Capital Project Planning, Impact Fees and Program Management Division
Stormwater Management Section

Pine Ridge Subdivision
Stormwater Feasibility Study

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Contents

1.0 INTRODUCTION

1.1 PROJECT PURPOSE

This report details the Pine Ridge Subdivision Stormwater Feasibility Study. The purpose of this study is to provide an assessment of the existing drainage conditions within the Pine Ridge Subdivision to determine areas of localized flooding during the 10 year-3 day and 25 year-3 day design storm events and then analyze possible solutions within areas that do flood. In order to assess the future impacts, flood conveyance, and mitigation needs within the existing subdivision a number of assumptions were established to best represent the base conditions given the limited resources available. This study presents the preliminary analysis of the existing stormwater management backbone system and presents possible solutions and recommendations to improve the current drainage scheme to limit and, in some areas, eliminate localized flooding. The elevation information for this report is in NAVD 1988.

1.2 PROJECT LIMITS

This project is generally located within the geographical boundary of US 41 to the west, Vanderbilt Beach Road to the north, Goodlette-Frank Road to the east and Pine Ridge Road to the south.

1.3 PROJECT OBJECTIVES

The objective of work includes 3 general tasks:

- Organize, consolidate and validate available information into a singular document.
- Develop a roadside swale system that will provide the greatest amount of stormwater storage possible within acceptable limits.
- Prepare a basic model of the secondary drainage system using ICPR.

These general tasks will be further outlined in the sections below.

1.4 PROJECT ASSUMPTIONS

As a part of this feasibility study, a number of assumptions were made based on the available data. The assumptions were made to establish both the existing and proposed conditions for the modeling efforts. The general assumptions for the project are as followed:

- Due to inconsistencies between LiDAR and available photometric data, survey data obtained by RWA, Inc. (2017) was used for crown of road elevations.
- Due to the level of detail inherent with LiDAR, data was not detailed enough to pick up roadside swales and full cross section surveys of every swale were not included in the project scope. An

assumed cross section for the base condition was used in the modeling efforts, which does not completely depict the existing field conditions.

- Due to the variability of roadside swales or lack thereof within each of the basins, a standard cross section was needed in order to develop the model with a reasonable number of sub-basins. Over 150 sub-basins were used in developing the model and standardizing on a consistent roadway swale cross-section allowed a comparative analysis of the existing conditions versus the proposed options. Therefore, the existing condition modeling for the project takes into account storage in roadside swales that is not currently present.
- In sub-basins where there are no available Flood Elevation Certificates, we have assumed an average FFE of one foot (1') above the average road centerline elevation.
- No tailwater data within the canal on the west side of Goodlette-Frank Road is available. Survey data of stain lines and discussion with County staff were used in determining tailwater elevation. We have assumed that the tailwater ranges between the control elevation to one foot (1') above the control elevation. These numbers were extrapolated along a hydrograph curve to obtain an estimated tailwater condition. The control elevation is 7.0 FT-NGVD or 5.75 FT-NAVD which was obtained from drainage area 5B from Pelican Marsh SFWMD Permit No. 11-01121-S, Application No. 950626-9
- Sub-basins were delineated from the survey data obtained by RWA, Inc. in approximate one foot (1') elevation intervals in order to fully utilize volume on the upstream end of each drainage basin.
- In an effort to provide conservative and consistently reliable data over time, rear and side yards of residential lots are not being accounted for in volume calculations for storage of stormwater, except for existing lakes. This also places assumed storage within County rights-of-way and under the control of the County Roadway Maintenance Section.
- Due to various front yard swale conditions found in the field, typical assumed cross sections were used for both the proposed and existing conditions in the models. Swale cross section exhibits are presented in Appendix C.
- For ICPR modeling efforts, invert elevations used for drainage pipes in the existing and proposed conditions were derived from the proposed cross section and local crown of road elevation obtained from survey information by RWA, Inc.

- As the existing lakes were not surveyed, lake areas were obtained from current aerials.
- It was assumed that there will be no reconstruction of roadways or centerline elevation changes associated with stormwater improvements.
- Lot use areas for pervious and impervious surfaces were taken as percentages from a small sample of fully developed lots within each sub-basin. This sample was of larger and newer homes since our assumption, based on recent observed construction, is that larger homes would continue to be constructed on lots that are currently occupied by older, smaller homes.
- It was assumed that all lots drained towards the front yard and to the roadside swales, with the exception of the lots that include lakes. In these cases consult the existing conditions exhibit in Appendix A for drainage boundary assumptions.
- All pipe sizes referenced are for circular pipes. Cost estimates were developed using the elliptical equivalent for 18" and larger pipes and are noted as such.

1.5 EXISTING STORMWATER SYSTEM DOCUMENTATION

The following information was used to establish a base condition for the preliminary and final model:

- 2006 Drainage Structure Inventory and Survey Report;
- Recently updated County GIS data;
- County Right of way permitting information;
- LiDAR elevation data;
- County Capital Project Information;
- Additional limited scope design survey completed by RWA, Inc. in 2017;
- South Florida Water Management District and Florida Department of Environmental Protection Environmental Resource Permits Issued for nearby properties and facilities;
- Flood Elevation Certificate database; and
- Field reconnaissance by RWA staff.

The data listed above was compiled into an overall existing conditions map attached as Appendix A.

1.6 COORDINATION

Consultant anticipates meeting with County staff during this task at the following milestones:

- Project kickoff to review data availability, limits and performance of drainage basins as understood by County staff.
- Progress Meeting to resolve information gaps and approach.

- Progress meeting to review initial data collection and documentation format after first sub-basin is completed.
- Progress meeting to review additional methodology for County approval prior to completing the remainder of the modeling for the study.
- Task Closure Meeting to review this report and final documentation.

Going forward, additional ongoing coordination with residents and stakeholders in the Pine Ridge Subdivision area will be critical to the success of subsequent projects as outlined in the Findings and Recommendations section of this report.

2.0 EXISTING CONDITIONS

2.1 LOCATION AND TOPOGRAPHY

Although this project is located within the geographical boundary of US 41 to the west, Vanderbilt Beach Road to the north, Goodlette-Frank Road to the east and Pine Ridge Road to the south, there are several areas around the perimeter of the Study Area which were removed from review. The areas in particular include the commercial areas along US 41 in the northwest, west central and southwest areas.

Generally, the existing topography within the Study Area falls gently from southwest to northeast, with a total elevation change of roughly nine (9) feet, ranging from elevations of about 18.30 FT NAVD in the southwest to elevations of 9.00 FT NAVD in the northeast of the subdivision. Due to areas of generally flat terrain, coupled with insufficient capacity in the current drainage system, there has historically been extensive out-of-bank/roadway flooding and in some cases localized flooding within the Study Area. The exhibits in Appendix A show the existing system with data compiled from sources described in other sections above.

2.2 LAND USE

The predominant existing land use for this subdivision is single family residential lots ranging in size from approximately 1 acre to 4.5 acres in size.

2.3 CURRENT STORMWATER MANAGEMENT FACILITIES

Presently, the Pine Ridge Drainage System is comprised of six (6) major lakes used for surface water storage, a roadside collection / conveyance network (comprised of swales, ditches and culverts) interconnected by different types of drainage facilities that move surface waters throughout the community. These drainage facilities range in type and size and include swales, ditches, underground drainage pipes and overland flow. The lands occupied by this stormwater management system have

several points of surface water inflow and outflow at the perimeter of the project boundary.

After multiple visits to the area during dry conditions and during storm events of various intensities and durations it is apparent that a majority of the flooding occurs as a result of undersized or completely filled ditches, undersized driveway culverts, blockages within driveway culverts and a general lack of storage and conveyance due to modifications to a typical and/or the original drainage system design.

2.4 RIGHT-OF-WAY

The current County right-of-way (ROW) consists of differing widths of sixty (60) and seventy (70) feet, asphalt roadways of approximately twenty (20) feet in width and minimal locations with sidewalks. The road network within the Pine Ridge Subdivision is a public right-of-way, currently owned and maintained by Collier County. Although a full title search was not completed as part of this study, it appears a portion of the drainage pipes within the Subdivision do not appear to be within drainage easements and are identified within each Basin in Section 3 of this report. The two southern lakes are not within County drainage easements and have historically been considered privately owned by the surrounding lot owners. The County does not maintain these lakes. Linear drainage easements that do exist are typically 5' wide along or between lots. Lakes that are within County owned easements are difficult to maintain due to limited access.

3.0 HYDROLOGY AND HYDRAULICS

3.1 ANALYSIS OBJECTIVE

The aim of the preliminary analysis was to analyze the existing system to determine the areas of concern. This was accomplished using the data and assumptions discussed in section 1.0 above. Once the existing model was finalized, a proposed model was completed to size an appropriate condition to improve the capacity and conveyance for both the 25 year and 10 year, 3 day events within the study area. Numerous pipes throughout the system were optimized using an iterative process in order to efficiently use available storage volume within the system for the design storm event and minimize roadway flooding with a free flowing outfall. A second series of model runs were developed that included an outfall discharge rate reduced as much as feasible to the existing condition while still providing a level of roadway flooding reduction.

A total of 6 drainage basins were identified as part of this project. The limits of each basin were identified based on available topographic data and field observations. These basins are approximated and may change in the future as additional topographic data is obtained for design.

As the models were developed, it became apparent that driveway culverts would have to be used as inline control structures within the roadside ditches in order to allow water to stage during larger storm events, taking advantage of the upstream volume within the ditches of each basin. The Sub-Basins were split up at approximate elevation changes of one (1) foot. See Appendix B for a map of names and locations of basins and sub basins. No ditch blocks were utilized to further stage water in the roadside swales. The following sections of the report present the findings and results for all 6 Sub-Basins.

3.2 BASIN 1

3.2.1 LOCATION

Basin 1 is the northernmost basin within the Pine Ridge Subdivision. It is generally bounded by Carica Road to the south, Cassena Road to the west, and Hickory Road to the north and east and includes two lakes. Figure 1 below illustrates the Basin 1 boundary.

Figure 1: Basin 1 Boundary

3.2.2 SPECIFIC ASSUMPTIONS

In addition to the general assumptions listed in Section 1.4 of this report, the following is a list of specific assumptions that were made for Basin 1:

- Based on the existing conditions information obtained by survey and field visits, several areas were identified that further defined the basin boundary. The information obtained showed that these areas drained to systems to the north and west or to the Goodlette-Frank Road canal. The following areas were removed from Basin 1; the western sections of Banyan Road and Sandpine Drive, Cassena Road north of Tupelo Road, a portion of Hickory Road north of Tupelo Road, and the eastern end of Carica Road.
- Field visits found that a control structure from Emerald Woods discharged into Carica Road. To incorporate this inflow into the Basin 1 model it was assumed that the discharge rate from Emerald Woods was in accordance with Collier County's allowable discharge rate for the area of .15 CFS per acre. Based on the 10 acre site, 1.5 CFS was used as a base flow within the model.
- Drainage pipe upsizing was restricted in-between lots leading to and from the two lakes to either two pipes of 30 inches each or a single 36 inch pipe.

3.2.3 EXISTING CONDITIONS

Based on survey data and current field conditions, Basin 1 was delineated from adjacent basins using current aerials as shown in Figure 1 above. The total area of this basin is approximately 111 acres and the existing elevations of the crown of road ranges from 17.00 to 9.00 FT NAVD. Basin 1 is comprised of 19 Sub-Basins. The exhibit in Appendix B illustrates the breakdown of the Sub-Basins within Basin 1. The drainage backbone for this basin is composed of road side swales, pipes, Lake 1 (Warbler Lake), and Lake 2 (Lake Bunting), which are approximately 9.76 acres and 3.70 acres respectively. Based on various field visits it was determined that approximately 20% or 3,475 LF of road side swales for this basin have been filled which do not provide adequate conveyance and storage to the system. Currently Sub-Basins 1 thru 4 drain to Lake 1 and Sub-Basin 5 drains to Lake 2. Overall the storm water flows from Lake 1 to Lake 2 and discharges into the Goodlette-Frank canal. The basin discharges to the canal via a 24" and a 30" pipe. Using the assumptions described in Section 1.4 and 3.2.1 above an ICPR model of the existing conditions was created as a benchmark to evaluate the proposed improvement.

Based on the model for existing conditions the 25 year – 3 day storm event generated flooding in 12 sub-basins. The flooding from this storm event ranged from 1.44 to 20.64 inches above crown of road, with an average of 8.63 inches. All flooding references are based on over the crown of road elevations for the remainder of this report. The 10 year – 3 day storm event showed flooding in 10 sub-basins. The flooding for the 10 year storm ranged from 0.96 to 16.44 inches above crown of road and averaged 6.67 inches. Table 1 summarizes the results for the existing conditions.

