipse pipes. It should be noted that modeling south of this canal is not part of this project's boundary and was not included in the modeling effort. The Gordon River continues further south than what is depicted in the *Gordon River Extension* Drainage Basin Map. Furthermore, additional outfalls into the Gordon River exist from GF Rd. For modeling purposes *all* runoff leaving the canal at Fleischmann Park is directed through the triple ellipse pipes that convey stormwater east to the Gordon River.

The *Link & Node Map* (**Exhibit 5.**) provides a location of each link and node in the existing conditions model for ease of reference. Nodes may physically represent manholes, inlets for a catchment, a junction of links, a pond, an outfall, or provide storage. Links represent open channels, closed conduits, pumps, weirs, orifices, or other special structures between two nodes.

Existing Conditions

Refer to **Exhibit 1.** for the discussion of the following existing conditions. **Exhibit 6.** depicts the existing conditions node maximum stages for the 25 Year – 3 Day storm events. In addition, the node and link results are provided in table format in **Appendix B.** for the 25 Year - 3 Day storm event.

Section A

Section A is defined as the area in the upper Gordon River North of Pine Ridge Rd from approximately 360 ft south of J&C Blvd to Pine Ridge Rd. This section is bordered by the Pine Ridge Industrial Park to the east, the Crossings, and Autumn Woods communities to the west. This area has the potential for a large conveyance, but also serves sub-basins with a large percentage of impervious area. Maintenance is challenging within this section since access easements only exist to the rivers top of bank, therefore, maintenance must be performed by boat. The channel bottom is shallow and the storage volume has been compromised by silt and vegetation growth. There may be potential to widen the easement in this area and create a maintenance access road. The main concern for this basin is maintenance and dredging, downstream improvements will lower its stages and lessen flooding potential.

Section B

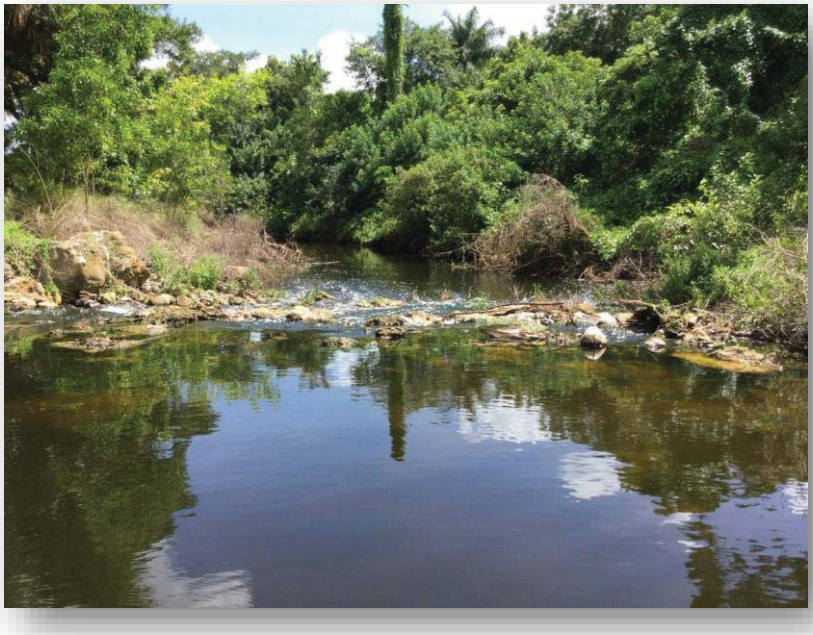
Section B spans the Gordon River from Pine Ridge Rd to the southern property line of the Forest Lakes community, just upstream of the Forest Lakes rock weir. This section passes all flows from Section A, in addition to the runoff from approximately half of the Country Club of Naples and all of the Forest Lakes communities. The Forest Lakes community stormwater management system was implemented prior to the water management regulations set forth by the South Florida Water Management District. The community was built at a lower elevation than that of the newly developed surrounding areas and has experienced street flooding issues for the past 40 years. The original design of the Forest Lakes community through this portion of the Gordon River are shown in plans by Black, Crow, & Eidsness, Inc. (1976) and indicate that three earthen dams exist, decreasing in elevation from north to south. Furthermore, a lake exists upstream of each earthen berm where water pools prior to flowing downstream. This water must stage up above each earthen berm and flow through a drastically constricted channel (downstream of the berm) to flow south. These three

berms create a cascading system in series that reduces the amount of conveyance possible through the river.

The Gordon River is covered by a drainage easement through this section which can be seen on the *Gordon River Extension Vegetation Map* (**Exhibit 7.**), the western bank of the river provides roughly ten feet between the easement and the top of bank. The eastern bank of the Gordon River borders residential properties and contains many boat docks and river access points. **Exhibit 7.** also indicates the extent of exotic vegetation overgrowth on the western bank of the river. This overgrowth consists primarily of Brazilian pepper that further constricts the channel and increases the difficulty of maintaining this section of the river.

Section C

Section C of the Gordon River runs from the southern property line of Forest Lakes community to the southern property line of the Royal Poinciana Golf Course. This reach is bordered by the Country Club of Naples, Royal Poinciana Golf Course, Hole-in-the-wall, and Wilderness. The Forest Lake rock weir is located at the north end of this section (pictured below).