Table 1: Basin 1 Existing Conditions Results Summary

	25 Year - 3 Day Existing Condition			10 Year - 3 Day Existing Condition		
Node ID	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)
B1-LB1	9.1	9.21	No Flooding	8.7	9.21	No Flooding
B1-LB2	8.55	9.21	No Flooding	8.31	9.21	No Flooding
B1-SB1A	9.66	9.05	7.32	9.4	9.05	4.2
B1-SB1B	9.63	9.05	6.96	9.37	9.05	3.84
B1-SB1C	9.49	9.05	5.28	9.18	9.05	1.56
B1-SB2A	14.53	14.63	No Flooding	14.25	14.63	No Flooding
B1-SB2B	12.72	13.34	No Flooding	12.41	13.34	No Flooding
B1-SB2C	11.93	10.21	20.64	11.58	10.21	16.44
B1-SB2D	11.51	10.21	15.6	11.2	10.21	11.88
B1-SB2E	11.51	10.21	15.6	11.2	10.21	11.88
B1-SB2F	11.53	10.21	15.84	11.21	10.21	12
B1-SB2G	13.11	13.34	No Flooding	12.82	13.34	No Flooding
B1-SB3A	10.05	9.67	4.56	9.75	9.67	0.96
B1-SB3B	9.96	10.2	No Flooding	9.65	10.2	No Flooding
B1-SB4A	9.12	9	1.44	8.71	9	No Flooding
B1-SB4B	9.12	9	1.44	8.71	9	No Flooding
B1-SB5A	9.74	9.37	4.44	9.55	9.37	2.16
B1-SB5B	9.58	9.21	4.44	9.36	9.21	1.8
B1-SB5C	9.33	9.53	No Flooding	9.06	9.53	No Flooding
GFC	6.75	7	No Flooding	6.75	7	No Flooding
		Max Flood Depht (in)	20.64		Max Flood Depht (in)	16.44
		Min Flood Depth (in)	1.44		Min Flood Depth (in)	0.96
		Average Flood Depth (in)	8.63		Average Flood Depth (in)	6.672
		Sub-Basins Flooded	12		Sub-Basins Flooded	10

3.2.4 PROPOSED CONDITIONS

Two proposed conditions were evaluated. The first is a maximum (max) discharge condition which optimizes both the internal stormwater pipe network and the discharge point to reduce basin wide flooding. The second condition optimized the internal stormwater pipe network but maintains the same size discharge structure to that of the existing condition to achieve discharge rates from the basin as close to the existing discharge rates.

The ICPR model for the proposed condition max discharge showed a significant improvement to the basin for both the 25 year – 3 day and the 10 year – 3 day storm events. During the 25 year storm event 7 sub-basins showed flooding compared to 12 sub-basins in the existing condition. The biggest improvement from this storm event is in the level of flooding. The flood depth ranges from 0.24 to 4.80 inches with an average depth of 3.69 inches. The basin discharge from this condition was 48.43 cfs for the 25 year storm event and 38.81 cfs for the 10 year storm event, utilizing both a weir of 96 inches (span) by 12 inches (rise) and two 18 inch pipes. The discharge from this condition results in an increase in the discharge rate of 193% and 155% for the 25 year and 10 year storm events, respectively.

During the 10 year – 3 day storm event under the max discharge condition the model showed no flooding throughout Basin 1. Table 2 summarizes the results for the proposed condition – max discharge for both the 25 year and 10 year - 3 day storm events.

Table 2: Basin 1 Proposed Condition - Max Discharge Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Proposed Condition - Max Discharge			Proposed Condition - Max Discharge		
Node ID	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)
B1-LB1	9.4	9.21	2.28	8.98	9.21	No Flooding
B1-LB2	8.03	9.21	No Flooding	7.8	9.21	No Flooding
B1-SB1A	9.43	9.05	4.56	9.01	9.05	No Flooding
B1-SB1B	9.43	9.05	4.56	9.01	9.05	No Flooding
B1-SB1C	9.43	9.05	4.56	9	9.05	No Flooding
B1-SB2A	14.53	14.63	No Flooding	14.25	14.63	No Flooding
B1-SB2B	13.2	13.34	No Flooding	12.73	13.34	No Flooding
B1-SB2C	10.23	10.21	0.24	9.57	10.21	No Flooding
B1-SB2D	9.91	10.21	No Flooding	9.15	10.21	No Flooding
B1-SB2E	10.1	10.21	No Flooding	9.34	10.21	No Flooding
B1-SB2F	10.21	10.21	No Flooding	9.45	10.21	No Flooding
B1-SB2G	13.11	13.34	No Flooding	12.82	13.34	No Flooding
B1-SB3A	9.46	9.67	No Flooding	8.99	9.67	No Flooding
B1-SB3B	9.43	10.2	No Flooding	8.99	10.2	No Flooding
B1-SB4A	9.4	9	4.8	8.98	9	No Flooding
B1-SB4B	9.4	9	4.8	8.98	9	No Flooding
B1-SB5A	9	9.37	No Flooding	8.59	9.37	No Flooding
B1-SB5B	8.92	9.21	No Flooding	8.48	9.21	No Flooding
B1-SB5C	8.56	9.53	No Flooding	8.22	9.53	No Flooding
GFC	6.75	7	No Flooding	6.75	7	No Flooding
		Max Flood Depht (in)	4.8		Max Flood Depht (in)	0
		Min Flood Depth (in)	0.24		Min Flood Depth (in)	0
		Average Flood Depth (in)	3.69		Average Flood Depth (in)	0
		Sub-Basins Flooded	7		Sub-Basins Flooded	0

The same discharge structure condition also showed major improvements to the existing condition however, not to the level of the max discharge scenario. Table 3 summarizes the modeling results for this condition. The 25 year – 3 day storm event model for this condition resulted in 8 flooded sub-basins with flood depths ranging from 0.36 to 6.12 inches and an average depth of 4.26 inches. The 10 year – 3 day storm event showed 5 sub-basins with flooding with flood depths ranging from 0.48 to 0.96 inches and an average depth of 0.72 inches. Overall Basin 1 under this condition produced a discharge rate of 26.38 cfs for the 25 year storm event and 21.18 cfs for the 10 year storm event using similar discharge structures. This is an increase of 5% and 2% for the 25 year and 10 year storm events, respectively.

Table 3: Basin 1 Proposed Condition - Same Discharge Structure Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Proposed Condition - Same Discharge Structure			Proposed Condition - Same Discharge Structure		
Node ID	Max Stage (ft)	Warning Stage (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Warning Stage (ft)	Depth at Crown of Road (in)
B1-LB1	9.51	9.21	3.6	9.08	9.21	No Flooding
B1-LB2	8.99	9.21	No Flooding	8.62	9.21	No Flooding
B1-SB1A	9.53	9.05	5.76	9.1	9.05	0.6
B1-SB1B	9.53	9.05	5.76	9.1	9.05	0.6
B1-SB1C	9.52	9.05	5.64	9.09	9.05	0.48
B1-SB2A	14.53	14.63	No Flooding	14.25	14.63	No Flooding
B1-SB2B	13.2	13.34	No Flooding	12.73	13.34	No Flooding
B1-SB2C	10.27	10.21	0.72	9.57	10.21	No Flooding
B1-SB2D	9.96	10.21	No Flooding	9.18	10.21	No Flooding
B1-SB2E	10.14	10.21	No Flooding	9.35	10.21	No Flooding
B1-SB2F	10.24	10.21	0.36	9.46	10.21	No Flooding
B1-SB2G	13.11	13.34	No Flooding	12.82	13.34	No Flooding
B1-SB3A	9.53	9.67	No Flooding	9.09	9.67	No Flooding
B1-SB3B	9.52	10.2	No Flooding	9.09	10.2	No Flooding
B1-SB4A	9.51	9	6.12	9.08	9	0.96
B1-SB4B	9.51	9	6.12	9.08	9	0.96
B1-SB5A	9.21	9.37	No Flooding	8.66	9.37	No Flooding
B1-SB5B	9.18	9.21	No Flooding	8.63	9.21	No Flooding
B1-SB5C	9.08	9.53	No Flooding	8.63	9.53	No Flooding
GFC	6.75	7	No Flooding	6.75	7	No Flooding
		Max Flood Depht (in)	6.12		Max Flood Depht (in)	0.96
		Min Flood Depth (in)	0.36		Min Flood Depth (in)	0.48
		Average Flood Depth (in)	4.26		Average Flood Depth (in)	0.72
		Sub-Basins Flooded	8		Sub-Basins Flooded	5

3.2.5 RECOMMENDATIONS

When analyzing both the proposed conditions and the existing conditions it is recommended that along with regrading and excavating of the roadside swales which provide both conveyance and storage that the backbone stormwater infrastructure be upsized to meet the current demands. Utilizing a condition which maximizes discharge provides the optimal flood improvements to the system. However, the resulting discharge is significantly greater than the existing. Utilizing the similar size discharge structure will also significantly improve the system although not to the level of the max discharge condition. Without a thorough review of the downstream condition, the more conservative recommendation is to utilize the similar discharge condition to maintain a discharge rate close to that of the existing system to not adversely affect conditions downstream in the Goodlette-Frank Canal. These proposed changes are projected to have an initial cost of $1,435,000. Detailed cost information is included in Appendix D.

3.3 BASIN 2

3.3.1 LOCATION

Basin 2 is located directly south of Basin 1. It can be generally described as located between Banyan Road and the horizontal projection of the western portion of Ridge Drive extending east towards Goodlette-Frank Road. Figure 2 illustrates the limits of the Basin 2 boundary.

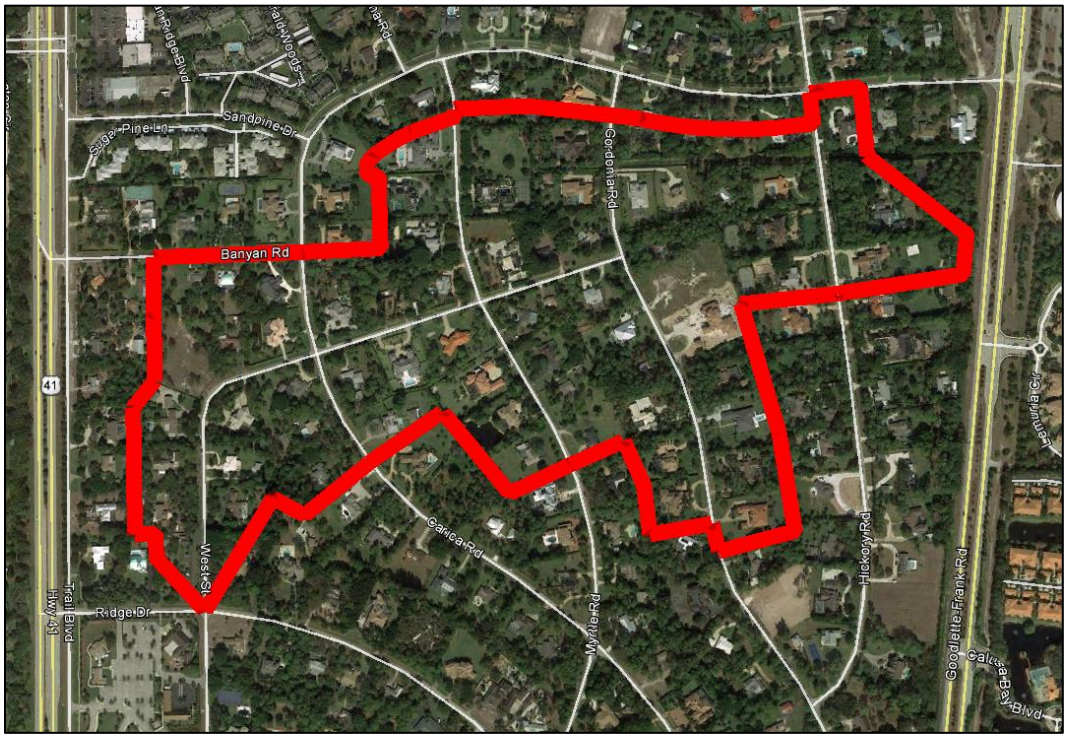

Figure 2: Basin 2 Boundary

3.3.2 SPECIFIC ASSUMPTIONS

In addition to the general assumptions listed in Section 1.4 of this report, the following is a list of specific assumptions that were made for Basin 2:

- Based on the existing conditions information obtained by survey and field visits, Basin 2 was delineated from adjacent basins using current aerials as shown in Figure 2 above. The existing drainage pattern showed that the residential areas fronting on Trail Boulevard drained to the US41 system which is outside the scope of this project. The following areas that were removed from this basin include; the western section of Banyan Road, western section of Ridge Drive west of West Street which is part of the Covenant Church ERP permit, and the eastern section of Carica Road east of Hickory Road which drains directly to the Goodlette-Frank canal.
- Stormwater conveyance currently provided through private property will remain. Conveyance

is currently provided through a swale along 700 Myrtle Road and the northern property boundary of 693 Gordonia Road.

- Based on limited record information and survey data on the drainage ditch within the basin, a typical cross section was assumed for the ditch based on a surveyed cross section obtained by RWA, Inc. (2017). The assumed ditch cross section can be seen in Appendix C.
- Drainage pipe upsizing was restricted on driveway culverts to a maximum size of 24 inches when using two pipes.

3.3.3 EXISTING CONDITIONS

The boundary for Basin 2 was delineated using current aerials based on information obtained by survey data and current field conditions as shown in Figure 2 above. The total area for Basin 2 is approximately 102.17 acres and the existing topography of the crown of road ranges from 17.92 to 10.25 FT NAVD. Basin 2 is composed of 25 Sub-Basins which are shown in Appendix B. The backbone drainage system for this basin consists primarily of road side swales which convey all stormwater towards the existing east-west drainage ditch. The drainage ditch is located at the north end of Gordonia Road and extends east until connecting to the Goodlette-Frank canal. The majority of the Sub-Basins drain east through West Street and onto Gordonia Road, eventually draining into the ditch. The ditch ultimately discharges into the Goodlette-Frank canal through a pair of 60”x38” elliptical pipes. Due to the absence of a control structure on the drainage ditch, as water levels in the Goodlette-Frank canal rise water from the canal will backflow into the ditch within the basin reducing available water storage.

Based on various field visits it was determined that approximately 15% or 2290 LF of road side swales for this basin have been filled which do not provide adequate conveyance and storage to the system. Using the assumptions described in Section 1.4 and 3.2.1 above, an ICPR model of the existing conditions was created as a benchmark to evaluate the proposed improvement.

The existing conditions ICPR model for the 25 year – 3 day storm event generated flooding in 14 Sub-Basins. The flooding above the crown of road ranged from 1.80 to 12.36 inches, with an average depth of 6.06 inches. The 10 year – 3 day storm event showed that 11 Sub-Basins had flooding which ranged from 0.96 to 9.36 inches over the crown of road with an average flood depth of 4.20 inches. Table 4 below summarizes the results for the existing conditions in Basin 2.

Table 4: Basin 2 Existing Conditions Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Existing Condition			Existing Condition		
Node ID	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)
B2-SB1A	16.57	17.02	No Flooding	16.20	17.02	No Flooding
B2-SB1B	16.27	16.11	1.92	15.99	16.11	No Flooding
B2-SB1C	14.87	14.26	7.32	14.61	14.26	4.2
B2-SB1D	14.88	14.26	7.44	14.63	14.26	4.44
B2-SB2A	14.83	13.80	12.36	14.58	13.80	9.36
B2-SB2B	13.48	13.33	1.8	13.29	13.33	No Flooding
B2-SB3A	12.00	11.23	9.24	11.78	11.23	6.6
B2-SB3B	11.49	11.12	4.44	11.28	11.12	1.92
B2-SB3C	11.73	11.12	7.32	11.51	11.12	4.68
B2-SB4A	17.01	17.02	No Flooding	16.62	17.02	No Flooding
B2-SB4B	15.93	16.11	No Flooding	15.22	16.11	No Flooding
B2-SB4C	14.73	15.19	No Flooding	14.24	15.19	No Flooding
B2-SB4D	14.43	14.26	2.04	14.03	14.26	No Flooding
B2-SB4E	14.81	15.09	No Flooding	14.26	15.09	No Flooding
B2-SB5A	14.27	13.80	5.64	13.90	13.80	1.2
B2-SB5B	14.01	13.20	9.72	13.68	13.20	5.76
B2-SB5C	12.57	13.06	No Flooding	12.27	13.06	No Flooding
B2-SB6A	12.12	13.06	No Flooding	11.91	13.06	No Flooding
B2-SB6B	12.67	12.20	5.64	12.45	12.20	3
B2-SB6C	10.39	10.92	No Flooding	10.24	10.92	No Flooding
B2-SB7A	11.69	11.12	6.84	11.46	11.12	4.08
B2-SB7B	11.21	10.95	3.12	11.03	10.95	0.96
B2-SB7C	8.97	10.25	No Flooding	8.71	10.25	No Flooding
B2-SB7D	10.50	11.50	No Flooding	10.26	11.50	No Flooding
B2-SB8A	8.67	10.25	No Flooding	8.46	10.25	No Flooding
GF-Canal	6.75	6.75	No Flooding	6.75	6.75	No Flooding
		Max Flood Depht (in)	12.36		Max Flood Depht (in)	9.36
		Min Flood Depth (in)	1.8		Min Flood Depth (in)	0.96
		Average Flood Depth (in)	6.06		Average Flood Depth (in)	4.2
		Sub-Basins Flooded	14		Sub-Basins Flooded	11

3.3.4 PROPOSED CONDITIONS

The ICPR model for the proposed condition max discharge showed improvements to flooding areas and depths for both the 25 year – 3day and the 10 year – 3 day storm events. During the 25 year storm event 8 sub-basins showed flooding compared to 14 sub-basins in the existing conditions. The overall flooding depth also improved. Depth ranges from 0.12 to 3.96 inches with an average depth of 1.37 inches were modeled. The overall Basin 2 discharge from this condition was 148.41 cfs for the 25 year storm event and 128.5 cfs for the 10 year storm event, utilizing two 48” pipes under Hickory Road and maintaining the two 60”x38” elliptical pipes at the discharge point of the ditch. The discharge from this condition results in an increase from the existing condition of 56% and 54% for the 25 year and 10 year storm events, respectively.

During the 10 year – 3 day storm event under the max discharge condition the model showed no flooding throughout Basin 2. Table 2 below summarizes the results for the proposed condition – max discharge for both the 25 year and 10 year - 3 day storm events.

Table 5: Basin 2 Proposed Condition - Max Discharge Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Proposed Condition - Max Discharge			Proposed Condition - Max Discharge		
Node ID	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)
B2-SB1A	16.19	17.02	No Flooding	15.93	17.02	No Flooding
B2-SB1B	16.03	16.11	No Flooding	15.74	16.11	No Flooding
B2-SB1C	14.26	14.26	No Flooding	13.63	14.26	No Flooding
B2-SB1D	14.30	14.26	0.48	13.68	14.26	No Flooding
B2-SB2A	13.83	13.80	0.36	13.30	13.80	No Flooding
B2-SB2B	13.15	13.33	No Flooding	12.78	13.33	No Flooding
B2-SB3A	11.56	11.23	3.96	11.01	11.23	No Flooding
B2-SB3B	10.99	11.12	No Flooding	10.56	11.12	No Flooding
B2-SB3C	11.08	11.12	No Flooding	10.66	11.12	No Flooding
B2-SB4A	16.67	17.02	No Flooding	16.42	17.02	No Flooding
B2-SB4B	16.16	16.11	0.6	15.19	16.11	No Flooding
B2-SB4C	14.66	15.19	No Flooding	14.13	15.19	No Flooding
B2-SB4D	14.27	14.26	0.12	13.74	14.26	No Flooding
B2-SB4E	14.73	15.09	No Flooding	14.08	15.09	No Flooding
B2-SB5A	13.86	13.80	0.72	13.39	13.80	No Flooding
B2-SB5B	13.32	13.20	1.44	12.89	13.20	No Flooding
B2-SB5C	13.06	13.06	No Flooding	12.68	13.06	No Flooding
B2-SB6A	12.49	13.06	No Flooding	12.22	13.06	No Flooding
B2-SB6B	12.47	12.20	3.24	12.20	12.20	No Flooding
B2-SB6C	10.52	10.92	No Flooding	10.24	10.92	No Flooding
B2-SB7A	11.09	11.12	No Flooding	10.60	11.12	No Flooding
B2-SB7B	10.83	10.95	No Flooding	10.39	10.95	No Flooding
B2-SB7C	10.03	10.25	No Flooding	9.72	10.25	No Flooding
B2-SB7D	10.51	11.50	No Flooding	10.23	11.50	No Flooding
B2-SB8A	9.44	10.25	No Flooding	9.18	10.25	No Flooding
GF-Canal	6.75	6.75	No Flooding	6.75	6.75	No Flooding
		Max Flood Depht (in)	3.96		Max Flood Depht (in)	0
		Min Flood Depth (in)	0.12		Min Flood Depth (in)	0
		Average Flood Depth (in)	1.365		Average Flood Depth (in)	0
		Sub-Basins Flooded	8		Sub-Basins Flooded	0

The same discharge structure condition also showed improvements to the existing condition. However, the improvements are not to the same level of the max discharge condition. Table 6 below summarizes the modeling results for this condition. The 25 year – 3 day storm event model for this condition resulted in 8 flooded sub-basins with flood depths ranging from 0.12 to 4.32 inches and an average depth of 1.41 inches. The 10 year – 3 day storm event for this basin under the same discharge condition showed no flooding for this proposed condition. Overall under this condition, Basin 2 produced a discharge rate of 143.67 cfs for the 25 year storm event and 126.42 cfs for the 10 year storm event using discharge through the existing elliptical pipes. This is an increase of 51% for both the 25 year and 10 year storm events.

Table 6: Basin 2 Proposed Condition - Same Discharge Structure Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Proposed Condition - Same Discharge Structure			Proposed Condition - Same Discharge Structure		
Node ID	Max Stage (ft)	Warning Stage (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Warning Stage (ft)	Depth at Crown of Road (in)
B2-SB1A	16.19	17.02	No Flooding	15.93	17.02	No Flooding
B2-SB1B	16.03	16.11	No Flooding	15.74	16.11	No Flooding
B2-SB1C	14.26	14.26	No Flooding	13.63	14.26	No Flooding
B2-SB1D	14.30	14.26	0.48	13.68	14.26	No Flooding
B2-SB2A	13.83	13.80	0.36	13.30	13.80	No Flooding
B2-SB2B	13.15	13.33	No Flooding	12.78	13.33	No Flooding
B2-SB3A	11.59	11.23	4.32	11.02	11.23	No Flooding
B2-SB3B	11.03	11.12	No Flooding	10.57	11.12	No Flooding
B2-SB3C	11.11	11.12	No Flooding	10.66	11.12	No Flooding
B2-SB4A	16.67	17.02	No Flooding	16.42	17.02	No Flooding
B2-SB4B	16.16	16.11	0.6	15.19	16.11	No Flooding
B2-SB4C	14.66	15.19	No Flooding	14.13	15.19	No Flooding
B2-SB4D	14.27	14.26	0.12	13.74	14.26	No Flooding
B2-SB4E	14.73	15.09	No Flooding	14.08	15.09	No Flooding
B2-SB5A	13.86	13.80	0.72	13.39	13.80	No Flooding
B2-SB5B	13.32	13.20	1.44	12.89	13.20	No Flooding
B2-SB5C	13.06	13.06	No Flooding	12.68	13.06	No Flooding
B2-SB6A	12.49	13.06	No Flooding	12.22	13.06	No Flooding
B2-SB6B	12.47	12.20	3.24	12.20	12.20	No Flooding
B2-SB6C	10.57	10.92	No Flooding	10.25	10.92	No Flooding
B2-SB7A	11.12	11.12	No Flooding	10.61	11.12	No Flooding
B2-SB7B	10.88	10.95	No Flooding	10.40	10.95	No Flooding
B2-SB7C	10.16	10.25	No Flooding	9.77	10.25	No Flooding
B2-SB7D	10.54	11.50	No Flooding	10.24	11.50	No Flooding
B2-SB8A	9.38	10.25	No Flooding	9.15	10.25	No Flooding
GF-Canal	6.75	6.75	No Flooding	6.75	6.75	No Flooding
		Max Flood Depht (in)	4.32		Max Flood Depht (in)	0
		Min Flood Depth (in)	0.12		Min Flood Depth (in)	0
		Average Flood Depth (in)	1.41		Average Flood Depth (in)	0
		Sub-Basins Flooded	8		Sub-Basins Flooded	0

3.3.5 RECOMMENDATIONS

When analyzing both the proposed conditions and the existing conditions it is recommended that, along with regrading and excavating of the roadside swales and ditches for conveyance and storage, the backbone stormwater infrastructure should be upsized to meet the current demands. Also, it is recommended that easements be obtained along private property where the primary stormwater conveyance is provided for the system. Utilizing a condition which maximizes discharge provides the optimal flood improvements to the system. Within this basin, due to the size of the existing discharge control, the proposed discharge is equally greater for both conditions. Therefore, utilizing the max discharge condition will minimize flooding within Basin 2 and will cause the same impacts downstream within the Goodlette-Frank Canal as the restrained discharge version. These proposed changes are projected to have an initial cost of $1,128,000. Detailed cost information is included in Appendix D.

3.4 BASIN 3

3.4.1 LOCATION

Basin 3 is the smallest basin within the Pine Ridge Subdivision. It is located along those portions of Hickory and Gordonia Roads between the southern boundary of Basin 2 and the Carica Road and Gordonia Road intersection. There are no large ditches or lakes in the conveyance system within this basin. Figure 3 illustrates the Basin 3 boundary.

Figure 3: Basin 3 Boundary

3.4.2 SPECIFIC ASSUMPTIONS

In addition to the general assumptions listed in Section 1.4 of this report, the following is a list of specific assumptions that were made for Basin 3:

- Stormwater conveyance currently provided through private property will remain. Conveyance is currently provided through 555 Hickory Road. This conveyance provides the discharge from Basin 3 to the Goodlette-Frank Canal.
- Discharge pipe upsizing was restricted between lots to a maximum of 36 inch for two pipes with a restriction of two 24 inch pipes for driveway culverts.

3.4.3 EXISTING CONDITIONS

The boundary for Basin 3 was delineated using current aerials based on information obtained by survey data and current field conditions as shown in Figure 3 above. The total area for Basin 3 is approximately 48.01 acres and the existing topography of the crown of road ranges from 12.74 to 10.32 FT NAVD. Basin 3 is composed of 13 Sub-Basins which are shown in Appendix B. The drainage backbone for this basin is composed primarily of road side swales which convey all the drainage toward a junction box located near 555 Hickory Road. Basin 3 ultimately discharges into the Goodlette-Frank canal through an 18 inch pipe located on private property.