The current rock weir spans the channel at approximately 40 feet long with a weir crest elevation of 6.0 ft NGVD. Since the rock weir is essentially an earthen berm and not an operable water control

structure, all upstream flow must stage up to 6.0 ft NGVD and constrict to a 40-foot-wide channel to continue downstream. The Forest Lakes community is considered to be low-lying and has had historical flooding issues with this weir in place, it is suspected that the weir elevation does not provide enough freeboard in comparison with the community's average grade.

The channel section downstream of the rock weir was recently improved with rip-rap protection and this increased conveyance downstream. However, by comparison with the rest of the Gordon River, it is not only too narrow but also too high in elevation. Current flow conditions or any proposed improvements upstream that increase the flow will be throttled through this portion of the river. South of the Royal Poinciana bridge, the river widens and runs along the Royal Poinciana golf course where it serves as a water quality treatment area with undulating natural banks, littoral plantings, and native vegetation. Silt build up is evident through this water quality area thereby limiting the channel capacity.

Section D

Section D incorporates the southern property line of Royal Poinciana Golf Course to the north side of Golden Gate Parkway. It is bordered by the Wilderness community to the west, a large natural area to the east in the Estuary at Gray Oaks, and Freedom Park to the southwest. Although the channel banks are shallow through this section of the river, this preserve area accommodates a greater flow capacity. **Exhibit 8.** illustrates the capacity of the Gordon River through section D. The black hatched area in the enlarged section view represents the 25 Year – 3 Day modeled maximum stage through this cross-section. The green hatch represents the equivalent modeled cross-sectional area that extends through the floodplain. The XPSWMM software uses vertical "glass walls" to contain flow and stack up within the cross-section rather than spilling out over the sides and becoming a source of model error. Since the stacking up of flow is not realistic, the equivalent area was used to depict a more realistic stage through this section of the river. The approximate 25 Year – 3 Day stage is 5.23 ft NGVD, based on the floodplain storage/capacity in this section, it has been determined that no additional capacity is needed.

Section E

Section E is tidally influenced, and spans from Golden Gate Parkway to the outfall at the Conservancy. This section of the Gordon River is bordered by the Naples Zoo and the Conservancy to

the west, and the Bears Paw community to the east. Four, 10 ft x 10 ft box culverts exist under Golden Gate Parkway just upstream of the existing AMIL gate. The box culverts are sufficiently sized to accommodate the flow in the river, however, they are susceptible to clogging during heavy wind and rain events by downed trees and debris. The existing AMIL Gate weir is outdated and in disrepair. The conveyance of the weir is not sufficient during heavy rain events and is a source of flooding in upstream communities. The design was originally meant to adjust automatically, allowing water out when needed and restricting backflow. However, County staff chains the gate open and manually lifts it out of the water to allow more conveyance in emergency situations. The AMIL Gate is the primary outfall structure for the entire GRE basin, if this structure can't pass the necessary peak flow, all upstream basins will continue to experience flooding issues.

Section F

The Royal Poinciana Swale runs from Coach House Lane and Poinciana Drive/Bolero Way, and outfalls into the main river on the east side at the southern Royal poinciana property line. It is bordered by Coco Lakes and Royal Poinciana Golf Course. The swale runs through the Coach House Lane community and is undersized. It frequently causes local street flooding in the Poinciana Village community. There is no additional area for swale excavation or expansion behind some of the homes in the area. Detailed survey information is needed within this area to determine precise channel limitations. The *Poinciana Village Outfall Branch Section Locations* (**Exhibit 9.**) highlights the existing cross sections in this area. These cross sections were modeled to assess the existing 5 Year and 10 Year storm capacity. The existing volume within the section is approximately 290,000 cf and has an average cross-sectional area of 47 sf. The existing channel can accommodate approximately 81% of a 10 Year – 3 Day storm event. To provide a 10 Year – 3 Day storm event level of service within the channel, an additional 11 sf of cross-sectional area, or 70,000 cf of storage is needed along the 6,070 ft long channel. A 10 Year – 3 Day storm event level of service would require a total cross-sectional area of 58 sf with a peak flow of 18 cfs.

Section G

Section G runs along the north side of Solana Road and Burning Tree Drive and includes the area from the west side of GF Rd to the outfall into the Gordon River. It is bordered by the Country Club of Naples community and the Royal Poinciana Golf Course entrance. Currently, this section acts as an outfall intercept, funneling water from the northwest side of the basin into the Gordon River. At

the northwest corner of GF Rd and Solana Dr, flow from the GF Rd ditch is split, either continuing south through a 24in RCP, or continuing east through a 76in x 48in ERCP. This drastic difference in pipe size indicates that flow from the northwest portion of the GRE basin is intended to be accommodated predominantly by section G. Flow continues east through a 4 ft x 8 ft box culvert, triple 36 in RCP at Burning Tree Drive, through a double 48in RCP, and finally outfalls into a natural channel that flows into the Gordon River. Flow conveyance through section G is constricted at Burning Tree Dr due to the transition from the box culvert to the triple 36in RCP and double 48in RCP further downstream. This section is causing unnecessary staging and flooding upstream along the west side of GF ditch. Furthermore, the Country Club of Naples community experiences significant flooding due to this constriction.

Section H

Section H initiates at the box culvert under GF Rd, extends through the Freedom Park ditch, and ultimately outfalls into the Gordon River. Flow is introduced to Freedom Park via the GF Rd ditch that accommodates runoff from the western sub-basins in the GRE. Once the stormwater flows through the 6 ft x 12 ft box culvert, it can enter Freedom Park by two routes. The stormwater can either be pumped into Pond A, by the park's stormwater pump station, or it can flow over the fabriform weir (weir crest elevation 6.0 ft NGVD), through the ditch, and ultimately outfall into the Gordon River. Water that is introduced into the park by the pump station will continue through a treatment train prior to its ultimate outfall into the Gordon River. Currently, the Freedom Park ditch is undersized and extremely overgrown. Approximately 2,000 ft downstream of the weir, the ditch is no longer defined. From here, all flow from the ditch continues to the Gordon River by overland flow. Historically, flows could freely pass through the Freedom Park ditch. In recent years, the Freedom Park Water Quality Treatment Improvements included the addition of the stormwater pump station and the fabriform weir. Since the implementation of these improvements, flow has since been restricted and reduced the ability to accommodate the runoff from the western sub-basins along the GF ditch. Freedom Park is a valuable resource to provide water quality treatment, stormwater storage, and conveyance for the northwest section of the GRE basin; unfortunately, it is being under-utilized.

Section I

Section I is comprised of the stormwater conveyance on the west side of GF Rd, starting north of Pine Ridge Rd and ending at Solana Rd. This portion of the GF ditch drains various communities to the north of Pine Ridge Rd and to the west of the ditch. Four road crossings are included within this section of the GF ditch; Pine Ridge Rd, Pompei Ln, Granada Blvd, and Solana Rd. Flow from the GF Rd ditch is split at the northwest corner of GF Rd and Solana Dr, just after the 66in RCP. This flow can continue further south through a 24in RCP, or continuing east, along Solana Rd through a 76in x 48in ERCP. The majority of the flow will continue east along Solana Rd, and is described further in section G above.

Section J

Section J includes the stormwater conveyance on the west side of GF Rd, starting at Solana Rd and ending at the box culvert that enters into Freedom Park. This portion of the GF ditch drains various communities to the west of the ditch, in addition to, the portion of flow that continues south from section I. These communities are prone to flooding as depicted by the high water marks shown in **Exhibit 3.** Four road crossings are included within this section of the GF ditch; Ohio Dr, Ridge St, Creech Rd, and 26th Ave N. Currently, 48in RCPs run under both Ohio Dr and Ridge St. These 48in RCPs constrict the flow downstream, thereby, preventing water to exit the western sub-basins. As part of the *West G-F Road Area Joint Stormwater-Sewer Project*, 4ft x 11 ft box culverts are to replace both 48in culverts. Further downstream, flow is constricted by a 54in RCP at Creech Rd and triple 36in RCPs at 26th Ave N. In addition, the existing GF ditch bottom is not uniform, does not provide enough capacity, and the inverts along this section are not configured to provide positive drainage downstream. To remedy flooding problems within the western sub-basins, these aforementioned issues need to be addressed.

Section K

Section K includes the stormwater conveyance on the west side of GF Rd, starting at the box culvert that enters into Freedom Park and ending at the outfall into the Gordon River through the Conservancy of Southwest Florida. This portion of the GF ditch drains a community to the west of the ditch, Naples High School, a portion of Golden Gate Parkway, a portion of GF Rd, the Coastland Center mall, Fleischmann Park, and the portion of flow that continues south from section J that is not accommodated by Freedom Park. This section of the GF ditch plays a major role in the flooding

events of the upstream sub-basins that rely upon outfalling into the ditch. Through section K, Golden Gate Parkway typically experiences ponding during heavy rainfall events. Flow is constricted through this section by the double 36in pipes that exist under both 22nd Ave N and an unmarked-grassed crossing to the east of Naples High School. Similar to section J, the existing GF ditch bottom is not uniform, does not provide enough capacity, and the inverts along this section are not arranged to provide positive drainage downstream.

Proposed Conditions

To analyze the proposed impact on the GRE basin, each proposed model scenario was compared to the existing conditions model (refer to **Appendix C.**). The tables provided in **Appendix C.** compare the average stage reduction within each project section. The average stage reduction is a comparison of the difference in average stage between the existing conditions and the proposed scenarios for each modeled storm event. A positive value indicates a stage reduction whereas a negative value indicates an increase in stage. In addition, this information was incorporated into chart format in **Appendix D.** that shows the impact of all modeled scenarios per each project section. These charts further illustrate the benefit of each scenario on a specific area within the basin. The proposed scenarios considered are provided below:

1. AMIL Gate Weir Replacement
2. Goodlette-Frank Supplemental Outfall & AMIL Gate Weir Replacement
3. Freedom Park Stormwater Pump Station & AMIL Gate Weir Replacement
4. Freedom Park Bypass Ditch & Spreader Swale & AMIL Gate Weir Replacement
5. Goodlette-Frank Ditch Improvements & AMIL Gate Weir Replacement
6. Solana/Burning Tree Box Culvert Extension & AMIL Gate Weir Replacement
7. Maintenance Access Road/ Seawall & AMIL Gate Weir Replacement
8. Forest Lakes Rock Weir Replacement & AMIL Gate Weir Replacement
9. All Proposed Improvements & Goodlette-Frank Ditch Improvements (NO Pump Station)

Priority Phase I - Section E

To remedy the issues experienced with the existing AMIL Gate located south of Golden Gate Pkwy, a new, fully automated, bottom-hinged crest gate is proposed in its place. Please refer to **Exhibit 10.** *AMIL Gate Weir Replacement (E.*1) for structure detail and section views in addition to the structure specifications table provided below.