Based on various field visits it was determined that approximately 12.6% or 800 LF of road side swales for this basin have been filled which do not provide adequate conveyance and storage to the system. Using the assumptions described in Section 1.4 and 3.2.1 above an ICPR model of the existing conditions was created as a benchmark to evaluate the proposed improvement.

The existing condition ICPR model summary for both the 25 year – 3 day and 10 year – 3 day can be seen in Table 7 Below. The model for the 25 year storm event showed flooding in 12 Sub-Basins that ranged from 3.24 to 14.04 inches above crown of road with an average flood depth of 9.08 inches. The 10 year – 3 day storm event also resulted in flooding in 12 Sub-Basins. However the flood ranged from 0.60 to 11.64 inches with an average flood depth of 6.60 inches.

Table 7: Basin 3 Existing Conditions Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Existing Condition			Existing Condition		
Node ID	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)
B3-SB1A	12.35	12.08	3.24	12.13	12.08	0.6
B3-SB1B	12.02	11.42	7.2	11.82	11.42	4.8
B3-SB1C	12.04	11.42	7.44	11.84	11.42	5.04
B3-SB2A	12.06	12.08	No Flooding	11.65	12.08	No Flooding
B3-SB2B	11.43	10.56	10.44	11.18	10.56	7.44
B3-SB2C	11.37	10.32	12.6	11.17	10.32	10.2
B3-SB2D	11.38	10.32	12.72	11.17	10.32	10.2
B3-SB2E	11.38	10.59	9.48	11.18	10.59	7.08
B3-SB3A	12.14	11.84	3.6	11.93	11.84	1.08
B3-SB3B	11.93	11.42	6.12	11.74	11.42	3.84
B3-SB3C	11.73	10.56	14.04	11.53	10.56	11.64
B3-SB3D	11.37	10.32	12.6	11.17	10.32	10.2
B3-SB3E	11.38	10.59	9.48	11.18	10.59	7.08
GFC	6.75	6.75	No Flooding	6.75	6.75	No Flooding
		Max Flood Depht (in)	14.04		Max Flood Depht (in)	11.64
		Min Flood Depth (in)	3.24		Min Flood Depth (in)	0.60
		Average Flood Depth (in)	9.08		Average Flood Depth (in)	6.60
		Sub-Basins Flooded	12		Sub-Basins Flooded	12

3.4.4 PROPOSED CONDITIONS

ICPR models for the Max Discharge condition and the Same Discharge Structure condition were evaluated.

The proposed condition with Max Discharge showed improvements to flooding areas and depths for both the 25 year – 3day and the 10 year – 3 day storm events. During the 25 year storm event 6 Sub-Basins showed flooding compared to 12 sub-basins in the existing conditions. The overall flooding depth also improved with depth ranges from 0.36 to 3.48 inches and an average depth of 1.78 inches. The overall Basin 3 discharge from this condition was 75.57 cfs for the 25 year storm event and 68.52 cfs for the 10 year storm event, utilizing two 36" pipes for discharge into the Goodlette-Frank Canal. The discharge from this condition results in an increase of 750% and 726% for the 25 year and 10 year storm events, respectively.

During the 10 year – 3 day storm event under the max discharge condition the model showed no flooding throughout Basin 3. Table 8 below summarizes the results for the proposed condition – max discharge for both the 25 year and 10 year 3 day storm events.

Table 8: Basin 3 Proposed Condition - Max Discharge Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Proposed Condition - Max Discharge			Proposed Condition - Max Discharge		
Node ID	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)
B3-SB1A	11.80	12.08	No Flooding	11.53	12.08	No Flooding
B3-SB1B	11.32	11.42	No Flooding	10.79	11.42	No Flooding
B3-SB1C	11.35	11.42	No Flooding	10.81	11.42	No Flooding
B3-SB2A	11.70	12.08	No Flooding	11.44	12.08	No Flooding
B3-SB2B	10.56	10.56	No Flooding	10.24	10.56	No Flooding
B3-SB2C	10.44	10.32	1.44	10.15	10.32	No Flooding
B3-SB2D	10.61	10.32	3.48	10.32	10.32	No Flooding
B3-SB2E	10.69	10.59	1.2	10.41	10.59	No Flooding
B3-SB3A	11.49	11.84	No Flooding	11.10	11.84	No Flooding
B3-SB3B	11.18	11.42	No Flooding	10.69	11.42	No Flooding
B3-SB3C	10.84	10.56	3.36	10.44	10.56	No Flooding
B3-SB3D	10.35	10.32	0.36	10.06	10.32	No Flooding
B3-SB3E	10.66	10.59	0.84	10.45	10.59	No Flooding
GFC	6.75	6.75	No Flooding	6.75	6.75	No Flooding
		Max Flood Depht (in)	3.48		Max Flood Depht (in)	0
		Min Flood Depth (in)	0.36		Min Flood Depth (in)	0
		Average Flood Depth (in)	1.78		Average Flood Depth (in)	0
		Sub-Basins Flooded	6		Sub-Basins Flooded	0

The Proposed Condition – Same Discharge Structure ICPR model produced significantly higher levels of flooding within the basin. Using the optimal pipe sizes for conveyance and like size 18 inch discharge pipe. The ICPR model results summary can be seen in Table 9 below. The 25 year – 3 day storm event generated flooding in 10 Sub-Basins with a flooding range of 1.44 to 12.72 inches of flooding with

an average of 8.34 inches. The 10 year- 3 day storm event model showed flooding to 7 Sub-Basins ranging from 6.72 to 9.96 inches with an average of 8.26 inches.

Overall under this condition, Basin 3 produced a discharge rate of 11.09 cfs for the 25 year storm event and 10.74 cfs for the 10 year storm event using discharge through the existing 18" pipe. This is an increase of 25% for the 25 year storm event and 29% for the 10 year storm event.

Table 9: Basin 3 Proposed Condition - Same Discharge Structure Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Proposed Condition - Same Discharge Structure			Proposed Condition - Same Discharge Structure		
Node ID	Max Stage (ft)	Warning Stage (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Warning Stage (ft)	Depth at Crown of Road (in)
B3-SB1A	11.99	12.08	No Flooding	11.59	12.08	No Flooding
B3-SB1B	11.62	11.42	2.4	11.35	11.42	No Flooding
B3-SB1C	11.63	11.42	2.52	11.36	11.42	No Flooding
B3-SB2A	11.67	12.08	No Flooding	11.43	12.08	No Flooding
B3-SB2B	11.37	10.56	9.72	11.15	10.56	7.08
B3-SB2C	11.37	10.32	12.6	11.15	10.32	9.96
B3-SB2D	11.38	10.32	12.72	11.15	10.32	9.96
B3-SB2E	11.38	10.59	9.48	11.15	10.59	6.72
B3-SB3A	11.77	11.84	No Flooding	11.42	11.84	No Flooding
B3-SB3B	11.54	11.42	1.44	11.27	11.42	No Flooding
B3-SB3C	11.43	10.56	10.44	11.18	10.56	7.44
B3-SB3D	11.37	10.32	12.6	11.15	10.32	9.96
B3-SB3E	11.38	10.59	9.48	11.15	10.59	6.72
GFC	6.75	6.75	No Flooding	6.75	6.75	No Flooding
		Max Flood Depht (in)	12.72		Max Flood Depht (in)	9.96
		Min Flood Depth (in)	1.44		Min Flood Depth (in)	6.72
		Average Flood Depth (in)	8.34		Average Flood Depth (in)	8.26
		Sub-Basins Flooded	10		Sub-Basins Flooded	7

3.4.5 RECOMMENDATIONS

After analyzing and comparing the existing conditions to both proposed conditions, we recommend that in addition to regrading and excavating of the roadside swales to provide a minimal level of storage in the system, improvements to roadway interconnects and driveway culverts be upsized to the maximum extent to meet the current demands. Since this is the smallest basin and there is no ability to store in a lake or ditch other than the roadside ditches, we recommend that the max discharge condition be utilized for this basin. This results in twin 36" discharge pipes to the Goodlette-Frank Canal. These proposed changes are projected to have an initial cost of $644,000. Detailed cost information is included in Appendix D.

Since the existing and proposed drainage is through private property, it is recommended that sufficient easements be obtained.

3.5 BASIN 4

3.5.1 LOCATION

Basin 4 is a smaller basin within the Pine Ridge Subdivision. It is located south of Basins 2 and 3 and is generally bounded by Ridge Drive to the south, West Street to the west, and Goodlette-Frank Road to the east. Figure 4 illustrates the Basin 4 boundary.

Figure 4: Basin 4 Boundary

3.5.2 SPECIFIC ASSUMPTIONS

In addition to the general assumptions listed in Section 1.4 of this report, the following is a list of specific assumptions that were made for Basin 4:

- Drainage from the south side of Carica Road that discharges into the Goodlette-Frank Canal travels north through two 48 inch pipes under the Carica Road sidewalk connection to Goodlette-Frank Road and continues north along the canal. Because there was no flow data for this canal, it was assumed that the existing pipes along the canal will meet proposed flows.
- Drainage pipe upsizing was restricted on driveway culverts to a maximum size of 30 inches when

using two pipes.

- No interconnects across Ridge Drive to Basin 5 were proposed due to the size of Basin 5.

3.5.3 EXISTING CONDITIONS

The total area for Basin 4 is approximately 74.81 acres and the existing topography from the crown of road ranges from 17.92 to 12.54 FT NAVD. Basin 4 is composed of 20 Sub-Basins which are shown in Appendix B. The drainage backbone for this basin is composed of road side swales which convey all drainage towards the south end of Carica Road. The road side swale at the end of Carica Road discharges directly to the Goodlette-Frank Canal. Discharge from the south side of Carica Road flows north in the Goodlette-Frank Canal through two existing 48 inch pipes. Based on the assumptions listed above, both drainage pipes within the canal were not included in the modeling efforts. For modeling purposes, the driveway culverts at the south end of Carica Road will be modeled as the discharge structures for this basin.

Based on various field visits it was determined that approximately 12.5% or 1,720 LF of road side swales for this basin have been filled which do not provide adequate conveyance and storage to the system. Using the assumptions described in Section 1.4 and 3.2.1 above an ICPR model of the existing conditions was created as a benchmark to evaluate the proposed improvement.

The existing condition ICPR model summary for both the 25 year – 3 day and 10 year – 3 day storm events can be seen in Table 10 below. The model for the 25 year storm event showed flooding in 18 Sub-Basins that ranged from 1.56 to 16.20 inches above crown of road with an average flood depth of 6.93 inches. The 10 year – 3 day storm event resulted in flooding in 15 Sub-Basins. However, flooding from that storm event ranged from 0.48 to 13.32 inches with an average flood depth of 5.34 inches.

Table 10: Basin 4 Existing Conditions Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Existing Condition			Existing Condition		
Node ID	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)
B4-SB1A	17.00	16.61	4.68	16.77	16.61	1.92
B4-SB1B	16.69	16.19	6	16.49	16.19	3.6
B4-SB1C	16.00	15.57	5.16	15.81	15.57	2.88
B4-SB1D	15.19	14.15	12.48	14.95	14.15	9.6
B4-SB1E	15.19	14.42	9.24	14.95	14.42	6.36
B4-SB2A	14.63	14.29	4.08	14.43	14.29	1.68
B4-SB2B	14.52	14.15	4.44	14.32	14.15	2.04
B4-SB3A	14.01	13.08	11.16	13.72	13.08	7.68
B4-SB3B	12.99	12.54	5.4	12.81	12.54	3.24
B4-SB3C	14.31	12.96	16.2	14.07	12.96	13.32
B4-SB3D	14.90	13.76	13.68	14.65	13.76	10.68
B4-SB3E	14.90	14.70	2.4	14.65	14.70	No Flooding
B4-SB3F	14.05	14.71	No Flooding	13.82	14.71	No Flooding
B4-SB3G	14.03	13.90	1.56	13.74	13.90	No Flooding
B4-SB4A	12.67	12.54	1.56	12.46	12.54	No Flooding
B4-SB4B	13.59	12.96	7.56	13.39	12.96	5.16
B4-SB4C	14.44	13.37	12.84	14.23	13.37	10.32
B4-SB4D	14.46	14.15	3.72	14.25	14.15	1.2
B4-SB5A	12.29	12.54	No Flooding	12.11	12.54	No Flooding
B4-SB6A	12.75	12.54	2.52	12.58	12.54	0.48
GFC	6.75	6.75	No Flooding	6.75	6.75	No Flooding
		Max Flood Depht (in)	16.2		Max Flood Depht (in)	13.32
		Min Flood Depth (in)	1.56		Min Flood Depth (in)	0.48
		Average Flood Depth (in)	6.93		Average Flood Depth (in)	5.34
		Sub-Basins Flooded	18		Sub-Basins Flooded	15

3.5.4 PROPOSED CONDITIONS

Basin 4 ICPR models for the Max Discharge condition and the Same Discharge Structure condition were evaluated. The proposed condition with Max Discharge showed improvements to flooding areas and depths for both the 25 year – 3 day and the 10 year – 3 day storm events. During the 25 year storm event 7 Sub-Basins showed flooding compared to 18 Sub-basins from the existing conditions model. The overall flooding depth also improved with depth ranges from 0.12 to 4.56 inches with an average depth of 1.80 inches. The overall Basin 4 discharge from this condition was 103.35 cfs for the 25 year storm event and 90.84 cfs for the 10 year storm event, utilizing two 30" pipes for the driveways at the end of Carica Road that serve as the discharge into the Goodlette-Frank Canal. The discharge from this condition results in an increase of 393% and 354% for the 25 year and 10 year storm events.