AMIL Gate Weir Replacement Structure Specifications

Description	Value	Units
Total Weir Length	80	ft
Weir Structure Crest Elevation	3.5	ft (NGVD)
Structure/Channel Bottom Elevation	-6	ft (NGVD)
Type of Gate	Bottom Hinged Crest Gate	--
Number of Gates	2	ea
Operation	Fully Automated	
Crest Gate Length (ea)	25	ft
Crest Gate Height (ea)	7	ft
Crest Gate Invert Elevation	-3.5	ft (NGVD)

Refer to the AMIL Gate Weir Replacement Exhibit for additional information & structure locations.

The existing AMIL Gate controls the tailwater for the entire GRE basin. Therefore, if more flow was able to be successfully passed through the proposed weir, it would drastically improve flooding issues of upstream sub-basins. Referring to the 25YR – 3DAY stage reduction table, max water stages were reduced in project sections C-H due to the implementation of the proposed weir replacement. Since the proposed crest gates are hinged at the bottom, the weir crest elevation can vary from -3.5 ft NGVD (fully open) to 3.5 ft NGVD (fully closed). Therefore, the crest gates can easily maintain or relieve the varying upstream stages that fluctuate throughout the year or be set to an elevation to prevent backflow/saltwater intrusion. The full automation provides faster and easy manipulation of the weir elevations remotely, thereby saving time during urgent flooding scenarios. A floating debris boom is recommended upstream of Golden Gate Parkway to prevent clogging and debris build up in the box culverts during heavy wind and rain events. Maintenance related activities will use the existing access area.

Priority Phase II - Supplemental Outfall

The *Goodlette Frank Supplemental Outfall* is a new outfall proposed to connect the GF ditch to the Gordon River. This outfall is proposed to be located south of Golden Gate Parkway in a 60 ft wide, County owned, parcel along the northern boundary of the Naples Zoo. This new connection would consist of box culvert improvements under Golden Gate Parkway and GF Rd, a linear pond improvement, and a fixed crest weir that would outfall into the Gordon River. Refer to **Exhibit 11.** for structure detail and section views, in addition to the structure specifications table provided below.

Goodlette Frank Supplemental Outfall Structure Specifications

Description	Value	Units
Box Culvert Improvements (1)		
Number of Box Culverts	2	ea
Box Culvert Height	5	ft
Box Culvert Width	12	ft
Goodlette Section		
Box Culvert Length	370	ft
Upstream Invert Elevation	2.5	ft (NGVD)
Downstream Invert Elevation	2.25	ft (NGVD)
Box Culvert Weir Length	10	ft
Box Culvert Weir Elevation	4	ft (NGVD)
Zoo Section		
Box Culvert Length	1,060	ft
Upstream Invert Elevation	2.25	ft (NGVD)
Downstream Invert Elevation	1.5	ft (NGVD)
Linear Pond Improvements (1)		
Total Length of Linear Pond	890	ft
Linear Pond Cross-Section Shape	Trapezoidal	--
Bottom Width	20	ft
Depth	5	ft
Left Bank Side Slope	1:1	--
Right Bank Side Slope	2:1	--
Control Structure Improvements (1)		
Type of Weir	Fixed Crest	--
Total Weir Length	33	ft
Weir Crest Elevation	2.7	ft (NGVD)
Structure/Channel Bottom Elevation	-2	ft (NGVD)
Maintenance Access Path (1)		
Maintenance Access Path Width	10	ft
Maintenance Access Path Length	1,803	ft

(1) Refer to the Goodlette Frank Supplemental Outfall Exhibits for additional information & structure locations.

This supplemental outfall is proposed to pass the additional flows that are not accommodated by Freedom Park. The next downstream connection between the GF ditch and the Gordon River is through the Conservancy of Southwest Florida. However, the Conservancy outfall is densely vegetated through its open channel, has a protected gopher tortoise preserve, and is not designed to be a major outfall for the GRE basin. The proposed supplemental outfall will accommodate the additional flows from GF Rd, the GF ditch, Naples High School, Golden Gate Parkway, the Coastland Center mall, and flow from upstream sections. An access road is proposed to connect from GF Rd to the control structure for maintenance of the supplemental outfall. Referring to the 25YR – 3DAY stage reduction table, max water stages were reduced in project sections C-F, H, J, and K due to the implementation of the proposed supplemental outfall and AMIL gate weir replacement. The stage reduction seen in sections H, J, and K illustrate how critical the supplemental outfall is to alleviating upstream flood stages. The success of other proposed projects within the GRE basin are contingent upon its implementation.

Priority Phase III - Section H

The implementation of two improvements are proposed to achieve the full potential of Freedom Park; the *Freedom Park Stormwater Pump Station* (H.1)(**Exhibit 12.**) and the *Freedom Park Bypass Ditch & Spreader* Swale (H.2) (**Exhibit 13.**). Both improvements are necessary to satisfy Freedom Park's full capacity. The proposed pump station will supplement the existing pump station and increase the stormwater entering the water quality treatment wetland system. The bypass ditch concept was intended to provide capacity for all stormwater entering Freedom Park, this assumption was to account for a non-functioning pump station due to loss of power. The bypass ditch is proposed to be widened and introduce flow to the wetland through a 180ft long spreader swale. The *Freedom Park Bypass Ditch & Spreader* Swale (H.2) improvement also includes the replacement of the existing fabriform weir. Refer to **Exhibit 12.** and **Exhibit 13.** for structure detail and section views, in addition to the structure specifications tables on the next page.

Freedom Park Stormwater Pump Station Structure Specifications		
Description	**Value**	**Units**
Pump Type	Submersible	--
Number of Pumps	2	ea
Pump Capacity, each	12,000	GPM
	29	cfs
Discharge Pressure	7.52	ft (TDH)
Motor	54	HP
Pump No. 1 Start Elevation	3.3	ft
Pump No. 1 Stop Elevation	2.3	ft
Pump No. 2 Start Elevation	3.7	ft
Pump No. 2 Stop Elevation	2.3	ft

Refer to the Freedom Park Stormwater Pump Station Exhibit for additional information & structure locations.

Freedom Park Bypass Ditch & Spreader Swale Structure Specifications		
Description	**Value**	**Units**
Fabriform Weir		
Weir Length	90	ft
Weir Crest Elevation	5	ft (NGVD)
Typical Bypass Ditch Dimensions (1)		
Total Length of Bypass Ditch	2,030	ft
Bypass Ditch Cross-Section Shape	Trapezoidal	--
Bottom Width	28.5	ft
Depth	3.5	ft
Side Slopes	2:1	--
Typical Spreader Swale Dimensions (1)		
Total Length of Spreader Swale	180	ft
Bottom Width	Varies	--
Depth	1.3	ft
Side Slopes	2:1	--
Spreader Swale Berm Elevation	2.3	ft (NGVD)

(1) Refer to the Freedom Park Bypass Ditch & Spreader Swale Exhibit for additional information & structure locations.

The existing fabriform weir located at the entrance to the ditch is proposed to be removed. In addition, the bypass ditch channel invert was lowered from existing conditions to convey more water through Freedom Park.

Referring to the 25YR – 3DAY stage reduction tables, max water stages were reduced in project sections B-K for the Freedom Park Bypass Ditch and Spreader Swale/AMIL gate weir replacement

scenario. The Freedom Park Stormwater Pump Station/AMIL gate weir replacement scenario provided stage reduction for sections C-H, J, and K. The proposed pump station and AMIL gate weir replacement had a greater impact on max stages through sections C-F. This indicates that more water is being treated and retained by the interconnected wetlands, thereby relieving stages through the Gordon River. The proposed bypass ditch/spreader swale and AMIL gate weir replacement provided more benefit in stage reduction to sections H, J, and K. This result suggests that the bypass ditch conveys more stormwater from the Goodlette ditch to the Gordon River. Cumulatively, these improvements increase water quality treatment, stormwater storage, and relieve flood stages throughout the GRE basin.

Priority Phase IV - Section J/ Section K

As part of the planned *West G-F Road Area Joint Stormwater-Sewer Project*, both 48in culverts under Ohio Dr and Ridge St are to be replaced with box culverts. To prevent impacting this project negatively, the 25 Year – 3 Day peak stage at Ohio Dr must not exceed 9.0 ft NGVD (per Collier County). This stage was only achieved through *one* modeling scenario, the 25 Year – 3 Day *All Proposed Improvements & Goodlette-Frank Ditch Improvements (NO Pump Station).* This modeling scenario includes the following proposed improvements:

1. Goodlette-Frank Ditch Improvements
2. AMIL Gate Weir Replacement
3. Goodlette-Frank Supplemental Outfall
4. Freedom Park Stormwater Pump Station (turned off to simulate loss of power)
5. Freedom Park Bypass Ditch & Spreader Swale
6. Solana/Burning Tree Box Culvert Extension
7. Maintenance Access Road/ Seawall
8. Forest Lakes Rock Weir Replacement

Please refer to **Exhibit 14.** *Goodlette Frank Ditch Improvements (J/K.1)* for the proposed improvements structure details and section views along Sections J and K. Additionally, the structure specifications table is provided on the next page.

Goodlette-Frank Ditch Improvements Structure Specifications		
Description	**Value**	**Units**
Typical Ditch Improvement Dimensions [1][2]		
Number of G-F Improved Ditches	7	ea
Total Length of Ditch Improvements	5,700	ft
Ditch Cross-Section Shape	Trapezoidal	--
Bottom Width	20	ft
Depth	7	ft
Side Slopes	1:1	--
Slope Stabilization	Fabric-form Concrete Revetment	--
Box Culvert Improvements [1]		
Number of Box Culverts [3]	6	ea
Ohio Drive [4]		
4'x12' Box Culvert Length	106	ft
Upstream Invert Elevation	3.84	ft (NGVD)
Downstream Invert Elevation	3.84	ft (NGVD)
Ridge Street [4]		
5'x12' Box Culvert Length	106	ft
Upstream Invert Elevation	3.48	ft (NGVD)
Downstream Invert Elevation	3.48	ft (NGVD)
Creech Road		
5'x12' Box Culvert Length	100	ft
Upstream Invert Elevation	3.4	ft (NGVD)
Downstream Invert Elevation	3.4	ft (NGVD)
26th Ave N		
5'x12' Box Culvert Length	113	ft
Upstream Invert Elevation	2.99	ft (NGVD)
Downstream Invert Elevation	2.99	ft (NGVD)
22nd Ave N		
5'x12' Box Culvert Length	135	ft
Upstream Invert Elevation	2.63	ft (NGVD)
Downstream Invert Elevation	2.63	ft (NGVD)
Section 5-B Box Culvert		
5'x12' Box Culvert Length	30	ft
Upstream Invert Elevation	2.55	ft (NGVD)
Downstream Invert Elevation	2.55	ft (NGVD)

(1) Refer to Goodlette Frank Ditch Improvements Exhibits for additional information & box culvert locations.