During the 10 year – 3 day storm event under the max discharge condition the model showed flooding in 2 Sub-Basins throughout Basin 4. The max flood depth ranged from 0.24 to 0.60 inches over the crown of the road. The average flood depth for the Sub-Basins was 0.42 inches. Table 11 below summarizes the results for the proposed condition – max discharge for both the 25 year and 10 year - 3 day storm events.

Table 11: Basin 4 Proposed Condition - Max Discharge Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Proposed Condition - Max Discharge			Proposed Condition - Max Discharge		
Node ID	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)
B4-SB1A	16.62	16.61	0.12	16.36	16.61	No Flooding
B4-SB1B	16.09	16.19	No Flooding	15.60	16.19	No Flooding
B4-SB1C	15.48	15.57	No Flooding	15.16	15.57	No Flooding
B4-SB1D	13.96	14.15	No Flooding	13.62	14.15	No Flooding
B4-SB1E	14.37	14.42	No Flooding	14.02	14.42	No Flooding
B4-SB2A	14.34	14.29	0.6	13.92	14.29	No Flooding
B4-SB2B	14.08	14.15	No Flooding	13.69	14.15	No Flooding
B4-SB3A	12.75	13.08	No Flooding	12.35	13.08	No Flooding
B4-SB3B	12.65	12.54	1.32	12.29	12.54	No Flooding
B4-SB3C	12.98	12.96	0.24	12.50	12.96	No Flooding
B4-SB3D	13.24	13.76	No Flooding	12.77	13.76	No Flooding
B4-SB3E	14.23	14.70	No Flooding	13.96	14.70	No Flooding
B4-SB3F	14.37	14.71	No Flooding	14.10	14.71	No Flooding
B4-SB3G	13.53	13.90	No Flooding	12.82	13.90	No Flooding
B4-SB4A	12.71	12.54	2.04	12.45	12.54	No Flooding
B4-SB4B	13.27	12.96	3.72	12.98	12.96	0.24
B4-SB4C	13.75	13.37	4.56	13.42	13.37	0.6
B4-SB4D	14.11	14.15	No Flooding	13.76	14.15	No Flooding
B4-SB5A	12.43	12.54	No Flooding	12.19	12.54	No Flooding
B4-SB6A	12.25	12.54	No Flooding	11.98	12.54	No Flooding
GFC	6.75	6.75	No Flooding	6.75	6.75	No Flooding
		Max Flood Depht (in)	4.56		Max Flood Depht (in)	0.6
		Min Flood Depth (in)	0.12		Min Flood Depth (in)	0.24
		Average Flood Depth (in)	1.80		Average Flood Depth (in)	0.42
		Sub-Basins Flooded	7		Sub-Basins Flooded	2

The Proposed Conditions - Same Discharge Structure scenario for Basin 4 was modeled to use similar pipe sizes for the driveway culverts at the south end of Carica Road that function as the last control prior to discharge into the Goodlette-Frank Canal. The model for this scenario produced the results summarized in Table 12 below. For the 25 year – 3 day storm event 16 Sub-Basins showed flooding which ranged from 0.12 to 16.56 inches above the crown of road, with an average flood depth of 7.28 inches. The 10 year - 3 day storm event showed flooding within 8 Sub-Basins with a flood depth ranging from 5.04 to 12.96 inches above the crown of the road, with an average of 9.86 inches. The 10 year storm event showed less flooding upstream but the same downstream Sub-Basins remained flooded which resulted in a higher average. During this scenario, the discharge from Basin 4 during the 25 year and 10 year storm event resulted in 22.60 cfs and 21.59 cfs respectively which is an increase of 8% from the existing conditions discharge for both events.

Table 12: Basin 4 Proposed Condition - Same Discharge Structure Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Proposed Condition - Same Discharge Structure			Proposed Condition - Same Discharge Structure		
Node ID	Max Stage (ft)	Warning Stage (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Warning Stage (ft)	Depth at Crown of Road (in)
B4-SB1A	16.62	16.61	0.12	16.36	16.61	No Flooding
B4-SB1B	16.09	16.19	No Flooding	15.6	16.19	No Flooding
B4-SB1C	15.48	15.57	No Flooding	15.16	15.57	No Flooding
B4-SB1D	14.25	14.15	1.2	13.86	14.15	No Flooding
B4-SB1E	14.47	14.42	0.6	14.06	14.42	No Flooding
B4-SB2A	14.41	14.29	1.44	14.1	14.29	No Flooding
B4-SB2B	14.25	14.15	1.2	13.93	14.15	No Flooding
B4-SB3A	13.90	13.08	9.84	13.61	13.08	6.36
B4-SB3B	13.90	12.54	16.32	13.6	12.54	12.72
B4-SB3C	13.92	12.96	11.52	13.62	12.96	7.92
B4-SB3D	13.94	13.76	2.16	13.64	13.76	No Flooding
B4-SB3E	14.25	14.70	No Flooding	13.95	14.70	No Flooding
B4-SB3F	14.39	14.71	No Flooding	14.1	14.71	No Flooding
B4-SB3G	13.99	13.90	1.08	13.63	13.90	No Flooding
B4-SB4A	13.92	12.54	16.56	13.62	12.54	12.96
B4-SB4B	13.99	12.96	12.36	13.68	12.96	8.64
B4-SB4C	14.11	13.37	8.88	13.79	13.37	5.04
B4-SB4D	14.22	14.15	0.84	13.96	14.15	No Flooding
B4-SB5A	13.90	12.54	16.32	13.6	12.54	12.72
B4-SB6A	13.88	12.54	16.08	13.58	12.54	12.48
GFC	6.75	6.75	No Flooding	6.75	6.75	No Flooding
		Max Flood Depht (in)	16.56		Max Flood Depht (in)	12.96
		Min Flood Depth (in)	0.12		Min Flood Depth (in)	5.04
		Average Flood Depth (in)	7.28		Average Flood Depth (in)	9.86
		Sub-Basins Flooded	16		Sub-Basins Flooded	8

3.5.5 RECOMMENDATIONS

From available information obtained by survey and field visits, all of the drainage flows and drains south to the end of Carica Road. This puts downstream Sub-Basins such as 4A and 3C at higher risk of flooding because conveyance along these basins must meet flows for the entire drainage area of 74.81 acres. Due to lack of available storage within Basin 4, it is recommended that the Max Discharge condition be used. Providing larger discharge pipes at the south end of Carica Road can significantly reduce the number of flooded sub-basins and magnitude of flooding when compared to the Same Discharge Structure condition. These proposed changes are projected to have an initial cost of $885,000. Detailed cost information is included in Appendix D.

3.6 BASIN 5

3.6.1 LOCATION

Basin 5 is the biggest basin within the study area. This basin is located between Center Street to the south, Trail Boulevard to the west, Ridge Road to the north (Basin 4), and Goodlette-Frank Road to the east. Figure 5 illustrates the Basin 5 boundary.

Figure 5: Basin 5 Boundary

3.6.2 SPECIFIC ASSUMPTIONS

In addition to the general assumptions listed in Section 1.4 of this report, the following is a list of specific assumptions that were made for Basin 5:

- Based on the existing conditions information obtained by survey and field visits, it was assumed that Trail Boulevard and lots along Trail Boulevard be removed from the drainage boundary. The information obtained showed that these areas drained to the US 41 drainage system which encompasses areas outside the scope of this project. The following area is not included within Basin 5; Trail Boulevard from Ridge Road to Center Street.
- Based on a South Florida Water Management District permit for the Covenant Presbyterian Church of Naples (Permit No. 11-03107-P; Application No. 130606-17), it was assumed that the property of the church and 12.7 acres of Low Density Single Family within West Place be removed from the drainage basin boundary. The permit shows that the drainage from the church and the single family area is captured and treated by the stormwater system at the church and then discharges to the north side of Myrtle Road with an ultimate discharge into Trail Boulevard and across US 41.
- Tailwater conditions for the Goodlette-Frank Canal were assumed to be the same as previous scenarios.
- Drainage pipe upsizing was restricted on driveway culverts to a maximum size of 30 inches when using two pipes and a maximum size of 36 inches using one pipe along property lines in-between lots.
- Based on the recent improvements to the interconnection pipe between the lakes in Basin 5, it is assumed that future improvements to these structures would not be required and therefore, the existing pipe sizes were utilized for this study.

3.6.3 EXISTING CONDITIONS

The boundary for Basin 5 was delineated using current aerials based on information obtained by survey data and current field conditions as shown in Figure 5 above. The total area for Basin 5 is approximately 313.38 acres and the existing topography from the crown of road ranges from 13.08 to 17.92 FT NAVD. Basin 5 is composed of 46 Sub-Basins which are shown in Appendix B. The drainage backbone for this basin is composed of road side swales which convey the drainage towards the two lakes within the basin, Lake 3 (Mockingbird Lake) and Lake 4 (Lake Egret) which are interconnected. Basin 5 discharges to the Goodlette-Frank Canal via an 18 inch pipe between Ridge Drive and the Canal.

Based on various field visits it was determined that approximately 24% or 10,195 LF of road side swales for this basin have been filled which do not provide adequate conveyance and storage to the

system. Using the assumptions described in Section 1.4 and 3.2.1 above an ICPR model of the existing conditions was created as a benchmark to evaluate the proposed improvement.

The existing condition ICPR model summary for both the 25 year – 3 day and 10 year – 3 day can be seen in Table 13 below. The model for the 25 year – 3 day storm event showed flooding in 38 Sub-Basins that ranged from 0.84 to 22.92 inches above crown of road with an average flood depth of 7.58 inches. The 10 year – 3 day storm event resulted in flooding in 33 Sub-Basins. However, flooding from that storm event ranged from 0.72 to 20.16 inches with an average flood depth of 5.84 inches.

Table 13: Basin 5 Existing Conditions Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Existing Condition			Existing Condition		
Node ID	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)
B5-SB10A	17.28	16.79	5.88	17.07	16.79	3.36
B5-SB10B	16.63	15.79	10.08	16.43	15.79	7.68
B5-SB10C	14.09	14.30	No Flooding	13.77	14.30	No Flooding
B5-SB11A	14.97	15.09	No Flooding	14.54	15.09	No Flooding
B5-SB11B	14.60	14.24	4.32	14.30	14.24	0.72
B5-SB11C	14.10	13.88	2.64	13.87	13.88	No Flooding
B5-SB11D	12.53	13.88	No Flooding	12.38	13.88	No Flooding
B5-SB1A	16.84	16.61	2.76	16.58	16.61	No Flooding
B5-SB1B	16.66	16.19	5.64	16.45	16.19	3.12
B5-SB1C	16.17	15.57	7.2	15.95	15.57	4.56
B5-SB1D	16.26	15.69	6.84	16.06	15.69	4.44
B5-SB1E	16.28	15.94	4.08	16.08	15.94	1.68
B5-SB2A	15.46	15.09	4.44	15.21	15.09	1.44
B5-SB2B	15.29	14.92	4.44	15.05	14.92	1.56
B5-SB2C	14.33	13.88	5.4	14.10	13.88	2.64
B5-SB2D	14.47	13.88	7.08	14.24	13.88	4.32
B5-SB2E	14.47	14.06	4.92	14.25	14.06	2.28
B5-SB3A	16.00	15.69	3.72	15.77	15.69	0.96
B5-SB3B	16.00	14.71	15.48	15.77	14.71	12.72
B5-SB3C	15.04	13.93	13.32	14.81	13.93	10.56
B5-SB3D	14.08	13.14	11.28	13.90	13.14	9.12
B5-SB3E	14.04	13.08	11.52	13.86	13.08	9.36
B5-SB4A	14.08	14.01	0.84	13.85	14.01	No Flooding
B5-SB4B	14.00	13.88	1.44	13.80	13.88	No Flooding
B5-SB4C	14.03	13.88	1.8	13.82	13.88	No Flooding
B5-SB5A	13.38	14.18	No Flooding	13.18	14.18	No Flooding
B5-SB5B	12.20	14.11	No Flooding	12.06	14.11	No Flooding
B5-SB5C	14.06	14.11	No Flooding	13.94	14.11	No Flooding
B5-SB6A	15.08	14.30	9.36	14.88	14.30	6.96
B5-SB6B	14.78	14.16	7.44	14.59	14.16	5.16
B5-SB6C	15.28	14.94	4.08	15.06	14.94	1.44
B5-SB6D	15.17	14.75	5.04	14.96	14.75	2.52
B5-SB7A	16.65	15.54	13.32	16.40	15.54	10.32
B5-SB7B	16.57	15.49	12.96	16.32	15.49	9.96
B5-SB7C	16.75	15.79	11.52	16.52	15.79	8.76
B5-SB7D	16.75	15.54	14.52	16.52	15.54	11.76
B5-SB8A	17.13	16.79	4.08	16.93	16.79	1.68
B5-SB8B	17.10	16.37	8.76	16.90	16.37	6.36
B5-SB8C	17.58	17.28	3.6	17.38	17.28	1.2
B5-SB8D	17.18	16.85	3.96	17.00	16.85	1.8
B5-SB9A	17.10	16.37	8.76	16.90	16.37	6.36
B5-SB9B	16.49	15.49	12	16.25	15.49	9.12
B5-SB9C	16.07	14.16	22.92	15.84	14.16	20.16
B5-SB9D	14.12	13.23	10.68	13.96	13.23	8.76
B5-SB9E	9.92	13.08	No Flooding	9.27	13.08	No Flooding
GFC	6.75	6.75	No Flooding	6.75	6.75	No Flooding
LAKE BASIN 3	10.00	13.08	No Flooding	9.15	13.08	No Flooding
LAKE BASIN 4	10.17	13.88	No Flooding	9.23	13.88	No Flooding
		Max Flood Depht (in)	22.92		Max Flood Depht (in)	20.16
		Min Flood Depth (in)	0.84		Min Flood Depth (in)	0.72
		Average Flood Depth (in)	7.58		Average Flood Depth (in)	5.84
		Sub-Basins Flooded	38		Sub-Basins Flooded	33

3.6.4 PROPOSED CONDITIONS

Basin 5 ICPR models for the Max Discharge condition and the Same Discharge Structure condition were evaluated.

The proposed condition with Max Discharge showed improvements to flooding areas and depths for both the 25 year – 3 day and the 10 year – 3 day storm events. During the 25 year storm event, 25 Sub-Basins showed flooding compared to 38 sub-basins from the existing conditions model. The overall flooding depth also improved, depth ranges from 0.48 to 10.08 inches with an average depth of 4.03 inches. The overall discharge from this condition was 48.96 cfs for the 25 year storm event and 48.58 cfs for the 10 year storm event, utilizing one 36" pipe from Mockingbird Lake into the Goodlette-Frank Canal. The discharge from this condition results in an increase of 297% and 369% for the 25 year and 10 year storm events, respectively.

During the 10 year – 3 day storm event under the max discharge condition the model showed flooding in 12 Sub-Basins throughout Basin 5. The max flood depth ranged from 0.24 to 6.36 inches over the crown of the road with an average flood depth of 2.72 inches. Table 14 summarizes the results for the proposed condition – max discharge for both the 25 year and 10 year 3 day storm events.

Table 14: Basin 5 Proposed Condition - Max Discharge Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Proposed Condition - Max Discharge			Proposed Condition - Max Discharge		
Node ID	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)
B5-SB10A	16.76	16.79	No Flooding	16.14	16.79	No Flooding
B5-SB10B	15.93	15.79	1.68	15.51	15.79	No Flooding
B5-SB10C	14.51	14.30	2.52	14.28	14.30	No Flooding
B5-SB11A	14.57	15.09	No Flooding	14.22	15.09	No Flooding
B5-SB11B	14.36	14.24	1.44	13.95	14.24	No Flooding
B5-SB11C	13.92	13.88	0.48	13.58	13.88	No Flooding
B5-SB11D	13.50	13.88	No Flooding	13.26	13.88	No Flooding
B5-SB1A	16.05	16.61	No Flooding	15.82	16.61	No Flooding
B5-SB1B	15.34	16.19	No Flooding	14.96	16.19	No Flooding
B5-SB1C	15.04	15.57	No Flooding	14.66	15.57	No Flooding
B5-SB1D	15.36	15.69	No Flooding	14.92	15.69	No Flooding
B5-SB1E	15.50	15.94	No Flooding	15.09	15.94	No Flooding
B5-SB2A	14.91	15.09	No Flooding	14.61	15.09	No Flooding
B5-SB2B	14.77	14.92	No Flooding	14.51	14.92	No Flooding
B5-SB2C	14.26	13.88	4.56	14.03	13.88	1.8
B5-SB2D	14.26	13.88	4.56	14.03	13.88	1.8
B5-SB2E	14.29	14.06	2.76	14.05	14.06	No Flooding
B5-SB3A	14.93	15.69	No Flooding	14.73	15.69	No Flooding
B5-SB3B	14.49	14.71	No Flooding	14.07	14.71	No Flooding
B5-SB3C	14.22	13.93	3.48	13.85	13.93	No Flooding
B5-SB3D	13.98	13.14	10.08	13.67	13.14	6.36
B5-SB3E	13.74	13.08	7.92	13.48	13.08	4.8
B5-SB4A	14.18	14.01	2.04	13.95	14.01	No Flooding
B5-SB4B	14.11	13.88	2.76	13.90	13.88	0.24
B5-SB4C	14.20	13.88	3.84	13.98	13.88	1.2
B5-SB5A	14.56	14.18	4.56	14.34	14.18	1.92
B5-SB5B	14.45	14.11	4.08	14.23	14.11	1.44
B5-SB5C	14.51	14.11	4.8	14.27	14.11	1.92
B5-SB6A	14.85	14.30	6.6	14.60	14.30	3.6
B5-SB6B	14.67	14.16	6.12	14.38	14.16	2.64
B5-SB6C	15.12	14.94	2.16	14.84	14.94	No Flooding
B5-SB6D	15.04	14.75	3.48	14.68	14.75	No Flooding
B5-SB7A	15.36	15.54	No Flooding	15.02	15.54	No Flooding
B5-SB7B	15.57	15.49	0.96	15.25	15.49	No Flooding
B5-SB7C	15.87	15.79	0.96	15.46	15.79	No Flooding
B5-SB7D	15.92	15.54	4.56	15.54	15.54	No Flooding
B5-SB8A	16.18	16.79	No Flooding	15.72	16.79	No Flooding
B5-SB8B	16.14	16.37	No Flooding	15.72	16.37	No Flooding
B5-SB8C	17.06	17.28	No Flooding	16.38	17.28	No Flooding
B5-SB8D	16.51	16.85	No Flooding	15.98	16.85	No Flooding
B5-SB9A	16.13	16.37	No Flooding	15.72	16.37	No Flooding
B5-SB9B	15.22	15.49	No Flooding	14.91	15.49	No Flooding
B5-SB9C	14.59	14.16	5.16	14.13	14.16	No Flooding
B5-SB9D	14.00	13.23	9.24	13.64	13.23	4.92
B5-SB9E	12.60	13.08	No Flooding	12.51	13.08	No Flooding
GFC	6.75	6.75	No Flooding	6.75	6.75	No Flooding
LAKE BASIN 3	10.11	13.08	No Flooding	9.07	13.08	No Flooding
LAKE BASIN 4	10.47	13.88	No Flooding	9.26	13.88	No Flooding
		Max Flood Depht (in)	10.08		Max Flood Depht (in)	6.36
		Min Flood Depth (in)	0.48		Min Flood Depth (in)	0.24
		Average Flood Depth (in)	4.03		Average Flood Depth (in)	2.72
		Sub-Basins Flooded	25		Sub-Basins Flooded	12

The Proposed Condition – Same Discharge Structure scenario for Basin 5 utilizes an 18 inch discharge pipe. The ICPR model for this scenario is summarized in Table 15 below. For the 25 year – 3 day storm event 26 Sub-Basins showed flooding which ranged from 0.48 to 12.48 inches above the crown of road, with an average flood depth of 4.33 inches. The 10 year-3 day storm event showed flooding within 14 Sub-Basins with a flood depth ranging from 0.24 to 9.00 inches above the crown of the road and an average of 3.07 inches. During this scenario, the discharge from Basin 5 during the 25 year and 10 year storm event resulted in 22.17 cfs and 21.55 cfs, respectively. The discharge rate for this scenario

increased 80% for the 25 year event and 108% for the 10 year event.

Table 15: Basin 5 Proposed Condition - Same Discharge Structure Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Proposed Condition - Same Discharge Structure			Proposed Condition - Same Discharge Structure		
Node ID	Max Stage (ft)	Warning Stage (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Warning Stage (ft)	Depth at Crown of Road (in)
B5-SB10A	16.76	16.79	No Flooding	16.14	16.79	No Flooding
B5-SB10B	15.93	15.79	1.68	15.51	15.79	No Flooding
B5-SB10C	14.51	14.30	2.52	14.28	14.30	No Flooding
B5-SB11A	14.57	15.09	No Flooding	14.22	15.09	No Flooding
B5-SB11B	14.36	14.24	1.44	13.95	14.24	No Flooding
B5-SB11C	13.92	13.88	0.48	13.58	13.88	No Flooding
B5-SB11D	13.50	13.88	No Flooding	13.26	13.88	No Flooding
B5-SB1A	16.05	16.61	No Flooding	15.82	16.61	No Flooding
B5-SB1B	15.34	16.19	No Flooding	14.96	16.19	No Flooding
B5-SB1C	15.04	15.57	No Flooding	14.66	15.57	No Flooding
B5-SB1D	15.36	15.69	No Flooding	14.92	15.69	No Flooding
B5-SB1E	15.50	15.94	No Flooding	15.09	15.94	No Flooding
B5-SB2A	14.91	15.09	No Flooding	14.61	15.09	No Flooding
B5-SB2B	14.77	14.92	No Flooding	14.51	14.92	No Flooding
B5-SB2C	14.26	13.88	4.56	14.03	13.88	1.8
B5-SB2D	14.26	13.88	4.56	14.03	13.88	1.8
B5-SB2E	14.29	14.06	2.76	14.05	14.06	No Flooding
B5-SB3A	14.93	15.69	No Flooding	14.73	15.69	No Flooding
B5-SB3B	14.49	14.71	No Flooding	14.07	14.71	No Flooding
B5-SB3C	14.22	13.93	3.48	13.85	13.93	No Flooding
B5-SB3D	13.98	13.14	10.08	13.67	13.14	6.36
B5-SB3E	13.74	13.08	7.92	13.48	13.08	4.8
B5-SB4A	14.18	14.01	2.04	13.95	14.01	No Flooding
B5-SB4B	14.11	13.88	2.76	13.90	13.88	0.24
B5-SB4C	14.20	13.88	3.84	13.98	13.88	1.2
B5-SB5A	14.58	14.18	4.8	14.36	14.18	2.16
B5-SB5B	14.47	14.11	4.32	14.25	14.11	1.68
B5-SB5C	14.54	14.11	5.16	14.30	14.11	2.28
B5-SB6A	14.86	14.30	6.72	14.61	14.30	3.72
B5-SB6B	14.72	14.16	6.72	14.43	14.16	3.24
B5-SB6C	15.13	14.94	2.28	14.84	14.94	No Flooding
B5-SB6D	15.07	14.75	3.84	14.68	14.75	No Flooding
B5-SB7A	15.35	15.54	No Flooding	15.03	15.54	No Flooding
B5-SB7B	15.53	15.49	0.48	15.24	15.49	No Flooding
B5-SB7C	15.86	15.79	0.84	15.46	15.79	No Flooding
B5-SB7D	15.91	15.54	4.44	15.54	15.54	No Flooding
B5-SB8A	16.18	16.79	No Flooding	15.72	16.79	No Flooding
B5-SB8B	16.14	16.37	No Flooding	15.72	16.37	No Flooding
B5-SB8C	17.06	17.28	No Flooding	16.38	17.28	No Flooding
B5-SB8D	16.51	16.85	No Flooding	15.98	16.85	No Flooding
B5-SB9A	16.13	16.37	No Flooding	15.72	16.37	No Flooding
B5-SB9B	15.23	15.49	No Flooding	14.90	15.49	No Flooding
B5-SB9C	14.71	14.16	6.6	14.34	14.16	2.16
B5-SB9D	14.27	13.23	12.48	13.98	13.23	9
B5-SB9E	13.56	13.08	5.76	13.29	13.08	2.52
GFC	6.75	6.75	No Flooding	6.75	6.75	No Flooding
LAKE BASIN 3	10.68	13.08	No Flooding	9.48	13.08	No Flooding
LAKE BASIN 4	10.78	13.88	No Flooding	9.52	13.88	No Flooding
		Max Flood Depht (in)	12.48		Max Flood Depht (in)	9
		Min Flood Depth (in)	0.48		Min Flood Depth (in)	0.24
		Average Flood Depth (in)	4.33		Average Flood Depth (in)	3.07
		Sub-Basins Flooded	26		Sub-Basins Flooded	14

3.6.5 RECOMMENDATIONS

Basin 5 is the largest basin within the Pine Ridge Subdivision with approximately 313.38 total acres. However, of that total acreage approximately 31.71 acres is lake area which provides significant storm water storage for the basin. For Basin 5 the Proposed Condition – Same Discharge structure is recommended because of the available storage from both lakes and the uncertainty related to

downstream effects. Please refer to the assumptions regarding Basin 5. Using the same discharge from Lake 3 to the Goodlette-Frank Canal does not significantly increase the flooding within the basin. However, using the same discharge structure significantly limits the amount of discharge when compared to the Max Discharge Condition which shows a discharge of 43.8 cfs and 39.29 cfs for the 25 year and 10 year storm events versus the Same Discharge Condition of 10.75 cfs and 10.51 cfs for the same storm events. Reducing the amount of discharge from the basin will reduce the impacts to downstream tail water conditions within the Goodlette-Frank Canal. These proposed changes are projected to have an initial cost of $2,972,000. Detailed cost information is included in Appendix D.