(2) All ditch inverts were lowered to coincide with the invert elevations of the corresponding box culverts & will now provide positive drainage from Ohio Drive down to the Coastland Center Mall.

(3) Four box culverts are included under the Goodlette Frank Ditch Improvements. The Ohio Drive & Ridge Street box culverts are included under the West G-F Road Area Joint Stormwater-Sewer Project.

(4) Included in the West G-F Road Area Joint Stormwater-Sewer Project. NOT included under the Goodlette Frank Ditch Improvements.

Upon review of the existing conditions through Sections J and K, it was evident that the GF ditch bottom is not uniform, does not provide enough capacity, and the inverts along this section are not configured to provide positive drainage downstream. Many sections of the ditch are constricted in width and the ditch bottom/pipe inverts are too high in elevation. In addition, pipe sizes at road crossing are too small to convey upstream flow. The ditch requires regrading and pipe crossings must be replaced with box culverts to provide conveyance downstream. All proposed box culvert and regraded ditch inverts were lowered to provide positive drainage in the downstream direction. Refer to the structure specifications table above for proposed invert elevations. A model scenario was run for the *Goodlette Frank Ditch Improvements & AMIL Gate Weir Replacement only*, this scenario's result was not able to achieve the 9.0 ft NGVD criteria at Ohio Dr. The stage reduction table for this scenario further illustrates how improvement to the ditch alone will not solve all flooding issues experienced in the GRE basin. It should be noted that without the implementation of the *five proposed improvements* listed below, a peak stage at Ohio Dr less than, or equal to, 9.0 ft NGVD *is not attainable*.

1. Goodlette-Frank Ditch Improvements
2. AMIL Gate Weir Replacement
3. Goodlette-Frank Supplemental Outfall
4. Freedom Park Stormwater Pump Station (turned off to simulate loss of power)
5. Freedom Park Bypass Ditch & Spreader Swale

Priority Phase V - Section G

Section G is a major conveyance for the stormwater runoff from the northwest portion of the GRE basin and roughly half of the GF ditch. Substantial street and yard flooding within the County Club of Naples is a result of undersized infrastructure along Solana Rd, GF Rd, and internally within the Country Club of Naples Community. A 4ft x 11ft box culvert is proposed to replace the existing infrastructure along Solana Rd, in addition to the 66in RCP along the west side of GF Rd. Please refer to **Exhibit 15.** *Solana/Burning Tree Box Culvert Extension (G.1)* for structure detail and section views, in addition to the structure specifications table provided on the next page.

Solana/Burning Tree Box Culvert Extension Structure Specifications		
Description	**Value**	**Units**
Box Culvert Height	4	ft
Box Culvert Width	11	ft
Total Box Culvert Length	1961	ft

Refer to the Solana/Burning Tree Box Culvert Extension Exhibit for additional information & structure locations.

Refer to the 25YR – 3DAY stage reduction tables for the *AMIL Gate Weir Replacement* scenario and the *Box Culvert Extension/AMIL Gate Weir Replacement* scenario for the following discussion. Since the implementation of the box culvert extension is meant to convey more flow to the Gordon River, increased stages in sections A-F are expected. This is supported by the stage reduction comparison between the two model scenarios. The *Box Culvert Extension/AMIL Gate Weir Replacement* scenario provides stage increase through sections A-C and stage reduction through sections D-F. However, the *AMIL Gate Weir Replacement* scenario provides stage reduction to a greater extent through sections D-F. This demonstrates more flow being conveyed to the Gordon River (sections A-F) due to the box culvert improvement. Furthermore, the box culvert improvement provides stage reduction to the Goodlette ditch (sections G-K) where the *AMIL Gate Weir Replacement* scenario does not. This substantiates the importance of upsizing the box culvert to relieve flood stages throughout the GRE.

Priority Phase VI - Section B

Various challenges exist through section B of the Gordon River. These challenges include flooding throughout the Forest Lakes community, exotic vegetation overgrowth, maintenance access, and constriction of the river due to the earthen berms and narrowed channel, resulting in capacity reduction of the river. The proposed improvement structure details and section views can be seen in **Exhibit 16.** *Maintenance Access Road/Seawall (B.1)*. The proposed improvement includes a maintenance access road/seawall along western bank, the entire length of section B. Improvements also include removal of the earthen berms as well as the deepening and widening of the channel. Improvement structure specifications are provided on the next page.

Maintenance Access Road/ Seawall Structure Specifications		
Description	**Value**	**Units**
Typical River Section Improvements		
Total Length of River Improvements	3,655	ft
River Cross-Section Shape	Trapezoidal	--
Channel Invert Elevation	-5	ft (NGVD)
Eastern Bank Side Slopes	4:1 from TOB	--
	2:1 to Bottom	--
Western Bank Side Slopes	2:1	--
Maintenance Access Road Improvements		
Total Length of Maintenance Access Road	3,742	ft
Total Width of Maintenance Access Road	10.6	ft
Total Length of Seawall	3,655	ft

Refer to the Maintenance Access Road/Seawall Exhibit for additional information & structure locations.