3.7 BASIN 6

3.7.1 LOCATION

Basin 6 is the southernmost basin within the Study Area. It is located south of Basin 5 and Center Street to the north, US 41 to the west, Pine Ridge Road to the south, and Goodlette-Frank Road to the east. Figure 6 illustrates the Basin 6 boundary.

Figure 6: Basin 6 Boundary

3.7.2 SPECIFIC ASSUMPTIONS

In addition to the general assumptions listed in Section 1.4 of this report, the following is a list of specific assumptions that were made for Basin 6:

- Several areas were removed from consideration for inclusion in the Basin 6 boundary based on the existing conditions information obtained by survey and field visits. The information obtained showed that these areas drained to systems that encompassed areas outside the scope of this project. The following areas that were removed include; Ridge Drive west of Caribbean Road, Center Street west of West Street, and Trail Boulevard.
- Based on existing conditions information and field visits, there appears to be no evidence of conveyance from the road side swales to the lakes within Basin 6. It is assumed that both lakes within the basin receive only rear lot drainage and discharge beyond the basin boundaries. Therefore, the lakes and applicable rear lot areas have been removed from the study.
- There are two discharges to Basin 6. The first discharge is to the east through a combination of overland flow and piped segments into the Goodlette-Frank Road stormwater system which ultimately drains to the south. Due to significant changes in the geometry of the canal on the west side of Goodlette-Frank Road an assumed tail water was used that ranged between the existing grade elevation of 11.45 ft. NAVD and one foot (1 ft.) above that existing grade. These numbers were extrapolated along a hydrograph curve to estimate a tailwater condition.
- Stormwater conveyance currently provided through private property will remain. Conveyance is currently provided through 110 Ridge Drive via a swale along the northern property line. This conveyance provides the discharge from the majority of Basin 6.
- The southern section of the basin including Caribbean Road and East Avenue drain toward the existing Pine Ridge Road stormwater system, which is the second discharge point for this basin. The Pine Ridge Road system then drains into the Goodlette-Frank Road system to the south, which is the same location where the northern portion of Basin 6 drains. Due to limited information on the functioning of the Pine Ridge Road stormwater system, the tailwater condition was assumed to range between the invert and top of pipe of the receiving storm pipe along the north side of Pine Ridge Road.
- Drainage pipe upsizing was restricted on driveway culverts to a maximum size of 24 inches when using two pipes and 30 inches for a single culvert. Sub-Basin interconnection piping was

restricted to a maximum size of 36 inches when using two pipes.

3.7.3 EXISTING CONDITIONS

The total area for Basin 6 is approximately 145.62 acres and the existing topography from the crown of road ranges from 18.30 to 15.62 FT NAVD. Basin 6 is composed of 31 Sub-Basins which are shown in Appendix B. The drainage backbone for this basin is composed of road side swales which convey the drainage towards both the Pine Ridge Road Stormwater System and the discharge swale located on 110 Ridge Drive. The cross section for the discharge swale is shown in Appendix C.

Based on various field visits it was determined that approximately 37.1% or 7,832 LF of road side swales for this basin have been filled which do not provide adequate conveyance and storage to the system. Using the assumptions described in Section 1.4 and 3.2.1 above an ICPR model of the existing conditions was created as a benchmark to evaluate the proposed improvement.

Based on the existing condition ICPR model summary for both the 25 year – 3 day and 10 year – 3 day storm events can be seen in Table 16 below. The model for the 25 year storm event showed flooding in 20 Sub-Basins that ranged from 0.48 to 23.16 inches above crown of road with an average flood depth of 5.88 inches. The 10 year – 3 day storm event resulted in flooding in 15 Sub-Basins. However, flooding from that storm event ranged from 0.12 to 19.44 inches with an average flood depth of 4.64 inches.

During the study period there were two instances where water appeared to be flowing northward along Goodlette-Frank Road, instead of to the south as the current plans show. It is possible that during heavy rain events, the swale along Goodlette-Frank can store water prior to it entering the stormwater system and it may have appeared to be flowing toward the north. More detailed review of the capacity of the inlets and piping along this section of Goodlette-Frank is needed to confirm the assumptions listed in this report and that flow continues to the south.

Table 16: Basin 6 Existing Conditions Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Existing Condition			Existing Condition		
Node ID	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)
B6-SB1A	16.95	16.76	2.28	16.57	16.76	No Flooding
B6-SB1B	16.75	16.66	1.08	16.36	16.66	No Flooding
B6-SB1C	16.34	16.66	No Flooding	15.96	16.66	No Flooding
B6-SB1D	14.93	15.69	No Flooding	14.79	15.69	No Flooding
B6-SB1E	16.20	15.69	6.12	16.01	15.69	3.84
B6-SB1F	17.14	16.49	7.8	16.90	16.49	4.92
B6-SB1G	17.79	17.75	0.48	17.53	17.75	No Flooding
B6-SB1H	18.35	17.92	5.16	18.15	17.92	2.76
B6-SB1I	18.49	17.78	8.52	18.30	17.78	6.24
B6-SB1J	18.48	18.05	5.16	18.29	18.05	2.88
B6-SB2A	17.91	17.80	1.32	17.59	17.80	No Flooding
B6-SB2B	17.33	16.59	8.88	17.10	16.59	6.12
B6-SB2C	16.06	15.84	2.64	15.84	15.84	No Flooding
B6-SB2D	14.87	15.69	No Flooding	14.74	15.69	No Flooding
B6-SB2E	17.13	16.49	7.68	16.84	16.49	4.2
B6-SB2F	17.67	17.75	No Flooding	17.34	17.75	No Flooding
B6-SB3A	17.79	17.30	5.88	17.48	17.30	2.16
B6-SB3B	17.77	15.84	23.16	17.46	15.84	19.44
B6-SB3C	14.61	15.69	No Flooding	14.50	15.69	No Flooding
B6-SB3D	16.33	15.69	7.68	16.09	15.69	4.8
B6-SB3E	16.87	16.89	No Flooding	16.49	16.89	No Flooding
B6-SB4A	17.64	17.00	7.68	17.48	17.00	5.76
B6-SB4B	17.51	17.00	6.12	17.35	17.00	4.2
B6-SB4C	15.32	17.00	No Flooding	15.22	17.00	No Flooding
B6-SB5A	17.27	17.00	3.24	17.06	17.00	0.72
B6-SB5B	16.44	17.00	No Flooding	16.14	17.00	No Flooding
B6-SB5C	14.99	17.00	No Flooding	14.68	17.00	No Flooding
B6-SB6A	18.46	18.28	2.16	18.29	18.28	0.12
B6-SB6B	16.45	16.07	4.56	16.19	16.07	1.44
B6-SB7A	17.94	18.28	No Flooding	17.64	18.28	No Flooding
B6-SB7B	15.31	16.07	No Flooding	14.78	16.07	No Flooding
GFC	12.45	14.00	No Flooding	12.45	14.00	No Flooding
PRD	12.36	12.36	No Flooding	12.36	12.36	No Flooding
		Max Flood Depht (in)	23.16		Max Flood Depht (in)	19.44
		Min Flood Depth (in)	0.48		Min Flood Depth (in)	0.12
		Average Flood Depth (in)	5.88		Average Flood Depth (in)	4.64
		Sub-Basins Flooded	20		Sub-Basins Flooded	15

3.7.4 PROPOSED CONDITIONS

Basin 6 ICPR models were evaluated for a Max Discharge condition with alternatives for the open swale or pipe discharge. The other condition that was evaluated was the Same Discharge Structure condition.

The Proposed Condition-Max Discharge open swale alternative scenario showed significant improvements to the flooding areas and depths for the 25 year and 10 year, 3 day storm events. The discharge swale was assumed to be consistent for both the existing and both proposed conditions. However, for the Max Discharge scenario pipe sizes within the roadway interconnects and the discharge pipes to the Pine Ridge Road Stormwater System where optimized producing greater discharge flows, thus reducing flooding.

The proposed condition with Max Discharge showed improvements to flooding areas and depths

for both the 25 year – 3 day and the 10 year – 3 day storm events. During the 25 year storm event 13 Sub-Basins showed flooding. The overall flooding depth also improved, depth ranges from 0.12 to 6.96 inches with and average depth of 2.13 inches. The overall Basin 6 discharge from this condition was 138.54 cfs to the Goodlette-Frank system and 87.47 cfs to the Pine Ridge stormwater system for the 25 year storm event and 114.31 cfs to the Goodlette-Frank system and 72.32 cfs to the Pine Ridge stormwater system for the 10 year storm event, utilizing one 30“ discharge pipe on each side of East Avenue and the east side of Caribbean Road, and one 24” discharge pipe on the west side of Caribbean Road. The discharge from this condition showed an increase to the Goodlette-Frank system of 73% and 60% for the 25 year and 10 year, 3 day storm events. The Pine Ridge Road stormwater system showed an increase of 75% and 64% for the 25 year and 10 year - 3 day storm events.

During the 10 year – 3 day storm event under the max discharge condition the model showed flooding in 4 Sub-Basins throughout Basin 6. The max flood depth ranged from 0.12 to 2.76 inches over the crown of the road. The average flood depth for the Sub-Basins was 1.50 inches. Table 17 below summarizes the results for the Proposed Condition - Max Discharge scenario for both the 25 year and 10 year - 3 day storm events.

Table 17: Basin 6 Proposed Condition - Max Discharge (Swale Alt.) Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Proposed Condition - Max Discharge (Swale Alt.)			Proposed Condition - Max Discharge (Swale Alt.)		
Node ID	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)
B6-SB1A	16.79	16.76	0.36	16.36	16.76	No Flooding
B6-SB1B	16.65	16.66	No Flooding	16.25	16.66	No Flooding
B6-SB1C	16.30	16.66	No Flooding	16.00	16.66	No Flooding
B6-SB1D	15.93	15.69	2.88	15.65	15.69	No Flooding
B6-SB1E	16.27	15.69	6.96	15.92	15.69	2.76
B6-SB1F	16.55	16.49	0.72	16.12	16.49	No Flooding
B6-SB1G	17.38	17.75	No Flooding	17.14	17.75	No Flooding
B6-SB1H	17.94	17.92	0.24	17.52	17.92	No Flooding
B6-SB1I	17.79	17.78	0.12	17.42	17.78	No Flooding
B6-SB1J	17.98	18.05	No Flooding	17.55	18.05	No Flooding
B6-SB2A	17.49	17.80	No Flooding	17.24	17.80	No Flooding
B6-SB2B	16.69	16.59	1.2	16.50	16.59	No Flooding
B6-SB2C	16.02	15.84	2.16	15.71	15.84	No Flooding
B6-SB2D	15.82	15.69	1.56	15.56	15.69	No Flooding
B6-SB2E	16.21	16.49	No Flooding	15.81	16.49	No Flooding
B6-SB2F	17.65	17.75	No Flooding	17.35	17.75	No Flooding
B6-SB3A	16.95	17.30	No Flooding	16.70	17.30	No Flooding
B6-SB3B	16.21	15.84	4.44	15.85	15.84	0.12
B6-SB3C	15.17	15.69	No Flooding	14.96	15.69	No Flooding
B6-SB3D	15.71	15.69	0.24	15.25	15.69	No Flooding
B6-SB3E	16.27	16.89	No Flooding	15.99	16.89	No Flooding
B6-SB4A	17.38	17.00	4.56	17.22	17.00	2.64
B6-SB4B	17.19	17.00	2.28	17.04	17.00	0.48
B6-SB4C	16.24	17.00	No Flooding	16.15	17.00	No Flooding
B6-SB5A	16.56	17.00	No Flooding	16.16	17.00	No Flooding
B6-SB5B	16.32	17.00	No Flooding	16.02	17.00	No Flooding
B6-SB5C	15.08	17.00	No Flooding	14.70	17.00	No Flooding
B6-SB6A	17.48	18.28	No Flooding	17.17	18.28	No Flooding
B6-SB6B	15.65	16.07	No Flooding	15.12	16.07	No Flooding
B6-SB7A	17.49	18.28	No Flooding	17.30	18.28	No Flooding
B6-SB7B	14.79	16.07	No Flooding	14.45	16.07	No Flooding
GFC	12.45	14.00	No Flooding	12.45	14.00	No Flooding
PRD	12.36	12.36	No Flooding	12.36	12.36	No Flooding
		Max Flood Depht (in)	6.96		Max Flood Depht (in)	2.76
		Min Flood Depth (in)	0.12		Min Flood Depth (in)	0.12
		Average Flood Depth (in)	2.13		Average Flood Depth (in)	1.50
		Sub-Basins Flooded	13		Sub-Basins Flooded	4

The proposed Condition – Max Discharge Structure Pipe Alternative scenario for Basin 6 utilizes three 36" discharge pipes onto the Goodlette-Frank system in place of the open swale. This alternative showed significant improvements from the existing conditions. Utilizing discharge pipes for the 25 year – 3 day storm event, showed flooding in 16 Sub-Basins which ranged from 0.36 to 11.04 inches above the crown of road, with an average of 4.34 inches. The 10 year – 3 day storm event showed flooding in 9 Sub-Basins with an average flood depth of 3.28 inches, ranging from 0.48 to 7.08 inches. The discharge rates for this alternative resulted in 95.20 cfs and 88.39 cfs for the 25 year and 10 year, 3 day storm events to the Goodlette-Frank system. The discharge rates to the Pine Ridge Drainage System resulted in 87.47 cfs and 72.32 cfs for the 25 year and 10 year, 3 day storm events. Table 18 below summarizes this alternative.