Limited by the existing drainage easement, the seawall and maintenance path will allow for regular maintenance of the system while still allowing channel widening for additional flow capacity. Furthermore, the access road will provide maintenance access to a proposed improvement discussed in section C that follows. Referring to the 25YR – 3DAY stage reduction tables, max water stages were reduced predominantly in project sections B and C.

Priority Phase VII - Section C

Since the Forest Lakes rock weir is essentially an earthen berm holding back flow and not an operable water control structure, the implementation of the *Maintenance Access Road/Seawall (B.1)* (in Section B) is limited to how much it will improve flooding issues. Therefore, a new, fixed crest weir with removable sluice gates is proposed to replace the existing Forest Lakes rock weir to relieve upstream stages. Please refer to **Exhibit 17.** *Forest Lakes Rock Weir Replacement (C.1)* for structure detail and section views, in addition to the structure specifications table on the next page.

Forest Lakes Rock Weir Replacement Structure Specifications		
Description	**Value**	**Units**
Total Weir Length	150	ft
Weir Structure Crest Elevation	5.5	ft (NGVD)
Structure/Channel Bottom Elevation	-1	ft (NGVD)
Type of Gate	Sluice Gate	--
Number of Gates	4	ea
Operation	Manual	--
Crest Gate Length (ea)	25	ft
Crest Gate Height (ea)	3.5	ft
Crest Gate Invert Elevation	2	ft (NGVD)

Refer to the Forest Lakes Rock Weir Replacement Exhibit for additional information & structure locations.

The northern sub-basins of the GRE are controlled by this existing rock weir. Therefore, if more flow was able to be successfully passed through the proposed weir it would drastically improve flooding issues of upstream sub-basins. Referring to the 25YR – 3DAY stage reduction table, max water stages were reduced in project sections A and B due to the implementation of the proposed Forest Lakes weir replacement. Since the proposed sluice gates are removable, the weir crest elevation can vary from 2.0 ft NGVD (fully open) to 6.0 ft NGVD (fully closed). The gates can maintain or relieve the varying upstream stages that fluctuate throughout the year or be set to an elevation to provide storage during the dry season for irrigation. The weir structure is proposed in a "v" shape to provide more weir length and increased flow downstream.

Priority Phase VIII - Section F

The extent of stage reduction through section F was analyzed for each modeled scenario and summarized in the stage reduction tables in **Appendix C.** and the stage reduction charts in **Appendix D**. The *Section F Stage Reduction – 25YR 3DAY* chart indicates that every modeled scenario provides a stage reduction of at least 0.11 ft. Alternative channel improvements that should be considered include the implementation of a 6 ft x 10 ft box culvert to provide additional capacity through the current swale or a bypass outfall into the Royal Poinciana stormwater system.

Results & Conclusions

Exhibit 18. depicts the *All Proposed Improvements & Goodlette Frank Ditch Improvements* scenario node maximum stages for the 25 Year – 3 Day storm event. In addition, the node and link results are provided in table format in **Appendix B.** for the 25 Year – 3 Day storm event for the *All Proposed Improvements & Goodlette Frank Ditch Improvements (NO Pump Station)* scenario. Approximately one foot of clearance is provided between the peak stage and the crown of the box culverts under Golden Gate Parkway in the 25 Year – 3 day *All Proposed Improvements & Goodlette Frank Ditch Improvements* model.

Upon review of the stage reduction charts for each section, it is obvious that no *one* improvement will be the remedy to all flooding issues experienced within the GRE basin. Cumulatively, however, stage reduction is evident for all basin sections in the *All Proposed Improvements & Goodlette Frank Ditch Improvements (NO Pump Station)* scenario. Over the years, the GRE basin has been built out with each stormwater system being designed on a case-by-case basis, without consideration to the impact these projects would have regionally. This master plan is meant to evaluate the basin on a comprehensive level by providing improvements that will function cooperatively and be mutually beneficial to one another. ***It is ABB's recommendation that the following eight proposed improvements be implemented.***

1.) AMIL Gate Weir Replacement

The existing AMIL gate controls the outfall for the entire GRE basin and does not allow enough flow to pass to relieve upstream flood stages. *Without the implementation of the AMIL Gate Weir Replacement, all upstream sub-basins will continue to experience flooding issues.*

2.) Goodlette-Frank Supplemental Outfall

The Conservancy of Southwest Florida swale is densely vegetated and not designed to be a major outfall for the GRE basin. However, it is currently the only interconnect serving the southwest sub-basins. The Goodlette Frank Supplemental Outfall will provide sufficient capacity to handle flow not accommodated by Freedom Park, as well as flow from Golden Gate Parkway to keep the road from inundation. *If the supplemental outfall is not implemented, Golden Gate Parkway and upstream sub-basins will continue to flood.*

3.) Freedom Park Stormwater Pump Station

Freedom Park's water quality treatment system is currently under-utilized. The treatment system is limited by the small pump station that introduces stormwater from the GF ditch into Freedom Park. *Without the addition of the proposed pump station, the full capacity and value of the treatment system will not be achieved.* Furthermore, flood stage relief will not be provided to the upstream sub-basins on the northwest side of the GF ditch.

4.) Freedom Park Bypass Ditch & Spreader Swale

Flow is prevented from entering the Freedom Park ditch due to the existing fabriform weir. Flow is further restricted due to the ditch being undersized, overgrown, and undefined downstream. *Without the replacement of the fabriform weir and implementation of the expanded bypass ditch and spreader swale, the flow required through Freedom Park to reduce flooding conditions in the upstream sub-basins is not possible, specifically in neighborhoods near Ohio Dr.* Furthermore, a larger stormwater burden will be sent downstream, negatively impacting the southern sub-basin flood stages.

5.) Goodlette-Frank Ditch Improvements

Improvements are proposed along the GF ditch from Ohio Dr down to the Coastland Center Mall. Through this section, the ditch bottom is not uniform, does not provide enough capacity, and the inverts along this section are not configured to provide positive drainage downstream. Furthermore, pipe crossings within this section are undersized and constrict flow. *Without the proposed box culverts, regraded ditches, and all culvert and ditch inverts being lowered to provide positive drainage, neighborhoods near Ohio Dr will continue to flood, and a peak stage at Ohio Dr less than, or equal to, 9.0 ft NGVD is not attainable.*

6.) Solana/Burning Tree Box Culvert Extension

Flooding in the northwest sub-basins along GF Rd and within the County Club of Naples is a consequence of undersized infrastructure along Solana Rd and GF Rd. *The proposed box culvert extension is necessary to correct the inundation conditions seen in the County Club of Naples community and the northwest sub-basins along GF Rd; without it, these areas will continue to flood.*

7.) Maintenance Access Road/ Seawall & 8.) Forest Lakes Rock Weir Replacement

The various challenges through this section of the Gordon River include historical flooding issues throughout the Forest Lakes community, exotic vegetation overgrowth, maintenance access, conveyance of flow downstream, and reduced capacity of the river due to the earthen berms and narrowed channel. *Without the implementation of the rock weir replacement, the removal of the earthen berms, and the deepening and widening of the channel, flooding issues throughout the Forest Lakes community will continue. Furthermore, the maintenance access road/seawall is necessary to provide the added capacity to the river by maximizing the bottom width of the channel to its fullest extent. Without the access road/seawall, exotic vegetation maintenance and maintenance access is unlikely and current conditions will worsen.*

To achieve the stages provided in **Exhibit 18.**, each improvement must provide the flow capacity presented in the *Basin Improvements Flow Summary Table,* below.

Basin Improvements Flow Summary Table - 25YR 3DAY	
AMIL Gate Weir Replacement	**Minimum Required Flow Capacity (cfs)**
Weir	322
Bottom Hinged Crest Gate No. 1	229
Bottom Hinged Crest Gate No. 2	229
Goodlette Frank Supplemental Outfall	
Goodlette Section Box Culvert	220
Goodlette Section Weir	12
Zoo Section Box Culvert	220
Linear Pond	220
Supplemental Outfall Weir	220
Freedom Park Stormwater Pump Station	
Proposed Pump No. 1	23
Proposed Pump No. 2	21
Total Required Flow Capacity	44
Freedom Park Bypass Ditch & Spreader Swale	
	276
Goodlette Frank Ditch Improvements	
Improved Ditch (ea)	310
Ohio Drive Box Culvert	230
Ridge Street Box Culvert	299
Creech Road Box Culvert	299
26th Ave N . Box Culvert	299
22nd Ave N. Box Culvert	299
Section 5-B Box Culvert	299
Solana/Burning Tree Box Culvert Extension	
	209
Maintenance Access Road/ Seawall	
Channel	964
Forest Lakes Rock Weir Replacement	
Weir	698
Gate No. 1	102
Gate No. 2	102
Gate No. 3	102
Gate No. 4	102

The Engineer's Opinion of Probable Costs for the eight proposed improvements conceptual design is provided in the table below. The breakdown of these costs are provided in **Appendix E.**

Conceptual Engineer's Opinion of Probable Costs		
Improvement		**Total Cost**
AMIL Gate Weir Replacement	$	4,506,000
Goodlette-Frank Supplemental Outfall	$	6,953,000
Freedom Park Stormwater Pump Station	$	1,944,000
Freedom Park Bypass Ditch & Spreader Swale	$	1,249,000
Goodlette-Frank Ditch Improvements	$	4,365,000
Solana/Burning Tree Box Culvert Extension	$	6,089,000
Maintenance Access Road/ Seawall	$	5,561,000
Forest Lakes Rock Weir Replacement	$	2,020,000
Total Cost of All Improvements	**$**	**33,202,000**

A *Cost Benefit Analysis* is also provided in **Appendix E.** and relates the volume of flooding reduced for each dollar spent on the proposed improvement. This analysis can be used as a tool to relate the improvements to each other while comparing their impact on stage reduction per dollar spent. It should be noted that the improvements and their ability to function as presented depends on the replacement of the AMIL gate weir first. Generally, the cost benefit analysis indicates a greater impact for improvements with a larger upstream runoff area.

The recommended *Gordon River Extension* Project Sections & Construction Phasing Sequence for the eight proposed improvements is shown in **Exhibit 1.** This is the recommended order of construction that takes into account the current lifespan of the existing systems, constructability, stage reduction, community impact during construction, operational demand (required ongoing maintenance), and the cost benefit analysis.