Table 18: Proposed Condition - Max Discharge (Pipe Alt.) Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Proposed Condition - Max Discharge (Pipe Alt.)			Proposed Condition - Max Discharge (Pipe Alt.)		
Node ID	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Min Crown of Road (Warning Stage) (ft)	Depth at Crown of Road (in)
B6-SB1A	16.85	16.76	1.08	16.48	16.76	No Flooding
B6-SB1B	16.73	16.66	0.84	16.39	16.66	No Flooding
B6-SB1C	16.48	16.66	No Flooding	16.19	16.66	No Flooding
B6-SB1D	16.39	15.69	8.4	16.08	15.69	4.68
B6-SB1E	16.61	15.69	11.04	16.28	15.69	7.08
B6-SB1F	16.80	16.49	3.72	16.45	16.49	No Flooding
B6-SB1G	17.46	17.75	No Flooding	17.09	17.75	No Flooding
B6-SB1H	17.95	17.92	0.36	17.50	17.92	No Flooding
B6-SB1I	17.81	17.78	0.36	17.38	17.78	No Flooding
B6-SB1J	17.98	18.05	No Flooding	17.52	18.05	No Flooding
B6-SB2A	17.51	17.80	No Flooding	17.24	17.80	No Flooding
B6-SB2B	16.69	16.59	1.2	16.44	16.59	No Flooding
B6-SB2C	16.42	15.84	6.96	16.10	15.84	3.12
B6-SB2D	16.32	15.69	7.56	16.02	15.69	3.96
B6-SB2E	16.57	16.49	0.96	16.21	16.49	No Flooding
B6-SB2F	17.65	17.75	No Flooding	17.35	17.75	No Flooding
B6-SB3A	17.06	17.30	No Flooding	16.68	17.30	No Flooding
B6-SB3B	16.54	15.84	8.4	16.08	15.84	2.88
B6-SB3C	16.04	15.69	4.2	15.77	15.69	0.96
B6-SB3D	16.31	15.69	7.44	16.00	15.69	3.72
B6-SB3E	16.42	16.89	No Flooding	16.15	16.89	No Flooding
B6-SB4A	17.38	17.00	4.56	17.22	17.00	2.64
B6-SB4B	17.19	17.00	2.28	17.04	17.00	0.48
B6-SB4C	16.24	17.00	No Flooding	16.15	17.00	No Flooding
B6-SB5A	16.56	17.00	No Flooding	16.16	17.00	No Flooding
B6-SB5B	16.32	17.00	No Flooding	16.02	17.00	No Flooding
B6-SB5C	15.08	17.00	No Flooding	14.70	17.00	No Flooding
B6-SB6A	17.48	18.28	No Flooding	17.17	18.28	No Flooding
B6-SB6B	15.65	16.07	No Flooding	15.12	16.07	No Flooding
B6-SB7A	17.49	18.28	No Flooding	17.30	18.28	No Flooding
B6-SB7B	14.79	16.07	No Flooding	14.45	16.07	No Flooding
GFC	12.45	14.00	No Flooding	12.45	14.00	No Flooding
PRD	12.36	12.36	No Flooding	12.36	12.36	No Flooding
		Max Flood Depht (in)	11.04		Max Flood Depht (in)	7.08
		Min Flood Depth (in)	0.36		Min Flood Depth (in)	0.48
		Average Flood Depth (in)	4.34		Average Flood Depth (in)	3.28
		Sub-Basins Flooded	16		Sub-Basins Flooded	9

The Proposed Condition – Same Discharge Structure scenario for Basin 6 utilizes two 18 inch and two 24 inch discharge pipes. The ICPR model for this scenario is summarized in Table 19 below. For the 25 year – 3 day storm event 14 Sub-Basins showed flooding which ranged from 0.24 to 9.00 inches above the crown of road, with an average flood depth of 3.57 inches. The 10 year – 3 day storm event showed flooding within 8 Sub-Basins with a flood depth ranging from 0.36 to 5.04 inches above the crown of the road, with the average of 2.13 inches. During this scenario, the discharge from Basin 6 to the Goodlette-Frank system during the 25 year and 10 year storm event resulted in rates of 127.07 cfs and 107.68 cfs, respectively. Discharge to the Pine Ridge Road stormwater system was 68.10 cfs and 60.41 cfs for the 25 year and 10 year, 3 day storm events. The discharge rate to the Goodlette-Frank system for this scenario increased by 58% and 51% for the 25 year and 10 year, 3 day storm events. Discharge to the Pine Ridge Road stormwater system increased by 36% and 37% for the 25 year and 10 year, 3 day storm events.

Table 19: Basin 6 Proposed Condition - Same Discharge Structure Results Summary

	25 Year - 3 Day			10 Year - 3 Day		
	Proposed Condition - Same Discharge Structure			Proposed Condition - Same Discharge Structure		
Node ID	Max Stage (ft)	Warning Stage (ft)	Depth at Crown of Road (in)	Max Stage (ft)	Warning Stage (ft)	Depth at Crown of Road (in)
B6-SB1A	16.82	16.76	0.72	16.40	16.76	No Flooding
B6-SB1B	16.69	16.66	0.36	16.30	16.66	No Flooding
B6-SB1C	16.38	16.66	No Flooding	16.07	16.66	No Flooding
B6-SB1D	16.14	15.69	5.4	15.83	15.69	1.68
B6-SB1E	16.42	15.69	8.76	16.07	15.69	4.56
B6-SB1F	16.66	16.49	2.04	16.27	16.49	No Flooding
B6-SB1G	17.45	17.75	No Flooding	17.11	17.75	No Flooding
B6-SB1H	17.94	17.92	0.24	17.51	17.92	No Flooding
B6-SB1I	17.81	17.78	0.36	17.40	17.78	No Flooding
B6-SB1J	17.98	18.05	No Flooding	17.54	18.05	No Flooding
B6-SB2A	17.50	17.80	No Flooding	17.24	17.80	No Flooding
B6-SB2B	16.68	16.59	1.08	16.48	16.59	No Flooding
B6-SB2C	16.21	15.84	4.44	15.87	15.84	0.36
B6-SB2D	16.05	15.69	4.32	15.75	15.69	0.72
B6-SB2E	16.39	16.49	No Flooding	15.97	16.49	No Flooding
B6-SB2F	17.65	17.75	No Flooding	17.35	17.75	No Flooding
B6-SB3A	16.95	17.30	No Flooding	16.70	17.30	No Flooding
B6-SB3B	16.26	15.84	5.04	15.87	15.84	0.36
B6-SB3C	15.07	15.69	No Flooding	14.90	15.69	No Flooding
B6-SB3D	15.64	15.69	No Flooding	15.20	15.69	No Flooding
B6-SB3E	16.34	16.89	No Flooding	16.05	16.89	No Flooding
B6-SB4A	17.41	17.00	4.92	17.25	17.00	3
B6-SB4B	17.27	17.00	3.24	17.11	17.00	1.32
B6-SB4C	16.60	17.00	No Flooding	16.48	17.00	No Flooding
B6-SB5A	16.53	17.00	No Flooding	16.14	17.00	No Flooding
B6-SB5B	16.31	17.00	No Flooding	15.99	17.00	No Flooding
B6-SB5C	15.81	17.00	No Flooding	15.21	17.00	No Flooding
B6-SB6A	17.48	18.28	No Flooding	17.17	18.28	No Flooding
B6-SB6B	16.82	16.07	9	16.49	16.07	5.04
B6-SB7A	17.49	18.28	No Flooding	17.30	18.28	No Flooding
B6-SB7B	15.55	16.07	No Flooding	14.94	16.07	No Flooding
GFC	12.45	14.00	No Flooding	12.45	14.00	No Flooding
PRD	12.36	12.36	No Flooding	12.36	12.36	No Flooding
		Max Flood Depht (in)	9.00		Max Flood Depht (in)	5.04
		Min Flood Depth (in)	0.24		Min Flood Depth (in)	0.36
		Average Flood Depth (in)	3.57		Average Flood Depth (in)	2.13
		Sub-Basins Flooded	14		Sub-Basins Flooded	8

3.7.5 RECOMMENDATIONS

After analyzing both the proposed and the existing conditions it is recommended that along with regrading and excavating of the roadside swales and upsizing of the existing stormwater interconnections and driveway culverts which provide both storage and conveyance that the Proposed Condition – Max Discharge Structure be used for this Basin. Because the existing discharge swale was used for both the existing and proposed models, discharge rates to the Goodlette-Frank system resulted in a 14% and a 9% difference for the 25 year and 10 year - 3 day storm events between both proposed conditions. Implementing the Max Discharge condition would significantly reduce the number of Sub-Basins flooding during a 10 year storm event from 8 to 4 as shown in Tables 17 and 18 above. These proposed changes are projected to have an initial cost of $1,371,000. Detailed cost information is included in Appendix D. The additional cost to enclose the swale would be approximately $175,000.

4.0 FINDINGS AND ADDITIONAL RECOMMENDATIONS

One of the goals of this preliminary analysis was to analyze the existing system to identify areas of concern. Based on the available data and assumptions as discussed in the previous sections, a model of the existing conditions for each of the six basins was developed to serve as the benchmark to evaluate the improvements resulting from the proposed conditions. After analyzing the 25 year and 10 year - 3 day storm events for the existing and both proposed conditions, it was apparent that the drainage system within the Pine Ridge Subdivision has a significant storage volume deficiency. This issue is pronounced within the basins that don't have any available storage such as lakes or canals and strictly rely on roadside swales to provide minimal storage. Therefore, to prevent frequent roadway flooding within the basins, larger discharge pipes must be installed resulting in greater discharge flow rates from each basin. It is recommended to excavate currently filled in swales and regrade most, if not all, of the existing swales to increase storage and provide consistent storm water conveyance within each sub-basin. Driveway culverts and storm interconnections should be upsized to meet modeled flow rates. Appendices A and B detail the existing conditions and recommended proposed condition, respectively, for each of the six basins covered in this report.

At the end of each section an estimate of the construction costs for the recommended alternative has been calculated. These planning level costs are listed below for comparison.

BASIN 1	$	1,435,000
BASIN 2	$	1,128,000
BASIN 3	$	644,000
BASIN 4	$	885,000
BASIN 5	$	2,972,000
BASIN 6	$	1,371,000
TOTAL	$	8,435,000

Research of available records indicates that both of the southernmost lakes within the Pine Ridge Subdivision are not owned by the County and based on available data and field visits there is no evidence of discharge to those lakes via swale or storm water pipes from the roadway swale system. For purposes of this study these areas were removed from the basin calculations and only County rights-of-way were

used for storage and conveyance of the stormwater in those areas.

Other items that need to be considered before implementation of any of the recommended solutions include the following:

- Possible storage for Basin 6 and additional review of the impacts of any additional drainage to the Goodlette-Frank Canal. Due to the many uncertainties regarding acquiring additional stormwater retention or storm sewer piping routes, we did not consider additional options for Basin 6. If the County was amenable to obtaining rights to utilize the lake at Pine Ridge and US41, and the calculations supported its use, the County could utilize this lake for additional storage within Basin 6 thus reducing the discharge rates to both the Goodlette-Frank and the Pine Ridge Road stormwater systems.
- The effect of the increase in discharge rates to the Goodlette-Frank canal have not been analyzed to determine what impacts there may be to downstream stormwater management systems that discharge to the canal.
- The Atkins Report from 2014 concludes that there may be a restriction to the Goodlette-Frank canal flow under Vanderbilt Beach Road. Resulting impacts from this capacity uncertainty have not been analyzed to determine if additional downstream improvements are required to fully realize the benefits of the proposed improvements.
- Other options such as using the FPL corridor on the east side of Goodlette-Frank Road or widening of the Goodlette-Frank canal for a regional storm water retention pond should be considered to reduce the peak flows within the Pine Ridge subdivision.

As evidenced by the number of swales that have already been filled, an important consideration is the effect that enclosed swales have on the function of the overall system. In simple terms, offsetting the reduction in the storage provided by a swale versus a piped system is important to consider. Conveyance can be addressed by properly sizing the piping to allow thru flow and inlets can be located appropriately to effectively convey surface water into the piped system, preventing surface flooding. The storage lost would be on the order of 2,000 cubic feet of storage per 100’ of ditch enclosed, depending on the required conveyance size in the particular area where the swale is located. This compensatory storage could be located elsewhere in the basin or by modifying existing lakes or ditches. The offset storage would need to be located such that it mimics the displaced storage or the model would need to be rerun to determine any cumulative effects.

Appendix A
Existing Conditions Exhibit

Appendix B
Proposed Conditions Exhibit

Appendix C
Typical Cross Sections

Appendix D
Opinion of Probable Cost